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Engineering Education for Smart Society

WEEF & GEDC 2016, Seoul

The World Engineering Education Forum &
The Global Engineering Deans Council, 2016

November 6-10, 2016

COEX, Seoul, Korea

Proceedings

Engineering Education for Smart Society

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C O N T E N T S

Selected scholarly papers which have star (*) in the presentation code will be published from Springer and journal of Engineering Education Research from Korean Society for Engineering Education.

Program at a Glance

Time	November 6, Sunday													Time
	Auditorium	300	301A	301B	307A	307B	307C	308A	308B	308C	E 5	E 6	E 1-4	
14:00-15:30				**SS06** How to Develop Higher Order Thinking Skill	**SS07** Engineering Pedagogical Education to Ensure the Quality of Engineering Education at Higher Education Institutions - The IGIP Prototype Curriculum	**SS08** Engineering Ethics Education in a Globalized World	**SS09** Engineering Education in the Gulf Cooperation Council Countries (GCC), The present & the Future							14:00-15:30
15:30-17:00														15:30-17:00
17:00-19:00	**Welcome Reception & GSF Closing Ceremony** (Hall E Lobby)													17:00-19:00

Time	November 7, Monday													Time
	Auditorium	300	301A	301B	307A	307B	307C	308A	308B	308C	E 5	E 6	E 1-4	
09:00~10:00	**Intergenerational Panel** (Hall E 5)													09:00~10:00
10:00~10:30	Coffee Break (Auditorium Lobby)												Exhibition/ Poster Session/ Coffee Break	10:00~10:30
10:30~12:00	**Opening & Keynote** (Auditorium)													10:30~12:00
12:00~13:00	Lunch													12:00~13:00
13:00~14:30	**PL01** (Auditorium)											**GEC**		13:00~14:30
14:30~14:40	Break													14:30~14:40
14:40~16:10		**Mo_EP_1***	**Mo_ED_1***	**Mo_IT_1**	**SS27** AEESEAP Workshop - Country Report -			**Mo_IE_1**	**SS10** Challenges, Barriers and Drivers for Partnerships Between Higher Education and Industry	**SS11** Gendered Innovations in Engineering Education	**SS01** Cyber Security for the Smart Society - An Extended Session Curated by Global Professional Services Firm Booz Allen Hamilton, in Partnership with GEDC & WEEF			14:40~16:10
16:10~16:40	Coffee Break					Coffee Break								16:10~16:40
16:40~18:10		**Mo_IT_2***	**Mo_ED_2**	**SS12** Student Voice and Action in Engineering Education		**CM06** KEDC General Assembly	**CM06** KEDC General Assembly	**SS13** Engineering meets Appropriate Technology	**SS14** Non-traditional Laboratories in Engineering Education	**SS15** Role of IFEES and GEDC in Catalyzing Transformations in Engineering Education in India				16:40~18:10
19:00~22:00	**GEDC Airbus Diversity Award Ceremony and Dinner** (Invitation only)													19:00~22:00

Simultaneous interpretation (Korean-English).
Complimentary shuttle bus service.

***CODE ABBREVIATION**

PL 01

- **Session order**
- **Session Type**
  - PL Plenary Session
  - SS Special Session
  - CM Committee Meeting
  - P Poster

Mo_EP_1*

- **Scholarly Presentation**
- **Session Order**
- **Topic**
  - EP Engineering Pedagogy
  - ED Engineering Diversity
  - IT ICT Education
  - IE Industry Engineering
  - EE Engineering Education
  - AE Advanced Education
  - CI Curriculum Innovation
  - ML Multidisciplinary Learning
  - PO Poster Session
- **Day**

Time	November 8, Tuesday													Time
	Auditorium	300	301A	301B	307A	307B	307C	308A	308B	308C	E 5	E 6	E 1-4	
09:00~10:10	**PL02** (Auditorium)													09:00~10:10
10:10~10:40	Coffee Break													10:10~10:40
10:40~12:10		**Tu_EE_1***	**Tu_AE_1***	**Tu_ED_3**	**CM01** AEESEAP	**SS16** Inclusive Engagement - Engineering for All	**SS17** Human-Centered Convergence Education		**CM02** GEDC General Assembly					10:40~12:10
12:10~13:20	Lunch													12:10~13:20
13:20~14:30	**PL03** (Auditorium)													13:20~14:30
14:30~14:40	Break													14:30~14:40
14:40~16:10		**Tu_CI_1***	**Tu_ML_1***	**Tu_ED_4**	**SS18** Study/Research/ Work opportunities for graduate students in Engineering Education	**SS19** Preparing Global Engineers for the Next Century	**SS20** 3D Printing and Education		**CM03** IFEES General Assembly		**SS02** Advanced Manufacturing -Challenges and Opportunities for Engineering Education	**GEC**	Exhibition/ Poster Session/ Coffee Break	14:40~16:10
16:10~16:40	Coffee Break													16:10~16:40
16:40~18:10		**SS22** Presidents Round Table	**SS 21_1** Corporate Partnership with University	**SS 21_2** Corporate Partnership with University	**Poster Presentation**									16:40~18:10
19:00~21:00	**Gala Dinner**													19:00~21:00

Time	November 9, Wednesday													Time
	Auditorium	300	301A	301B	307A	307B	307C	308A	308B	308C	E 5	E 6	E 1-4	
09:00~10:10	**PL04** (Auditorium)													09:00~10:10
10:10~10:40	Coffee Break													10:10~10:40
10:40-12:10		**We_ML_2***	**We_IE_2***	**We_EE_2**	**We_EP_2**	**SS23** Building Inclusive Learning and Working Environments for LGBTQ Engineers	**SS24** Korea-Kazakhstan -Germany Engineering Education				**SS03** GEDC - Top Tips Session			10:40-12:10
12:10~13:20	Lunch													12:10~13:20
13:20~14:30	**PL05** (Auditorium)													13:20~14:30
14:30~14:40	Break												Exhibition/ Poster Session/ Coffee Break	14:30~14:40
14:40~16:10	**SS25** 2016 Global University Industry Cooperation Forum	**We_EE_3***	**We_ED_5***	**We_AE_2**	**CM05** IFEES Executive Committee Meeting	**We_IE_3**	**SS26** Publishing Successfully in the IEEE Transactions on Education				**SS04** Resilience and Sustainability - Smart Communities, Big Questions			14:40~16:10
16:10~16:40		Coffee Break												16:10~16:40
16:40~18:10		**We_EP_3***	**We_ML_3**	**We_CI_2**		**We_AE_3**					**SS05** GEDC Global Grand Challenges Scholars Program Workshop			16:40~18:10
19:00~22:00	**IFEES Awards Dinner & 10th Anniversary Celebration Supported by Total** (Invited only)													19:00~22:00

Time	November 10, Thursday
	Kintex
11:00~12:30	**E^2FESTA Opening Ceremony**
13:30~14:30	**E^2FESTA**
14:30~16:30	**PL06** (303+304)
16:30~17:30	**Closing Ceremony** (303+304)

Time	November 11, Friday
	Industry Tour
08:30~13:00	Samsung Innovation Museum & Samsung Advanced Institute of Technology

Simultaneous interpretation (Korean-English).

Complimentary shuttle bus service.

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- **Day**

Mo_EP_1*_1

A quantitative study of the role of active learning and engagement in improving environmental engineering students' learning performance

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Abstract : *The objective of this study was to identify and quantify the key mechanisms through which active learning can enhance the students' level of engagements as well as their learning performance, in the context of environmental engineering. Despite the limitations of the small sample size, positive relationships were observed between active learning, engagement and learning performance.*

Keywords : *active learning; evaluation methodologies; improving classroom teaching; intelligent tutoring systems; interactive learning environments; learning communities; teaching/learning strategies*

INTRODUCTION

A primary reason for the attrition of students from engineering is their perception of a learning environment that fails to motivate them and is unwelcoming [1, 2]. There is an obvious connection between motivation and engagement. It is therefore important to keep the students attention high by keeping the learning experience fresh. This can be achieved by creating an active learning environment, revolving around the use of information and communications technology (ICT), e.g., with classroom response systems (clickers), computer-based tutorials, scaffolded mini-projects [3]. However, there is a lack of quantitative studies that relate the impact of active learning to engagement and students' learning performance [4]. Furthermore, there is a need to obtain more data in an Asian context and for environmental engineering students, so as to cover a broad range of educational context and disciplines.

OBJECTIVES

Addressing the gaps described above, the objective of this study was to identify and quantify the key mechanisms through which active learning can enhance the students' level of engagements as well as their learning performance, through the elaboration of a conceptual framework (Fig 1a). We hypothesize : (H1) active learning improves students' engagement; (H2) active learning improves students' learning performance; (H3) engagement improves students' learning performance.

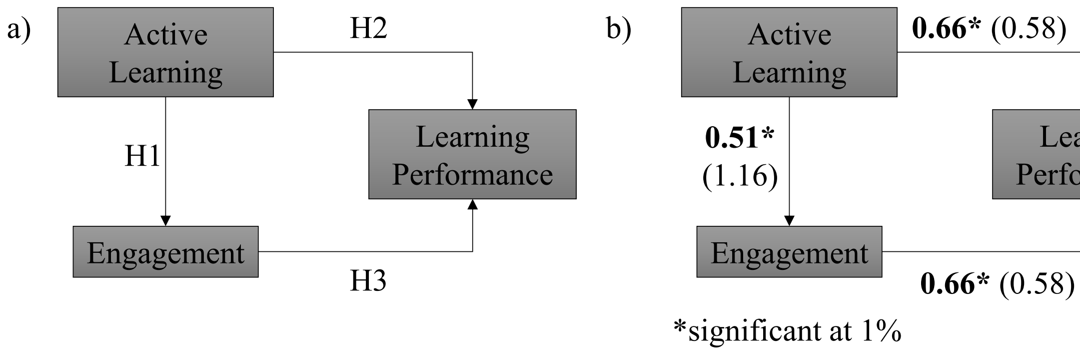

Fig 1a) Conceptual framework; b) Structural equation modelling (SEM) results for the proposed model

METHODS

Three ICT-based active learning activities were implemented in an environmental engineering undergraduate module. First, clickers' quizzes were interspersed alongside lecture material; Second, hands-on sessions on online climate models were incorporated into the tutorials and third, students were given a project for which they were assessed based on a video presentation. An anonymous survey was administered to the students comprising 19 items adapted from the literature [4-8]. Data reliability and validity was verified by confirmatory factor analysis (CFA) using the robust maximum-likelihood estimation method and then the proposed model was tested by structural equation modelling (SEM).

RESULTS

The questionnaire was used to extract 9 factors and these were divided into 3 constructs, namely active learning, engagement and learning performance (Table 1). First, the model was validated by CFA, based on the standardized loadings, R2 coefficients, composite reliability coefficient (CRC) and the average variance extracted (AVE). Next, the structural relationships were tested in the model with the help of LISREL (Fig. 1b). The numbers in bold represent the structural coefficients for significance level at 1% and the values in brackets correspond to the t-values. The structural coefficients for significance level at 1% (in bold) indicate a positive relationship between active learning and learning performance, active learning and engagement and engagement and learning performance, providing support for H1, H2 and H3. A limit of the study is shown in the small t-values (in brackets), which was attributed to the small sample size (Class size of 60 and questionnaire response rate 62%).

CONCLUSION

The CFA indicated that our constructs were well defined with high correlations among the individual items included in these constructs. Positive relationships were observed between active learning, engagement and learning performance. The full paper will showcase our efforts to improve our statistical data for small data sets by using the analysis of variance (ANOVA) and bootstrapping [9].

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Table 1 Constructs, Items and CFA results

Constructs and Items	Standardized factor loading (>.60)	R2 (>.50) Coefficient of determination	AVE* (>.50)	CRC** (>.70)
Active Learning	0.87			
AL_1. Freedom to participate in one's own learning	0.96	0.91	0.83	0.93
experience				
AL_2. Feedback from classmates	0.93	0.86		
AL_3. Creating one's own learning experience	0.84	0.70		
Engagement				
ENG_1. Lecture sessions	0.91	0.83		
ENG_2. Tutorial sessions	0.90	0.80	0.82	0.85
ENG_3. Video format	0.90	0.80		
Learning Performance				
LP_1. Helpfulness of tutorial problems	0.86	0.83	0.65	0.87
LP_2. Helpfulness of online tutorials	0.93	0.80		
LP_3. Helpfulness of projects	0.60	0.80		

Mo_EP_1*_2

A STUDY ON ENGINEERING STUDENTS' MOTIVATION TOWARDS COMPUTER PROGRAMMING

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Abstract : *Computer programming course is considered as one of the most challenging courses in engineering. This course has the reputation of being difficult and demotivating. Therefore, a study has been conducted to explore engineering students' motivation in learning computer programming. The lenses of principles used in this study are learner-centred and knowledge-centred principles based on How People Learn framework. The study was conducted through observation and interview methods for one semester. The results have shown that, students require instructors' consideration on their background and needs to motivate them. Also, the computer programming should be introduced in a more contextualized way. Applications of computer programming have grabbed the students' interest towards the subject. Hence, both of the principles were found as equally important in a computer programming class.*

Keywords : *Motivation, Computer Programming, Student-Centred Learning, Knowledge-Centred Learning*

INTRODUCTION

The 21st century challenges have addressed computer programming as an important skill and knowledge for future engineers. Therefore, computer programming is considered as compulsory in engineering curriculum. Engineering students however, found computer programming as a difficult and demotivating subject. This has also leads them to not pursue computer programming in their future tasks and career. In an effort to improve an introductory computer programming course, a study has been conducted by valuing students' perception and learning experience.

OBJECTIVES

A concern about engineering students' learning in a computer programming subject is their motivation. Therefore, this study was conducted to investigate engineering students' motivation to learn computer programming. In investigating learners' motivation, it is essential to understand the learning environment. An effective learning environment can be explored through various lenses of principles as introduced in How People Learn framework by Bransford et al. (1999). Parts of the principles are the learner-centred and knowledge-centred learning environment.

METHODS

The studied samples were eighty-six (86) first-year engineering undergraduates in introductory computer programming classes. The students were observed in their classes for fourteen (14) weeks of lesson. Later, ten (10) students were interviewed to gain their experience and perception on their learning and motivation.

RESULTS

Learner-centred element in the classroom was found as crucial to engage and motivate engineering students in learning programming. The important aspect in a learner-centred principle is valuing students' prior knowledge about computer programming, the students' difficulties in learning computer programming, the students' preferences in learning styles and the students' sources of motivation. Most of the students found programming as difficult because of limited knowledge on computer programming. As for the preference in learning, group discussion was found as more motivating than an individual learning. Rewards and satisfaction were also found to motivate the students in learning programming. The rewards are such as good grades, parents' satisfaction, task satisfaction and peers' acknowledgement.

On the other hand, a knowledge-centred principle was found as important for creating contextualization in a computer programming class. Contextualization develops students' interest on computer programming thus motivates them to learn. Such as, a course project consists of a real-world problem and solution. Students are also found to be motivated on knowing the real application of computer programs in their daily life and future career. Instructors' understanding in the subject area also motivates the students. Instructor's knowledge on students' background, the instruction, the instructors' credibility in the subject area and utilization of the course's material in learning were found to be the emerging themes. These findings also revealed that part of the knowledge-centred principle; it is also falls in learner-centred principle. For instance, the students' difficulties on the subject matter.

CONCLUSION

The study has concluded that students' perception and experience is important to improve a learning environment. The results also raise the needs for computer programming instructors' to consider several learning environment principles when devising the course's pedagogical approach and activities.

REFERENCES

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Mo_EP_1*_3

THE EMPIRICAL RESEARCH ON HUMAN KNOWLEDGE PROCESSING IN NATURAL LANGUAGE WITHIN ENGINEERING EDUCATION

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Abstract : *The state-o-the art of the computer supported or enhanced teaching and learning processes is mostly focused on a content acquisition, processing, and management, virtual learning environments, learning analytics, educational data mining. There is an absence of such approaches which are based on knowledge exchange between machines and humans in knowledge based processes. This paper just describes such approach. Within an empirical participatory action research on technology-enhanced learning the issue knowledge is understood as a key element of any automation of human knowledge processing. So, teaching is considered as a typical knowledge based process. Some examples of such solutions are briefly mentioned.It is also emphasized that a complex computer supported collaborative learning requires in the real practice to solve combined pedagogic(didactic) and informatics research.*

Keywords : *Human knowledge processing, technology enhanced learning, computer supported collaborative learning, human computer interactions, engineering education*

INTRODUCTION

Despite of the huge progress of ICT there is still an absence of computer support of teaching and learning. It is especially on personal level of a teacher or students in relation how to exchange human knowledge flow between humans and machine (computer). This is due to the fact that this processes operate with knowledge, which are from informatics point of view considered as uncertain processes working with unstructured heterogeneous data. So, to write computer programs as an abstract of real world is very hard problem. In the case of teaching process, there is a need to share such data (human knowledge) between teacher and many students. In addition, a flow of knowledge must be provided in a appropriate pedagogical (didactic) quality, in real or synchronized time (classroom, at home, online), moreover within a limited time of teaching hour. Thus, logically these processes must be automated. However, in comparison with automation of a technical system, which produces a product with required technical parameters, hence the teaching is a process within a living system, nobody can guarantees that students were optimally educated, even whether they will understand the pedagogical/content knowledge or be able to use the learning knowledge in real practice. The following text illustrates on some examples how these limitations are solved within a long-term empirical research, i.e. how a processing human knowledge via computers works within the engineering teaching of bachelors.

OBJECTIVES

Our research is aimed at a complex all-in-one solution of automation of teaching and learning with focus on all kind of processes performed by a teacher as the key player, in order to assure its sustainability as a knowledge worker, who manages the human knowledge based processes. Such automation should also enlarges his cognitive skills and mental activities in order to work as a "mental prosthesis". This covers all categories of teaching. Actually, a focus is on the computer supported collaborative learning, that requires pedagogical and informatics research in parallel, including development or innovation of informatics tools, specific software (all-in-one application using a natural language), which is machine readable as well. A specific goal is on programming the communication, feedback, and mass knowledge production, processing, transfer and utilization within the teacher's daily teaching.

METHODS

Our research, which is performed under an umbrella of technology enhanced learning, represents a typical empiric participatory action research. Within the long-term research a system solution was build, i.e. personal virtual learning environment, virtual learning space with tutorials, calculation tools, communication channels for each study program (background of environmental protection, chemistry, programming languages, integrated safety), including writing own all-in-one beta software WPad for mass human knowledge processing (the application is installed on the each classroom's computer, or students notebooks). Actually a teacher's cloud application is tested, especially a transfer of knowledge between computers, cloud, faculty's server and network. For this purpose, the utility model is used, which is related to a system of processing of unstructured data via using a specific data structure - this is just the "switcher" between humans and computers which enables one to perform the mass knowledge processing (it is a part of the registered utility model Nr. 7340 by a national patent office 12/2015). This infrastructure is now used for combined pedagogical and informatics research for computer supported collaborative learning (CSCL) in order to model knowledge exchange and sharing.

RESULTS

Due to the long-term research there are some categories of results : (1) pedagogical - unification of content and teaching processes to be computerizable, e.g. research on CSCL methods within modelling the writing semester work, incl. producing a shared additional teaching material directly by students, (2) informatics – adaptation, personalization, development of IT applications, knowledge transfer via network and cloud, synchronization of blended learning, knowledge base building, the utility model, (3) integrated outputs into daily teaching - CSCL cases of study (automation of writing semester works, model of teaching the programming languages, additional training materials from chemistry created by students for students), diploma works which were tested for production of eLearning materials by pre-service teachers, or information systems for technological purposes.

CONCLUSION

The presented empirical research on technology enhanced learning is based on the collaboration of humans and computer via a specific data structure, which works as a virtual knowledge unit. Teacher and students input their knowledge into this unit, that is controlled by an all-in-one software. The transfer of knowledge between hardware and software systems (cloud, classroom computers, students' notebooks, wifi, networks) is performed according to the above mentioned utility model. This is a optimal background for modelling the knowledge exchange and sharing within solving the CSCL.

According to the latest results, it seems, that the number of actions related to a one content item requires to solve plenty of actions related to number of paths, instructions and cognitive activities (communication, feedback). This is a challenge for an idea of educational robot or intelligent system.

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Mo_EP_1*_4

IT Trends in European Technology Education : Students' Perspective

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INTRODUCTION

Living in the era of digitalization, the set of valuable skills is being redefined, and digital literacy is raising its importance, as well as the application of Information and Communications Technology (ICT) in numerous educational contexts. Higher education institutions are vital actors in the production of labor force and the definition of academic credentials are changing rapidly nowadays [1], in order to face the new market and social demands marking the course towards development. Thus, the current technological progress has introduced technology and its services in higher education, including an "abundance of resources and relationships [made] easily accessible via the Internet" [2].

However, judging from the importance of higher education, the emergence and exponential course of the new technological trend in learning is regarded at least as detrimental. Nevertheless, online and distant learning supporters are increasing, while the general impact of technology in tertiary studies is perceived as positive [3], even in a traditionally 'in person' educational area, such as Engineering. Consequently, the awareness of the technological benefits and looming drawbacks should be acknowledged and discussed to provide further solutions in the issues emerging from the application of technology in learning. This paper presents the engineering students' view on these new upcoming learning styles and the effect on their education as well as the impact on their university's curriculum.

Board of European Students of Technology (BEST) is a non-profit, non-governmental student organisation consisting of more than 3500 internationally minded engineering students from 33 countries. With 96 Local BEST Groups in universities, BEST is increasing its student dynamics, providing high quality services for more than 1.3 million engineering and technology students. The organisation focuses on complementary education, career support and educational involvement, through which it aims at developing students. BEST is keeping students aware of educational matters and promotes students' opinions to other higher education partners.

MATERIALS AND METHODS

Events on Education (EoEs) are organised by BEST in order to establish a discussion platform between higher education stakeholders. EoEs are events where students, academics and company representatives meet to discuss topics related to education. The main goals of this type of events are making the students' voice heard through the exchange of opinions and experience and increasing their involvement in education.

EoE Bratislava gathered 21 technology students from all over Europe to discuss the topics "Teaching with Technology and Learning Styles". Firstly, university and company representatives presented an overview of existing Information Technology (IT) systems and their use in educational processes such that participants were able to analyse new technological trends and their influence on the learning process. Afterwards, participants' opinions and ideas were collected by means of discussions, debates and other sessions facilitated by members of the Educational Committee of BEST. The facilitation methods included

Brainstorming, Learning Café, Fishbone diagram, SWOT analysis, Debate and Reversal. The outcomes of the EoE were analysed at the end of the event and all the information was translated into a report.

RESULTS

During EoE Bratislava innovative concepts in educational technology were analysed [4]. More specifically, the students evaluated the main advantages and problems related to Virtual Exchange Programs, Open Access materials and Remote Labs. These contemporary concepts were considered very interesting and bearing great potential for the student's academic development. Also Open Source Social Networks (OSSN) were investigated and suggestions for improvement were made. For example, participants emphasized the importance, for both open source and social networks, of being user-friendly and having powerful search and content upload options, an attractive design and high-quality contents. They also suggested elements to improve OSSN such as an international collaboration, expert verification and the implementation of a rating system.

Despite the overall enthusiasm, students were also worried about safety when using the internet for educational purposes. Inter alia, they fear incorrectness of information, poor maintenance of the platforms and a lack of motivation for active students' participation and teachers' involvement.

In general, the use of IT in education was thus evaluated as a powerful, but risk-bearing trend. EoE Bratislava's participants shared their concerns regarding the reliability of sources, the validation of users and content, security, maintenance and infrastructure and real-life contact.

Finally, also the effect of using IT systems on students' cognitive development was analysed. An imminent side effect of easy and fast access to knowledge was found to be lazy behaviour and superficial learning. Participants agreed that more traditional resources such as books and face-to-face interaction with professors and tutors remain necessary for in-depth comprehension and cognitive development.

CONCLUSION

In order to plan changes in education due to Information Technology, students have been able to give specific input on how valuable but risk-bearing those changes can be. Yet they are crucial for the improvement of today's engineers. IT in university thus shows high potential if its implementation respects the students' and teachers' needs.

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Mo_EP_1*_5

Integrating and Leveraging Fundamental Technical Skills in Industry Sponsored Capstone Courses

T. H. DeAgostino & **R. L. Dougherty**

Mechanical Engineering at the Kansas

Senior Design (SD), or Capstone, ranges across the spectrum as to how it is taught at various universities. Regardless of location in that spectrum, SD's purpose is to give the students an experience which envelopes as much as possible of the students' technical education while emphasizing the aspects of : producing a product, planning, team work, overall design process/procedure, societal concerns, economics (covering all types of resources, including the environment), safety for all (product users and non-users, manufacturers, etc.), and ethical behavior in all phases of the engineering profession. Most of these aspects are encompassed in the ABET-guided approach to engineering education.

One method of delivering these messages to the students is to use faculty-developed projects which carefully and specifically address each of the SD aspects. If the projects are properly 'designed', they exercise the students in every area of interest, in which students need experience. However, such projects can also 'feel' fictitious and unrealistic to students, may not be embraced by students, and limit student engagement. Education is the main thrust here, and a product is very secondary. An alternate approach is the use of 'outside' Sponsors of the projects. Such projects typically do not involve all areas of design, leaving out, for instance, the environment or consumer purchasing issues. Contrary to the first method, these types of projects involve final products which may be quite important to the Sponsors. Certainly education is of high importance, but a final product is of relatively equal value - - which actually can indeed be another 'educational' aspect of SD. In 'real life', the final product is extremely important. Thus, the results are not just academic in nature (meaning only applicable for a course grade), but are actually used by the Sponsors to meet specific needs of industry and society.

These two methods have strong tradeoffs, but clearly involve different metrics for success, as well as different overall views of SD and its goals. The authors have been involved in the application of both methods/approaches, and will provide more information on both in the full paper. However, they have found that the second approach appears to 'resonate' best with students, giving those students a strong SD experience which puts them in a most desirable position for the next stage in their engineering careers. Thus, the second method will be the main focus of the full paper, which helps to ensure that engineering fundamentals and the leveraging of technical skills are not abandoned by students.

First Approach : The first approach involves faculty members developing a project which, based upon their experience in academics and industry, would be similar to projects that engineers would face when working in an industrial environment. These projects are designed to include ALL aspects of the design procedure, so that the students see how each design step is taken and achieved. Such projects differ from those provided by industry Sponsors, since typical industry-sponsored projects do not encompass ALL aspects of design. So, industry-sponsored projects may leave out valuable experiences for the students. However, since first-approach projects are 'made up', students may have more difficulty taking these projects seriously - - thus, not immersing themselves in the work. In addition, 'academic' (first approach) projects do not necessarily have a 'final product' goal, but [rightly] focus on education - - learning the design process. But these 'academic' projects may actually 'back fire', because, in the 'real world', the final product is the main focus (with the understanding that cost, manufacturability, safety, ethics, etc. must be included). So, the second approach seeks to balance the academic need for learning the design process with the 'real world' need to produce a functioning viable product.

Second Approach : Thus, in the second approach [used here], the 'balance' between academic and industry needs is struck through the use of two faculty members who stress these two major aspects of the design process.

While utilizing industry sponsored projects enables a greater degree of "reality" and applicability for students, two advisors with differing backgrounds, each of which emphasizes different aspects of an engineering project, can be highly successful in ensuring that fundamentals and technical skills are not abandoned in pursuit of a practical solution to the projects focus. The two advisors serve different roles :

1. An industry experienced faculty member to serve as "project manager"
2. A technically skilled academic researcher to serve as "technical advisor"

In addition, the Sponsor serves the extremely valuable role of being the Client, who wants academic skills, but also wants a final product for its customers - - or at least a product that clearly shows how the Sponsor should proceed in developing that marketable product.

This serves more than just the purpose of ensuring timing is met and theory is not forgotten. It also requires the students to trade off the conflicting demands of "two bosses" and a Client, and learn to make ambiguous priority decisions in the accomplishment of their project. In the increasing complexity of engineering in industry, it is quite common for engineers to be ensconced in a matrix organization, with the very real prospect of trying to appease at least two constituencies, if not more.

The complete paper will provide :

- Details of the process used at this university
  - o Examples showing both successes and less successful outcomes
  - o Recommendations for changes to improve outcomes
- An explanation of both advisors' roles
  - o How the two roles intersect
- How sometimes ambiguous and conflicting direction actually serves students well
- How students can be allowed to founder periodically, and when all else fails, return to using actual engineering to solve the "Problem"
- Examples as to how students have responded to the 'two-advisor-and-client' direction
  - o How students have been encouraged [and required] to focus energy/time on all three aspects : academic learning, project accomplishment, and the final product

The two advisors work together to guide the students in balancing the conflicting demands, and ensuring that students can respond and react to the natural ambiguity, as well as the designed ambiguity.

Mo_ED_1*_1

PERCEPTION OF COMPLEX ENGINEERING PROBLEM SOLVING AMONG ENGINEERING EDUCATORS

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Abstract : *According to the Washington Accord, skills to solve complex problems in engineering are important in the curriculum of engineering education. Some of the attributes of complex problem solving in engineering include no obvious solution and have many parts or sub-parts, require in-depth engineering knowledge, involve wide area of issues in engineering and a diverse group of stakeholders. To fulfill the accreditation exercise, engineering educators must be able to design complex engineering problems to assessment the learning of this important skill. Therefore, this research was conducted to explore what do engineering educators perceived as complex engineering problems and how did they design these problems in order to foster this skills among their students. A focus group discussion was conducted among 12 engineering educators. The audio recording was transcribed and analysed qualitatively. The result shows that only one engineering educator understands complex engineering problems and most of the attributes. The other were not able to tell more than three of the attributes. Therefore, in designing complex engineering problems, most of them did not fulfill the attributes of complex engineering problems. As a conclusion, training on the attributes of complex engineering problems is needed to ensure that the teaching and learning of engineering programmes fulfill the accreditation criteria.*
Keywords : *complex engineering problems, problem solving, accreditation*

INTRODUCTION

The grand challenges of the 21st century require human race to solve problems and face uncertainties that we have never faced before. According to World Economic Forum [1], the top most important skill for the fourth industrial revolution by 2020 is Complex Problem Solving. Therefore, it is ever more demanding to have competent problem solving skills to survive in this century. Students must equip themselves with abilities to think critically, creatively and solve problems at all level of education especially at the tertiary level. Moreover, engineering students are required to have the skills in knowledge acquisition, synthesis, reasoning, problem analysis, operation and evaluation [2]. Hence, engineering students should be able to deal with and solve complex problems.

In order to produce engineers with the ability to solve complex engineering problems, engineering educators must be able to design complex engineering problems to assess the acquisition of the skill. This means that engineering educators must know the attributes of complex engineering problems. According to the Washington Accord [3], complex engineering problems are problems that :

a. Cannot be resolved without in-depth engineering knowledge.
b. Involve wide-ranging or conflicting technical, engineering and other issues.

c. Have no obvious solution and require abstract thinking and originality in analysis to formulate suitable models.
d. Involve infrequently encountered issues.
e. Outside problems encompassed by standards and codes of practice for professional engineering.
f. Involve diverse groups of stakeholders with widely varying needs.
g. High level problems including many component parts or sub-problems.

OBJECTIVES

This study seek to identify the understanding of engineering educators on the attributes of complex engineering problems and how they design the problems.

METHODS

Focus group discussion was conducted among 12 engineering educators. They were interviewed on what they understand about complex engineering problems and how they design the problems to assess their students. The discussion were video recorded. The discussion was transcribed into texts for analysis. The data was analysed quantitatively using the method introduced by Mills and Huberman [4].

RESULTS

The result shows that only one engineering educator can tell most of the attributes of complex engineering problems. The attribute mentioned the most is that in-depth engineering knowledge is needed to solve the problems. Then, it was followed by the problems involve infrequently encountered issues. And finally, the problems have many sub-problems, or they are complex in nature. The rest of the 11 engineering educators can only tell no more than three attributes of complex engineering problems.

With minimal understanding of the attributes of complex engineering problems, some engineering educators cannot explain how they are able to design complex engineering problems. Most of them refer to the learning outcomes when designing complex engineering problems because they believed that complex engineering problems must involve in-depth engineering knowledge and sometimes, knowledge out of the syllabus.

CONCLUSION

Therefore, it is important for the institution to give training and educate the engineering lecturers on the attributes of complex engineering problems so that they can design engineering problems that can be used to assess complex problem solving skill in engineering. This will ensure that the engineering programme meet the accreditation requirement and produce engineers with the skill needed to meet new challenges in the future for the survival of mankind.

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Mo_ED_1*_2

PROGRAM OUTCOMES FRAMEWORK AS SEEN BY EUR-ACE AND BY CTI IN THE CONTEXT OF QUALITY ASSURANCE PROCESS

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Abstract : *In Europe, ENAEE has created since 2005 a frame concerning engineering education : the EUR-ACE label. This frame is now extending to other continents such as Asia and Africa. The agencies authorized by ENAEE to deliver EUR-ACE Label have, amongst other points, to prove they satisfy criteria concerning the learning outcomes of their graduates. The paper will present how the items of the two accreditation systems are fully compatible.*
Keywords : *EUR-ACE, CTI, Learning Outcomes, engineering education*

INTRODUCTION

In France Engineering education exists only at Master's level; since 2005 we have defined the learning outcomes that are those of an engineer at this level. However this framework changes every 3 or 4 years because society and engineers are changing. In February 2016, 14 competences have been considered by CTI as necessary as well by academic people as by people from industry -CTI is a joint agency between academy and profession-. CTI is at this moment authorized to deliver EUR-ACE label. In 2015 ENAEE had a strong debate about the evolution of its own criteria [1]. We want to show how CTI's criteria [2] fulfill these new requirements. At this moment ENAEE is working together with IEA, they have already defined Best Practices and now they are comparing their criteria [3]. The work we present is really important because CTI, at this moment, has common discussions and reflections with ABET, and the characteristics that make criteria common are fundamental.

OBJECTIVES

When ENAEE authorizes an agency to award EUR-ACE label, its first demarche is to observe the process the agency uses to evaluate institutions : the reference books describing accreditation criteria are studied and their application during visits are observed.

METHODS AND CRITERIA

Program Outcomes describe the knowledge, understanding, skills and abilities which an accredited engineering degree program must enable a graduate to demonstrate. These Program Outcomes have to be considered as the 'minimum threshold' defined by the ENAEE community and to be fulfilled in order to assure the quality of engineering programs.
The Program Outcomes can be used in both the design (by engineering academics) and the evaluation (by accreditation agencies) of programs in all branches of engineering and for different profiles.
The standards describe the Program Outcomes that accredited programs must meet, but do not prescribe how they are realized. Consequently, no restriction is implied or intended by the EAFSG in the design of programs to meet the specified Program Outcomes. HEI's retain the freedom to formulate programs with an individual emphasis and character, including new

and innovative programs, and to prescribe conditions for entry into each program.

The Program Outcomes are described separately for both Bachelor and Master Degree programs with reference to the following eight learning areas :

Knowledge and understanding; Engineering Analysis; Engineering Design; Investigations; Engineering Practice; Making Judgments; Communication and Team-working; Lifelong Learning.

Concerning CTI criteria, their ordering is different and at the first glance, seem to be not very coherent with the previous ones because they are ordered in 3 different themes.

The six first criteria concern the acquisition of technical and scientific knowledge and the mastery of their implementation :

1 The knowledge and understanding of a large field of fundamental knowledge and the analysis and synthesis skills associated
2 The ability to mobilize resources of a specific scientific and technical field
3 The mastery of tools and methods of engineer : identification, modelling, and problem solving, even if those are incompletely defined or unfamiliar, the use of computer based tools, analysis and design of systems
4 The capacity to design, make concrete test and validate solutions, methods, innovative products, systems and services
5 The capacity to lead researches as well fundamental as applied, to implement experimental devices, to be open to collaborative practices for job
6 The ability to find pertinent information, to evaluate its quality and to use it

The second chapter concerns the adaptation of graduates to the constraints of companies and society :

7 The ability to take into account the issues of the companies
8 The ability to take into account the issues of relations at work, ethics, responsibility, safety and health at work
9 The ability to take into account environmental issues
10 The ability to take into account issues and needs of society

Finally, the third chapter takes into account the organizational, personal and cultural dimension

11 The ability to insert in professional life, to integrate in an organization,
12 The ability to undertake and innovate either in the frame of personal and professional experiences
13 The ability to work in an international context
14 The ability to be self-aware, to make self-assessment, to manage skills

CONCLUSION

The paper will present item by item how criteria match to one another : a strict comparison is not here the good solution. An observation of CTI criteria with regards to the CDIO system would also be of interest to compare those two systems.

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Mo_ED_1*_3

Engineering challenges in term of academic and professional training

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Abstract : *This article aims to present a new profile of the engineer based on a thorough analysis of the current world, which includes as main topics : the high demands of professional training from the companies, the ability to raise sustainable solutions that solve current problems, ability to cooperate efficiently in an environment of multidisciplinary and peer work, the ability to grow as a leader and guide to address the socio-economic landscape at regional and global level, the ability to project into the future to anticipate potential problems and generate improvements techniques, the need to handle and keep abreast of the latest technology, the requirement to have a responsible attitude to the environment, and especially the promotion of research which with perseverance have brought humanity to discover and develop important aspects of current knowledge.*
Keywords : *Current engineer profile, skills, abilities, today.*

I. INTRODUCTION

The notion of the word engineer that currently circulates is that of an individual especially designed for the manufacturing industry, where its main function is to create, design and optimize, consumer products, processes, services and machinery. However, culminated college career as an engineering student, this applies for such positions as research groups, head of areas where the application of technologies in administrative processes is needed, and perhaps also in participating actively in training and implementation of policies. Therefore, it presents the urgent need for an engineer to work jointly with professionals from other disciplines, and with the local government as a result of the complexity of our problems and consider in their actions social, technical, scientific, economic and environmental factors, think globally, act with a view to the future and resolve the root problems considering the challenges posed by technological change.

II. REQUIREMENT OF VOCATIONAL EDUCATION

Based on the literature review, can be emphasized the statements made by the head of the World Bank for Latin America and the Caribbean, November 2013, which highlights the lack of engineers noting that Latin American companies introduce new products less frequently than other similar economies and invest in research and development less than 0.5% of GDP average, which represents a third of the level of China and a quarter of the high-income countries. For the Forbes magazine for Mexico is not to increase the number of engineers, but committed and interdisciplinary professionals.

In this context, the question arises : Are there few engineers today? We are part of a society in constant learning and immediate access to information, but with little development of professional skills as the ability to write correctly, or social, as behaving in a meeting, skills considered in selecting a suitable candidate. In this sense, the problem is not a lack of engineers, but the weak development of skills.

III. ADDRESSING CAPACITY

An engineer does not have absolute freedom to choose the problems that he finds interesting he should propose solutions to everything that he is presenting. Knowing that these solutions must meet requirements "than in many cases" are contradictory and in conflicts. He must provide a reliable answer within a range of feasibility that complies with the most relevant, and where generally the cost excels, due to, restrictions because it costs money to be efficient. Therefore, the solution of an engineer consists in the optimal solution, result in which all parameters have been considered.

In this sense, universities should have posed to what market are attending, if it is of middle, intermediate managers or it is an sphere of operations, focusing on learning strategies :

1) Based on the problems, a doctor is not formed from the desktop.

2) Based on projects.

3) Based on collective learning.

4) Based on solving situations from a concrete reality.

IV. THE ENGINEER AND SOCIAL GROUPS

The current professional engineer must be trained not only intellectually in its scope but also in humanitarian sciences because their work is collective and not individual. This social aspect is not developed or very little treated at universities, even when human relationships are the support so that any teamwork productive. Thus, in order that multidisciplinary work have optimal results is essential that professionals are prepared to deal with people from respect and cooperation and so as to create working relationships with peers that will streamline the results, optimize resources, respond the demands, gain wealth, build trust and, in turn, be sustainable.

V. ENGINEERING AND ECONOMY

Satisfying needs from a product or service, the economic factor becomes indispensable. For this reason, the engineer must make an integral analysis of the market, namely the needs and demands of humanity and thus achieve solve short-term problems and with good results. The satisfaction of these needs is accomplished through an intellectual process that, with limited resources since everything has a cost, culminates with the discovery of a technically and economically optimal solution.

From this point of view, it is worth the engineer who can assume a leadership role in the field in which it is performed, being aware that their role does not cover purely numerical and design issues but rather, from a global conception of problems must integrate social, economic and environmental variables to obtain sustainable and effective media solutions and technologies available.

VI. THE ENGINEER AND THE NEW TECNOLOGIES OF INFORMATION AND COMMUNICATION

Bourdieu says that no one can predict with certainty the exact configuration or operation of the organizations of the century, however, organizations will be fully impregnated with technology, because the technological advantages can greatly improve global competitiveness.

In this sense, have an automated center and a highly responsive allowed to grow and maintain high standards of excellence, but the engineer the executor to achieve great results with lower costs. Here, where the importance of adequate training programs and technological tools that allow the engineer to socialize proposals and develop action plans in response to academic, economic or political problems. Engineers must be prepared for the demands of everyday promoting the use of technology in organizations, allowing it to more appropriate and efficient solutions to accompany greater range, creating economies of scale.

VII. ENGINEERING AND ENVIRONMENT

Engineering has contributed significantly in creating technology to improve the quality of life of people but, in turn, has not considered the environmental, economic and social factors that brings with the environmental impact as a result of human activity.

In this context, today's engineering should seek to counteract the damage "already produced" to stop the imminent deterioration of our planet, develop sustainable techniques and eco friendly, optimize the use of natural resources and research on alternative forms of energy to replace resources nonrenewable such as oil and natural gas, that are profitable, but in turn, safe and clean. This is the most important engineering challenge and the world, since from this depends the future of our planet and terrestrial life as we know it today.

ACKNOWLEDGMENT

The human curiosity has led him to consider many questions and to explore different ways to answer them. On the other hand the need to survive has made man a technical creative being and has taken his reasoning ability to unimaginable limits. This behavior is characteristic of human being and is what distinguishes it over other forms of terrestrial life. Engineering besides covering all aspects of man mentioned above, use the critical analysis, creativity, imagination, experience and knowledge to solve problems as from technology.

With this paper we want to emphasize that the maximum aim of engineering responds "nothing more, nothing less" than to mankind since the latter arises as from man as a rational, technical and social person that seeks to survive and excel in the world. All the above capabilities mentioned reflect what we might call the profile of the current engineer, who is a product of the demands and challenges of our world today.

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Mo_ED_1*_4

STUDY ON THE ACCREDITATION CRITERIA FOR MASTER'S LEVEL ENGINEERING PROGRAMS

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Abstract : *This paper analyses the accreditation criteria for master's level engineering programs of the typical accreditation systems in Europe and the United States, focusing on the differences between general criteria for master's level programs and those for baccalaureate level and putting forward proposals for the design of the accreditation criteria for master's level programs in China. While steadily constructing its own accreditation system for master's level engineering education, China could consider collaborating with international accreditation organizations, seeking substantial equivalence of accreditation.*

According to the accreditation criteria of the typical accreditation organizations such as ENAEE, ABET, EngC and ASIIN, the general criteria for master's level programs and those for baccalaureate level ordinarily fall within the same criteria system. There can be very good connection between the criteria for the two levels. The differences between the criteria for the two levels mainly lie in "student outcomes", with differentiation in the extent and content of graduate competence requirements, for instance, the differences in the depth and scope of knowledge and abilities, and competence requirements only for the master's level. These differences are reflected not only in general criteria but also in subject-specific program criteria in a full and more specific way.

In view of the development tendencies of international engineering education accreditation and considering the actual situation of master's level engineering education in China, we would put forward five principles for the designing of an accreditation criteria for master's level programs in China: (1) Being students-focused and student outcomes-oriented; (2) With continuous improvement of program as the objective; (3) Being clearly positioned, reflecting differences between master's level and baccalaureate level, and emphasizing differences between different types of academic degrees; (4) Considering the connection between the criteria of the two levels; (5) Substantial equivalence to the accreditation criteria of the typical accreditation organizations.

Keywords : *Master's Level, Engineering Education, Accreditation Criteria*

Mo_IT_1_1

OBJECT RECOGNITION IN IMAGES BASED ON THE DEEP LEARNING

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Abstract : *Two approaches for automatic object recognition in the digital images will be presented. The first approach is based on the conventional Taxonomy in Computer Vision : automatic detection and extraction of region of interest (ROI) and classification of ROI using SoftMax function. This approach we call as ROI-Based classification. The second method is based on classification of whole image based on deep neural network (DNN) – called as DNN-Classification. The approach for the ROI-Based classification describes the classical method where generic hand-crafted visual feature descriptors (HOG, SIFT, LBP) have been used. However, the DNN-classification approach extracts and learns the wide spectrum of visual features automatically. These two approaches have been applied for the detection and classification task of predefined template, where DNN models showed great result by outperforming the state-of-the art solution.*

Keywords : *Feature Descriptors : HOG, SIFT, LBP; Deep Learning; Template Classification and Detection; Convolutional Neural Network, GoogleNet, Overfeat*

INTRODUCTION

The automatic object detection and recognition is one of the main research areas in the computer vision and machine learning fields. In the past, wide spectrum of feature descriptors such as Scale Invariant Feature Transform (SIFT) [1] and Histogram of Oriented Gradients (HOG) [2] have been invented and widely used. These feature descriptors describe an image based on low level visual features (color, edge, gradient etc.). However, generic and hand-crafted visual feature descriptors are limited to fully describe the whole image. The Deep Neuronal Network (DNN) models, especially Convolutional Neural Network (CNN), able to extract as low (first layers) as high visual features (last layers) from the images. The Deep Learning concept have been known and first used in XX century for document recognition task [3]. However, it became popular only in 2010 when Alex Krizhevsky presented his model [4] on ImageNet Large Scale Visual Recognition Competition. The usage of GPU helped to deep learning models to effectively calculate, learn and classify the images faster. The work of later winners of ImageNet challenge is based on Deep Neural Network concept (GoogleNet, ResNet).

In our work the DNN and generic visual descriptors applied in template recognition task, where the template is rectangular shaped object containing different geometrical shapes inside.

OBJECTIVES

The objectives of this paper is to automatically detect and recognize the template, based on state-of-the art and deep learning approaches and compare their results.

METHODS

Data driven methodology have been proven and widely used in pattern recognition field. The data for binary classification (template or not) problem have to be decomposed to positive (examples with templates) and negative samples (without templates). In supervised learning process, the classifier learns to distinguish the positive and negative data using the data truth labels. In our work, we use 8000 negative and 2000 positive samples for training process for both approaches. For the testing part, 320 positive and negative samples have been used. The positive samples for the training set are cropped templates in different form of scale and rotation. However, for the testing set, the positive samples are the images which contains the template itself. Negative samples can be considered as any type of images which do not contain the template itself.

The ROI-Based Classification method first detects the candidates as region of interest. For each of them the feature vector will be calculated using one of generic feature descriptors (LBP or HOG). Then, classifier will be trained using obtained feature vectors with corresponding data truth labels.

For the DNN-Classification approach, we used both GoogleNet and Overfeat CNNs as feature extractor. The latest fully connected layer works as classifier (SoftMax) with two nodes (template or non-template). The philosophy of GoogleNet is to go deeper by creating the network inside the network. The GoogleNet distinguishes from other nets by its "inception" module, which forms a subnetwork inside of it. The GoogleNet consists of 9 inceptions modules. The width of inception modules ranges from 256 filters (in early modules) to 1024 (in top inception modules) [5]. Overfeat model is popular with its feature extractor, which could be applied to different type of vision task. There are two types of feature extractors, such as fast and accurate. As its name implies, the accurate model is more accurate than the fast one, but it requires nearly more twice connections [6].

The sliding window idea have been applied in the second approach. Different sized window will slide through the image and classify the cropped portion as template or not. Object in the frame could be appeared in different kind of size and rotation. That is why it was decided to use three different types of sliding window with sizes 45*45, 90*90 and 135*135. For all of these three cases, the vertical and horizontal step size was equal to 15. Each cropped window first must be converted to feature vector, then classified. After sliding the window through the image, multiple correctly classified objects can be found. Next step is to combine all correctly classified and closely located bounding boxes to together.

RESULTS

Two different types of methods have been applied to template detection problem. Deep learning approach showed high performance in comparison to generic visual features. However, training the deep convolutional neural network is time consuming and costly in terms of resources.

The length of Overfeat feature vector is 4 times longer than GoogleNet's. However, in terms of time, calculating the Overfeat features is much faster in comparison to GoogleNet's features. But the accuracy of classifying the template for GoogleNet is higher than accuracy of Overfeat.

The ROI-Based Classification approaches, which identify the candidates and verifies them, has lower accuracy in comparison DNN approach. The total accuracy depends on candidate selection as well as verification stages. However, the HOG and LBP visual features showed good performance in verification stage by perfectly describing the image visual features.

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Mo_IT_1_2

MOTIVATION AND METHODOLOGY TO EMBODY PROFESSIONAL RESPONSIBILITY AND ENGINEERING ETHICS FOR SOCIETAL BENEFITS

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Abstract : *It is a fact that engineering has always existed within the domain of social interests and had enormous impact on our society. Engineering is based on dependence, influence, and a synergistic relationship with our society which started from the dawn of humankind and has been an ongoing process even today. Hence conduct of an engineer towards the public and to this society should always be an integral part of the life of every professional engineer.*
Keywords : *Professionalism, Responsibility, Ethics.*

INTRODUCTION

Engineering plays a crucial role in today's life to such an extent that it shaping our worldviews. Every aspect of our day to day life is seen through with technology that significantly defines our relation-ships to ourselves and others in this world. A review of the previous literature on this area study provides a definition of an engineer, explanation of design process, and of "what engineers do" (3-6). These articles also explore area of professional ethics in engineering and legal aspects of engineering (7, 8, and 9). Davis has presented a historical view of engineering ethics (10). Yet, differences exist as to what engineers do (11 vs. 3).In this brief study, we will explore the relationship between engineers and society, and professional responsibilities of engineers. This study is vital for engineers for discharging their professional responsibilities, and for students who want enter engineering stream

OBJECTIVES

Professional Responsibility and Engineering Ethics for Societal Benefits will be motivated by :

- Considering the convergence of scientific knowledge with social need
- Teaching professional responsibility and engineering ethics to engineers

METHODS

Different methods are proposed to implement Professional Responsibility and Engineering Ethics for Societal Benefits.

A) Scientific Knowledge, Societal Need and Engineering

In the figure1, we can see an overlap of scientific knowledge with societal need. It is to observe that engineering domain which applies scientific knowledge to fulfill the needs of society. It is in the interest of society to increase scientific knowledge, engineers and scientists who both play vital play in scientific research can better fulfill the societal need.

Figure 1

Figure 2

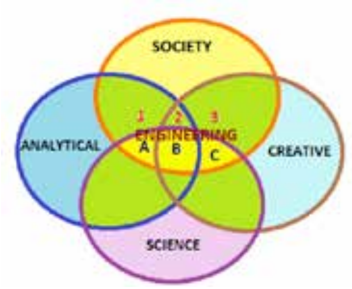

Figure 3

From figure 1, once safely deduce that central focus of the engineering is to apply scientific knowledge to meet societal needs. We can extend this analogy by superimposing the human creativity versus the analytical aspect of the human enterprise. We can represent this aspect through another diagram as shown in figure 2. As shown in the diagram, we may pursue creative efforts without involving analytical skills, and also may apply analytical skills without needing the domain of creativity. To examine engineering enterprise, we superimpose Diagrams 1 and 2 (Figure 1 and Figure 2) to create a new diagram figure 3.By considering the convergence of scientific knowledge with social need, we will consider three sectors, shown as A, B, and C which are shown in Venn diagram, Figure 3.Sector A represents the junction of analytical talent with the engineering skills and may be used to represent engineering science. Sector B, represents engineering design and problem solving as it is the intersection of knowledge and need with both creative and analytical capability. Sector C is the conjunction of our creative capacity with the engineering domain and is viewed as representing instinctive leaps which is often responsible for revolutionary findings in technology.

B) Emphasis on Teaching Engineering Ethics and Professional Responsibility

The emphasis on teaching engineering ethics and professional responsibility to engineers is justified as work of engineers has an enormous impact on our society and this world. When we discussed engineer's interaction with society and its needs, it clearly showcased a how responsible are engineer's to our society. Over period of time, engineering education has made good progress by focusing on the basic sciences which are major part of in engineering like mathematics, chemistry, and physics among the few. Recent trends toward focus to include discussion of ethics and professional responsibility in the curriculum of engineering education have received very little attention. This leads to one fearing that professional responsibility may also have been underemphasized not just in engineering education but also in the real time practice of engineering.

Few of the topics that come under engineering ethics and professional responsibility are

- Welfare of the Public
- Professional Ethics and Behavior
- Legal Obligations of Engineers
- Safeguarding Environment and Public
- Quality Assurance

Each of the above topics directly relates to the interaction of an engineer with clients, society, employers, employees, and to the engineering profession. One of the best example on how to develop ethical code of conduct without making others one feel that the ethics is being on them is to follow ethics formation and regulation process followed by Attorneys. Attorney state bars and their members develop and periodically review their professional codes of conduct. Also a statewide debate about these codes which held and these discussions can be heated and temperamental. This can be expected as there is numerous views and suggestion and this is good process as this will make one and all feel inclusive in the ethics formation. Due to this inclusive process to develop and review codes, attorneys readily accept and follow these codes.

The Personal involvement by students provides them an opportunity to inculcate their "professional code" into their real time work as engineering professional. This allows students to personally relate and internalize their professional responsibilities and to develop a fundamental understanding of their obligations and resulting consequences.

RESULTS

In reality, analytical skills only partially fulfills the requirements of engineer and not sufficient for a complete engineering education. A class room education which uses problems where all variables are accurately known with a existence of only one correct answer fails to creative situations engineers encounter in real job and at the same time, it fails to stimulate creativity. A change to above mentioned class room education trend is move towards using open-ended problems in the engineering classroom which would turn out to be a more complete engineering education. Representation of engineering in this article differs from the view presented by Koen (3). Our focus has not been on the product, but towards the engineer's interaction with society. The emphasis on teaching engineering ethics and professional responsibility to engineers by encouraging the students/professionals by Personal involvement is justified as work of engineers has an enormous impact on our society and this world.

CONCLUSION

The most effective path to ensure adherence to engineering code is for the personal involvement of each engineer in developing, integrating and following the guidelines on safety and the best interest of all in the society, professional ethics, law, environment and quality. These should become a natural extension and are considered part of engineering methodology. Also as since it is not practically possible for all professional engineers to be part of process of developing national professional codes; it would best to localize this process for example by developing professional codes at company, division, or departmental levels.

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Mo_IT_1_3

ENGINEERING FOR A SMART SOCIETY – A THEORETICAL UNDERSTANDING OF EDUCATIONAL STRUCTURE FOR THE INTERNET OF THINGS

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Abstract : *One of the greatest challenges facing engineering education for a smart society is understanding how to teach design methodologies to students when contemporary products require a far more sophisticated blending of technologies than any time in history. For objects that can be classified as belonging to the Internet of Things (IoT), design requires not just excellence in the traditional disciplines of mechanical, civil, electrical, computer and bio-engineering. It also requires integrative overlap between these disciplines, that necessarily would move beyond the addition of another silo.*

By using a combination of Conway's Law, the empathetic connection literature, and Don Beck's Spiral Dynamics, curricular directions will be developed that advocate for an educational approach whereby engineering faculty can meet these challenges. Through a combination of Project-Based Learning, collaborative exercises, and industrial clients, a strategy will be explained for accomplishing larger goals. Case studies will be given that demonstrate correct, emergent student behavior for creating the Smart Societies the future will demand of our graduates.

Keywords : *Internet of Things, collaborative learning, Conway's Law*

Mo_IT_1_4

Impact of Engineering Design on Confidence, Attitudes, and Engineering Awareness : A Global Comparative Study

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Abstract : *Nurturing design skills in students is in the heart of all engineering curricula. While academic courses and capstone activities inject the design process in students, involvement in practical design activities is believed to have higher impact on student preparation for engineering professions. Capitalizing on this fact, this paper aims to study the impact of Shell Echo-Marathon (SEM), an international engineering design competition, on engineering student attitudes, confidence, and awareness. Impact measure methodology of the empirical investigation is highlighted together with the process of instruments development. This is followed by details on the investigation findings. The paper concludes the existence of impact of SEM on shift in perceptions, confidence, and attitudes of engineering profession, engineering nature, and personal skills.*

Keywords: *Design, Engineering Education, Attitudes, Confidence, Education*

Mo_IT_1_5

Developing a Certificate Program in Computer Networks Technologies, Security, and Cloud Computing Services

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Abstract : *The objective of this note is to report the description of the certificate program in the area of computer networks, security, and cloud computing under development at The Pennsylvania State University – Fayette (PSU-Fayette) campus.*
Keywords : *Computer networks, security, cloud computing, certificate.*

INTRODUCTION

The subjects of computer networks and information security are covered in any IST academic program at many colleges and universities across USA. Relatively recent developments in cloud computing services created a new demand for a certificate program for IT personnel and staff members of various manufacturing and service industries that will cover not only networking and security issues, but also an emerging technology of cloud services. That was the major thrust behind the activities leading into creation of the certification program.

OBJECTIVES

The objective of this note is to describe the contents of the certificate program in the area of computer networks technologies, security, and cloud computing under development at The Pennsylvania State University – Fayette (PSU-Fayette) campus. The subjects of computer networks and information security issues are covered in a regular IST degree program [1] at PSU but due to an increased interest of local industry in these topics especially in light of new technology of cloud services, there appeared to be a need to be addressed by such a certificate program. Author, among other subject matters, was involved in development of IST curriculum and instructing of many IST courses. For background information on networking, information security, cybersecurity, and server based applications which are subject of certification the reader is referred to references [2-7].

CERTIFICATE

Author's interest in the computer networks and information security issues resulted in various publications [8-13] and in an involvement in a certificate initiative. Currently, the author plays a coordinating role in the developing of the certification program in the area of computer networks, security, and cloud computing services. The certificate program under consideration will cover the essential concepts of computer networks (peer-to-peer and client/server local area networks (LANs), wide-area networks (WANs) technologies, including : planning, installation, server configuration, resource management, remote access, performance monitoring, and optimization); security (malware, attack tactics, data security, cryptography, wireless/mobile security, authentication/access techniques); and cloud computing (virtualization and virtual machines including Hyper-V, security, IaaS/PaaS/SaaS and clouds). Laboratory exercises will cover the following subjects :
Operating systems and Networking :

a. MS Windows and Linux environments

b. Basic concepts of networking : topologies, protocols, packet switching, routing

c. Server – client services (Email service, Web server)

Cybersecurity :

a. Information Security

b. Cryptography

c. Virtual penetration (using Kali Linux)

Cloud services :

a. Creating a VM using Amazon AWS EC2

b. Using Microsoft MS Azure

c. Storage in cloud using Amazon AWS S3

d. Infrastructure as IaaS – cloud computing security (using Apache CloudStack and OpenStack open source cloud middleware systems).

CONCLUSION

The goal of this note was to describe the certification program in networking, security, and cloud services to be offered to IT professionals and engineering personnel for variety of local industries which may include manufacturing, high-tech, and healthcare sectors.

It is planned to offer the certification program in computer networks, information security, and cloud computing in 2017-2018 academic year.

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Mo_IT_1_6

An Interdisciplinary Approach to Forecasting Film Success : A Look at How Big Data is used to Create an Analytical Model

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Abstract : *This study aims to analyze the factors that contribute to the successful commercialization of movies and also to develop a program for the integrated management of box-office performance forecasting. Korea has become the 10th largest film industry in the world [3]. However, analytical study results and the forecasting using the factors contributing to successful commercialization have not been approached holistically. Therefore, this study aims to develop a system for the holistic research of factors that contribute to a film's success. Using big data, the new research model will manage the analytical results gained from socio-historical factors and also from both internal and external factors that contributed to the commercial success of films viewed by more than 10 million people in Korea. As mentioned, our study will build a model based on the analysis of tnhe variables of success using big data, implementing software programs, and in so doing will further our ability to forecast the commercial success or failure of films. It will take 'Film Engineering' beyond simple 'Story Engineering'. 'Film Engineering' in this study is an interdisciplinary approach based on the areas of film that include high-tech engineering and even mainstream media and big data. Our study will broaden research horizons and needs to be developed in such a way that it can be integrated into the field of engineering education. In addition, this study can allow for the creation or new academic courses that will contribute to the development of human resources research.*
Keywords : *Film-Engineering, Big Data, socio-historical factors, Analytical Models*

INTRODUCTION

This research is about developing integrated system for forecasting box office grossing film using Big-data analysis. There for using Big-data, we want to build up a systematic integrated system. For this, films during in these last five years and more than five million viewers will analysis about socio-historical factors etc [2][4]. The preformed of this research will follow : ① Analysis the reason about box office grossing film → ②Build up film success forecasting model and a Big-Data[1] platform for the analysis on primary factors → ③ Development grading program for success of film using Big-Data.

Through this process can predict box office grossing film if build predictive models and software development, will have a significant impact on improving the productivity of the film, and it will significantly contribute to the film industry through the results of these fusion research.

OBJECTIVES[5]

This study aims to develop a system for the holistic research of factors that contribute to a film's success. Using big data, the new research model will manage the analytical results gained from socio-historical factors and also from both internal and external factors that contributed to the commercial success of films viewed by more than 10 million people in Korea.

METHODS

This paper will be conducted in order to develop the movie box office predictions programs via the built engineering approach utilizing big data after indexing the movie box office Factors in film, literature, journalism, and machine learning. First, the variety of independent variables need to derived for establish the box office element analysis system, those derived independent variable is displayed as a final target value to grading for a box office [6].

In this derivation the objective function that represents the target value to minimize (or maximize) satisfy the constraints in a set independent variable, based on the mechanical engineering reasons method through optimization theory to find the solution to the step of developing a box office prediction software via computer engineering It leads to[7].

In this paper, how to re building promote technology development in engineering technology is the one of the most important work. Next, the design documentation for the modeling and stochastic model for this scenario is the main process of analysis and assessment. Also it followed this process to leverage the Hadoop system for collecting, analyzing, processing big data ensuring the efficiency and reliability of data management.

CONCLUSION

In this paper, starting from a position to look at survey also fusion between field meet in the large framework of the scheme a view of the life and human beings. Engineering is a study to meet with industry using the science. Fusion in the field of film, to meet movie content, will be in the direction to be able to take advantage of this in the movie industry. In this paper, we try to broaden the horizons of the fusion research of the way of such fusion research in the movie field of points in the new term "Film Engineering".

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Mo_IT_1_7

CORRELATION AMONG FACULTY, TEACHING ASSISTANT AND STUDENTS' TEAM EVALUATIONS OF CAPSTONE DESIGN PROJECT

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Abstract : *Capstone Design Course is mainly operated in reference to team-based learning and evaluation. The goal of research is to explore to what extent students' ranked evaluation of other teams' performance is correlated with the professor's or teaching assistant's evaluation. With the validity of students' evaluation, the research suggests how to incorporate peer team evaluation into the part of formal evaluation process traditionally done by professor and teaching assistants.*
Keywords : *student peer evaluation, relationship of peer evaluation and faculty evaluation, engineering design evaluation, higher education, capstone design assessment*

INTRODUCTION

The Capstone Design Course in Mechanical Engineering represents the culmination of undergraduate engineering education. Recently, Korean engineering education adopts Capstone Design Courses. Main interest of engineering faculty is how to evaluate students' performance properly. As most of colleges require relative assessment, professors have difficulty implementing team evaluation in Capstone Design Courses. Therefore, under relative assessment, fair and valid evaluation methods that students can involve in Capstone Design Courses are demanded.

OBJECTIVES

The purpose of this study was to examine the correlation among peer students, faculty and teaching assistants (graduate students) evaluation. This study aims for demonstrating that student peer evaluation as part of formative and summative assessment could be used. As evaluation is a part of learning and students' motivation for learning increase, peer team performance evaluation can be recommended for capstone design evaluation.

METHODS

Every five weeks the performance of each team is evaluated by students in other teams, teaching assistants, and professors. In Capstone Design Course, students evaluated other teams' performance in every five weeks, three times in total, two of which are formative assessments, and one of which are summative assessment. The first formative assessment is for ideation, the second formative assessment is for process of project, and the final assessment is for perfection of prototypes. Students were offered different evaluation criteria in every assessment. Senior Capstone Design teams are formed by 5-6 students and advised by faculty and graduate teaching assistants.

RESULTS

Significant positive correlations were found between peer, faculty, and graduate teaching assistants but no significant difference. The findings suggest that student peer team evaluation can be valuable for Capstone Design Course in mechanical engineering education.

CONCLUSION

This study demonstrates that student peer team evaluation can be used as a formative and summative assessment to evaluate mechanical engineering students' Capstone Design Course. But investigations into friendship effects and potential for bias might also be carried out.

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Mo_IT_1_8

APPLICATION OF VIRTUAL CLASSROOMS AS A TEACHING STRATEGY TO ENCOURAGE ENVIRONMENTAL EDUCATION

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Abstract : *Currently with all the technological advances that have become evident since the late twentieth century, knowledge multiplies faster than ever and is distributed almost instantaneously. Digital technology is present in everyday life and collaborates with the changes that occur at work, family and environmental education in this case. The purpose of this document is to present a way to link information technology and communication ICT to environmental education for college students, making virtual spaces that provide students a didactic interaction with the subject. It is easier for students of this century connect to social and environmental issues since technologies allow them to connect more quickly and efficiently the same way. For the preparation of this article a series of searches of different methodologies job of ICT in education were made, a display of different virtual classrooms used for higher education was held and institutional virtual spaces adapted to both these meet pedagogy of it. This methodology will be applied to the Department of Environmental Education for Engineers as a pilot to test the functionality of ICT in environmental issues related to spaces. The virtual space created has 6 spaces or modules linked to the themes of the subject which feature educational activities designed for students to feel comfortable with the space and create an environmental culture.*
Keywords : *Environmental Education, Higher Education, ICT*

INTRODUCTION

Technological advances mean new challenges arising in education, in this case in higher education where students hope to make the most of the teaching strategies of the University for Professional Development. Most students have extensive knowledge of technology tools so that the use of virtual classrooms becomes a teaching strategy not only for environmental education but for the acquisition of any new knowledge ensuring quality in education and integrating the advances of the digital age. This document represents the inclusion of new technologies "virtual classrooms" to provide an academic space dedicated to environmental education in higher education; is expected to virtual classroom is a great support for the creation of an environmental culture which has become a challenge of the XXI century backed by several documents such as the Agenda 21 Rio de Janeiro in which states aimed at ensuring the environmental education in the continual education to mitigate from culture environmental impacts afflicting our planet, if we use the virtual spaces we can ensure that access to environmental education with proactive nature can adapt to the contexts of those who receive this service, although the plan pilot only for higher education is the classroom can be adapted to the needs of the recipient. As an educational community we are seeking to contribute to sustainable development from educational programs that generate an environmental culture and to use all these new technologies not only to ensure higher quality education but to encourage the use of these tools in higher education in our country.

OBJECTIVES

- ICT IN EDUCATION

Currently with all the technological advances that have become evident since the late twentieth century, knowledge multiplies faster than ever and is distributed almost instantaneously. Digital technology is present in everyday life and collaborates with the changes that occur at work, family and education. UNESCO (United Nations Organization for education, science and culture) proposes public policies to harness the potential of ICT for education and development. Globally the incorporation of ICT in curriculum more comprehensive plans, as a tool that enhances the quality of education and skills of students and teachers for the twenty-first century is looked for.

"The introduction of ICT in classrooms highlights the need for a new definition of roles, especially for students and teachers. The first, thanks to these new tools can acquire greater autonomy and responsibility in the learning process, forcing the teacher to leave its classic as the sole source of information "role (UNESCO, 2013)

One of the main areas of priority development with regard to ICT in education is to consider the way these favor the development of new, more relevant and efficient educational practices by incorporating new logic, new strategies and educational resources, to facilitate the development of individual learning plans, collaborative work creating new experiences and better connectivity with expectations and experiences that students have the twenty-first century.

"it has been found that ICT can have an impact on the essential skills and competencies for the globalized digital world today, as motivation for learning, communication, ability to handle information, self-directed learning, among others "(OEI, 2010)

METHODS

VIRTUAL CLASSROOMS

"The incorporation of ICT in the classroom generates processes of educational innovation that are expressed in a series of changes, such as the role of teacher and student, changes in physical spaces, changes in didactics, how to assess, in the resource utilization, both managers as teachers and students and are prepared to assume the responsibilities arising from this transformation." (Parra, 2014)

"A classroom is a communication system that makes it possible for a group of people to come together with the intention of learning something. According to her (Rajasingham, 1996), the idea of a virtual class is that "everybody can talk and be heard and be indented" during the course of the instructional process. Consequently, the concept of interaction was crucial." (Husu, 2000)

The virtual classroom is a teaching strategy that develops over the Internet, which incorporates a wide range of ICT to facilitate learning, communication and collaboration, which may vary between forums, surveys, questionnaires, chat, spaces for the development of activities among others. We select the virtual classrooms because are the most complete virtual strategy that implement all the helps and tools that the ICT gives; this is a space that have all Teaching Strategies that need a classroom and has all the things that a class need.

RESULTS

ENVIRONMENTAL EDUCATION THROUGH VIRTUAL CLASSROOMS

Despite the environmental issues within recent years the need to promote an environmental culture in which solutions and habits in students contribute, from experiences where they can interact with the teacher using previous knowledge to provide solutions arises to situations that affect their community.

That is why the development of a professorship aimed at promoting environmental education from an engineering point of view in which students can raise their own ideas as viable solutions to minimize the negative impacts present in their environment is proposed. The development of the chair in engineering programs arises from the strong development in the profession of environmental solutions through engineering history has had a strong influence on both positive and negative environmental impacts; contribution to a cleaner environment : from the oldest activities undertaken by man as water treatment to more modern solutions such as green buildings and renewable energy engineering interventions for the purpose of this century is evident.

This academic through the use of virtual classrooms would facilitate the diffusion of environmental culture space and access to virtual classrooms is much simpler and can be distributed regardless of the location of the student and the teacher; this will not only facilitate an environmental education to contribute to sustainable development but also would facilitate the inclusion of ICT with environmental and educational purposes received.

CONCLUSION

This academic space is aimed at engineering programs as engineering whose fundamental objective is to meet the needs of the community, so it is necessary today that the same has to be one of the pioneers professions the continued development of environmental solutions. For the development of this academic space different themes will be presented each with a problem related to the local community. The advantages of this academic space are that the issues remain the same anywhere in the world problems adapting to local problems. (Castellanos, 2016)

Each subject was selected with an analysis of what have been the most critical case studies present in our community; these problems are suggested to the student so that they can select different proposals; the idea of establishing these problems is to guide the student so before making the project the course 6 weeks in which these issues will be presented and students will investigate solutions already given through engineering will be taken. We started this project with the environmental educations for engineers because the engineer must have within their profile environmental awareness as it is necessary to tackle the present date crisis. That is why an assessment of the basics should be done as are the environmental crisis and how it influences the engineer in mitigating it. "Since 1972 with the conference on the human environment in Stockholm and subsequent Earth Summits in Rio de Janeiro (1992) on environment and development and Johannesburg (2002) on sustainable development, has exhibited interest in promoting a reflexive attitude and proactive search for a new model of civilization "(Aguirre, 2006) for some, the environmental crisis is evident and is leading to the extinction of life.

our goal is to create a virtual space designed so that students find an incentive to use their knowledge for the generation of solutions to environmental problems, which is a virtual space provide the student with managing their time and the acquisition of information that favors the development of their solution, also facilitate the exchange of ideas from forums or debates to be developed in this virtual space. After the pilot plan work is expected to reach all academic programs of the university in order to ensure the inclusion and development of a massive environmental culture in our institution.

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Mo_IE_1_2

MANUFACTURING POWER STRATEGY AND THE PRACTICE OF ENGINEERING EDUCATION REFORM IN CHINA

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Abstract : *"Human-oriented" principle is the foundation of the "Made in China 2025" Plan. This study detailed analyzes the basic connotation on the strategy of reinvigorating manufacturing in China, and the current situation and key problems faced by Chinese Higher Engineering Education under the new international and domestic situation. The study regards four typical cases in Zhejiang University as the research objects, through the content analysis method to extract the four characteristic modes on "cross-disciplinary", "professional", "diversification" and "internationalization". Meanwhile, the study tries to put forward some systematic countermeasures and suggestions to deepen Higher Engineering Education reform in China, and to enhance the training quality of engineering and technical talent, laying the foundation for creating holistic engineering education paradigm.*
Keywords : *Made in China 2025; Engineering Education Reform; Countermeasures and suggestions*

Mo_IE_1_3

ATTITUDE AND ROLE OF INSTRUCTORS IN MANUFACTURING ACTIVITES WITH STUDENTS

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Abstract : *Utsunomiya University Faculty of Engineering has developed education programs focused on innovation for undergraduate students, and has repeatedly improved them in various ways, with the aim of cultivating an affinity for manufacturing, autonomy, and creativity. Innovation-focused education programs for undergraduates include the cross-disciplinary project-based learning (PBL) subject Innovation Engineering for first year students, designed to motivate students in engineering and to serve as an introduction to specialist courses. Furthermore, Innovation Engineering II and III are also offered, with the aim of improving capabilities that enable the adoption of plan-do-check-act (PDCA) cycles. This report describes the attitude and role of instructors, through the process of leading classes in the subject "Innovation Engineering II," with consideration of the differences in standpoint of companies and universities.*

Keywords : *Engineering Education, Problem-Based Learning*

1. INNOVATION-FOCUSED EDUCATION

1.1 Innovation Engineering I

One of the features of the classes in this subject is that students are divided into cross-disciplinary groups. The students as the groups engage in communication regarding their assigned themes. They work through a process of problem solving. Finally, they each make a presentation. The instructor and teaching assistant for this subject leave students to work autonomously as far as possible, and interfering as little as possible. The students cultivate autonomy, creativity, and originality; they develop communication skills, and presentation skills. These are the aims of the subject.[1]-[5]

1.2 Innovation Engineering II and III

These subjects form part of the innovation-focused education provided by the faculty. By tackling projects requiring specialized expertise, students cultivate management capabilities. The students also pursue their projects autonomously and strive for standardization in their manufacturing activities. The subjects can also be regarded as a means to build on the skills developed in Innovation Engineering I.

2. ACTUAL CLASSES

2.1 Creating illumination installations

Over a number of years, one of the project themes offered in Innovation Engineering II at Utsunomiya University is the creation of illumination installations. In forming cross-disciplinary teams, it is quite difficult to select themes that provide for work in each of the various fields of specialization. The theme of illumination is one that allows for a wide range of technological elements.

2.2. Attitude of instructor

In my experience in the harsh reality of a company environment, with pressures to meet deadlines and make profits, even when there is strong encouragement, there is no time whatsoever for patiently allowing people to learn from mistakes. How was it possible, then, to allow students to learn from mistakes in this illumination creation project? It's clear that the answer lies in the perception of being in an educational setting. In line with this logic, there have been attempts to set up educational bodies within companies for training recruits and conducting periodic education, as opposed to depending solely on on-the-job training (OJT). The number of such initiatives has been limited, however, and most companies continue to rely on OJT for their education needs. Accordingly, innovation-focused education programs at universities, in which students are free to make mistakes, represent a big opportunity for nurturing creativity. I regard this as a mission and plan to continue making efforts in this direction.

3. ANOTHER ROLE PLAYED BY INNOVATION-FOCUSED EDUCATION

In much of the field of manufacturing today, the creators and users of products have no interaction with each other. This means the ideas and skills of creators are not directly evaluated by users. Company activities are result-oriented, and more weight is given to costs than anything else. In some cases, this becomes excessive, resulting in the shipment of defective products. The creations of the students are seen and appreciated by many people at the contest venue. The essence of education lies exclusively in the relationship between instructor and students, but students mentioned that the contest allowed them for the first time to experience the relationship between creator and user and to have their work directly assessed by users.

4. CONCLUSION

Typically, instructors in university education are specialists in the fields they teach, while students simply receive guidance from them. In manufacturing education, however, there are many challenges that lie outside both the instructor's field of specialization, and also that of the students. My next challenge is to investigate the differences in educational effectiveness of combinations of the specialist and non-specialist disciplines of instructors and students, through classroom assessment questionnaires after learning, and follow-up questionnaires after graduation.

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Mo_IE_1_4

ON CAMPUS ENTREPRENEURIAL ECOSYSTEM : ITS IMPACT ON STUDENT LEARNING

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Abstract : *Presence of industrial ecosystem in the neighborhood of educational institutions is observed to be enhancing the quality of learning experience created for engineering students. This presence can have positive influence on evolving curriculum aligning to the needs of industry, bringing in right kind of skills and practices in curriculum and offering quality mentoring to students thereby helping them have smooth transition into professional world. However not all engineering educational institutions have this advantage of being part of an industrially vibrant environment. The gap between industry and academia remains wide for such institutions having poor access to industrial environment. Promoting entrepreneurship activities by setting up of technology business incubations on campus is one of the ways in creating industrial environments on campus. Such presence of industry and entrepreneurs on campus will not only fuel economic value creation, but also offer academia an opportunity to develop better understanding of industrial needs and practices. A properly designed collaborative network of in-campus startups and students helps to situate student learning in the context of engineering professional practice, thus making learning both purposeful and joyful. It will expose faculty members to industrial practices and help develop collaborations. Such collaborations also have the potential to transform educational institutions into low cost innovation centers for these small enterprises. This paper describes the efforts put by our Institution in this direction of using presence of industry and entrepreneurs on campus, particularly in the field of information technology, and the gains to both industry and institution.*

Keywords : *industry – institution collaboration, entrepreneurship, capstone projects*

INTRODUCTION

Research and innovations in engineering and technology space are the major drivers contributing to economic growth of a region. Presence of industries and universities compliment each others' efforts in boosting innovations. Research in Universities has impact on regional innovations due to localized knowledge spillovers [1]. There are empirical studies conducted that find evidences of such knowledge spillovers and their impact in the USA [2] and European countries [3,4]. However, not all Engineering Institutions enjoy proximity to industrially vibrant environments. Such Engineering Institutions situated in industrially under developed regions offer challenges for educators in creating conducive learning eco system for learners in terms of aligning curriculum to the needs of industry, building learning contexts for learners, exposing faculty members to industry practices and offering research challenges to academia of relevance to industry. One of the ways to find solution to this problem is to promote entrepreneurship on campus. An experiment in this direction was undertaken by our Institution situated in a region which is considered industrially backward. It was done through establishing a center by name Center for Technology Innovation and entrepreneurship whose objective is to promote entrepreneurship on campus [5] which was done by inviting successful professionals from outside in addition to inside promotion. Presence of entrepreneurs on campus has benefitted in creating an ecosystem conducive to engineering education as well in addition to creating jobs.

This paper focuses on the gains from this experiment with a focus on curriculum, student learning, faculty exposure and enhanced visibility for institution.

OBJECTIVES

Presence of industrial activity on campus through entrepreneurs has significant impact on engineering education ecosystem. This paper focuses on the impact of such an effort in terms of :

i) Enhancing quality of engineering curriculum by bringing in industrial relevance
ii) Creating learning contexts
iii) Improving faculty quality
iv) Building Institutional image through product development and IP
v) Gains for the industry

METHODS

Capstone project forms an important part of curriculum. It offers the students an opportunity to integrate their learning from various courses and apply it to solve complex engineering problems. It is observed that students need better quality mentoring while doing capstone project. Since capstone project acts as a sort of toll gate, right feedback on overall curriculum could be expected from the stakeholders involved. Therefore, a strategy of involving collaborative work with industry at capstone project level was adopted. This is outlined in Figure 1. As a first step showcasing of skills, competencies of both students and faculty members along with infrastructure and facilities available were done to a carefully chosen few industries. An assessment of the same by industry and their needs resulted in capstone problem definitions. In the next step strategy for making up for skill deficiency and required training is carried out. This is followed by project planning and execution. Clarity about the roles and responsibilities of industry and is very much essential for success. Last phase of this cyclic process is evaluation of the outcomes of the project and incorporate learning for the next cycle which begins with showcasing the projects to identified industries. This method has resulted in continuous increase in participation of number of students and industry.

RESULTS

The efforts through this initiative have given tangible results and can be bucketed in the following way :

Curriculum Quality Enhancement and Pedagogy : Gaps in terms of engineering concepts, deficiencies in terms of relevant skills were noticed. This resulted in making the curriculum relevant.

Student Learning : Opportunity to work on a complex engineering problem, exposure to industry practices, training on latest technology and tools, quality mentoring from experts and project internships are some of the major gains for the students. Further we observe a increase in student motivation as they see role models in the entrepreneurs on campus.

Faculty Quality : Exposure to industry practices, training on latest tools and technology, opportunity to work on product idea and sharing of IP

Further, industry gets continuous access to talent and institution acts as low cost innovation centre for industry. We also see a steady growth in all the dimensions mentioned above.

CONCLUSION

Presence of industrial ecosystem created through entrepreneurial activities has immense potential to transform engineering education making it purposeful and joyful. Such a presence offers a win- win combination for both industry and institution.

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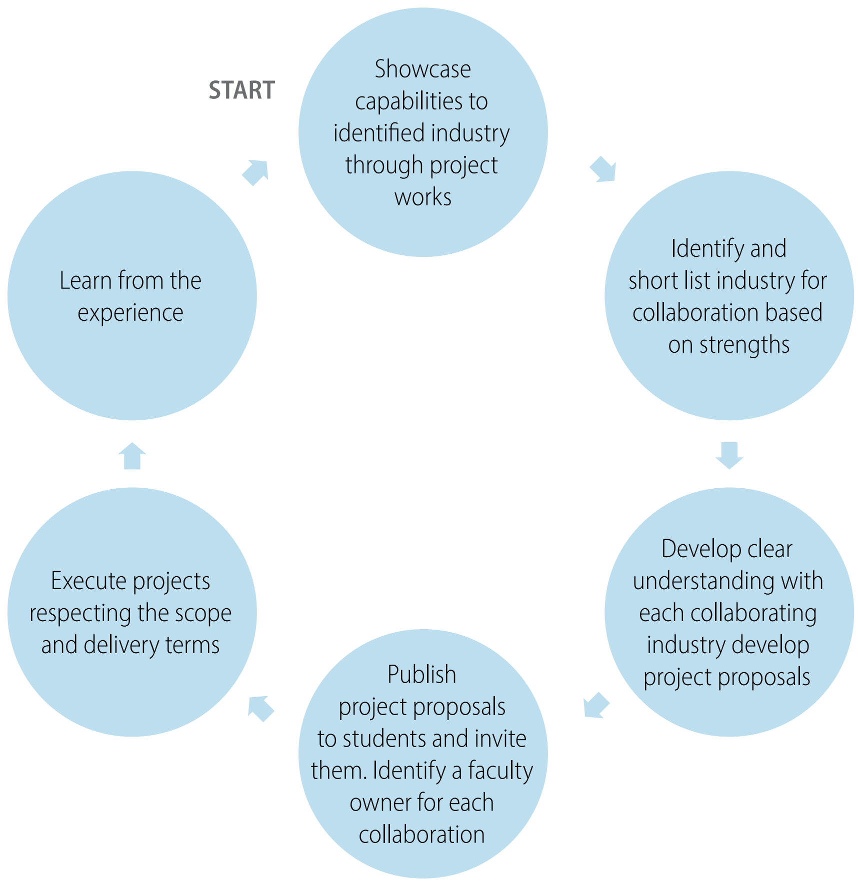
Figure 1



An Important Process in Efficient Starting-up of PBL Curriculum

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Abstract : *The newly established English Program for Engineering at Burapha University, Thailand, has decided to implement Problem/Project Based Learning (PBL) as main method of instruction. As PBL is a relatively new teaching method in Thailand, the experiences of implementing it justify in-depth consideration. Here, the first two semesters applying PBL were compared by mean of starting up procedures for implementation. The first semester of PBL setup was led by a workshop where management and lecturers (approx. 30 individuals) were laid out with the basics of PBL, following by ideation, conceptualization, implementation plan and assessment procedures while the second phase was based on individual discussion between lecturers participating in the program. It was found that the workshop procedure was a crucial process for successful application of PBL. Workshop provides the basic concepts of PBL, project plan and the implementation plan were based on collective agreement of all lecturers and management. The second phase results in excessive workload, un-focus theme of student projects as well as the overlap assessment of the students. It is concluded that workshop that include foundation of PBL, ideation, conceptualization and action plan are a crucial procedure for the successful implementation of PBL.*

Keywords: *Problem/Project based learning, Workshop, implementation*

INTRODUCTION

Problem/Project based learning (PBL) can be considered a modern way of education and this has raised an increasing number of PBL programs around the world, however, several factors influence the success or failure of the implementation [1]. The objective of this paper is to report two types of PBL implementation steps led by workshop and without workshop, which has significant influent on the results of students learning, respectively.

Semester 1

PBL semester led by workshop "Envision PBL in Engineering Program" was conducted. The procedures of workshop are 1) PBL foundation to lay out basic understanding of PBL to lecturers 2) Ideation of various topics led by questions. The questions such as "What do you expect as the students' character after graduation", "How to teach students in 21st century?" were posted and ideas were obtained from lecturers, 3) Cases problem solving. This step is to provide various cases and the participants were separated into a small group, brainstorming to create the concepts and milestone of PBL implementation. The cases were for example, "What should be the 1st PBL project?" "How to combine science subjects into a semester project", "How to assess the PBL project and integrate it into the content courses?" The results were presented to all the audiences. 4) Last step is to combine the milestone of the previous step into a single implementation and make an action plan. The key element of outcome of this workshop is to setup the PBL working group who supervise the PBL processes.

The workshop had laid a good foundation on which PBL could be implemented. All involved lecturers had agree upon the type and scope of project before the start of the semester. This had several positive effects. There was a sense of ownership of the course by all the involved lecturers as a group, which helped to create a positive working environment for the faculty and reduced possible conflicts. On the side of the students, the workload was manageable and assessment was not overlapping. Additionally both students and faculty feedbacks were predominantly positive. It therefore can be concluded that the first semester of PBL was a success.

Semester 2

The second semester was led by an organized workshop but was based on individual introductions of PBL to the lecturers. A plan was given by the head of the program and individual talk between the head of the program and lecturers was conducted to provide the tentative project and agreement on examination date as well as assessment methods. Due to the individual treatment of faculty members, no common understanding of PBL was created. More importantly, no joined feeling of ownership emerged but rather individual lecturers felt as the owners of the courses their taught. As a result, they independently came up with projects that increased the students' workload considerably and lacked integration of knowledge. This also let to overlap in the assessment process, as students' and lecturers became confused by the objective of their respective subjects. It should be noted that the lack of joined ownership, resulted in a feeling of competition and significantly increased conflict within the faculty.

RESULTS

Table 1 Results of PBL implementation led by the workshop and without the workshop

	Semester led by workshop	Semester with individual lecturers
Number of projects	2	3
Integration of project results into subjects	yes	No – it was scored in individual subjects
Owner of project	PBL working group	Individual lecturers
Workload for students	Easily monitored and balance	Difficult to monitor and balance/depending on individual lecturers
Assessment overlap	no	yes, and sometimes confused with the objective of the subjects
Conflict between lecturers on PBL	no, because lecturers share overall basic of PBL	yes, different lecturers have different understanding/plan/ workload of assignment and how PBL is implemented.
Student's feedback on PBL and content subjects	difficult, but maintain high momentum and curiosity	difficult and lack of momentum in many cases

CONCLUSION

A series of workshops on PBL is an important key element on successful implementation of PBL. Workshop will lay out the basic background on PBL and the clear plan of implementation and assessment. Workshop where lecturers create the plan together also increase the attitude of sharing toward PBL curriculum rather than individual subject based.

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Mo_IT_2*_1

APPLICATION OF MACHINE LEARNING TO DEDUCING AND OPTIMISING CURRICULUM STRUCTURES

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Abstract : *In a healthy academic programme, curriculum structure is regularly reviewed for the purpose of staying relevant in the field, adapting to the changing preparedness of incoming students and streamlining the delivery of academic content. However, curriculum structure is not often formally structured for application of modern methods such as those in the field of Artificial Intelligence. In this paper, a novel approach is presented for the determination of curriculum structures. The approach is based on the data-mining of student records and the statistical evaluation of the multiple routes developed by students to graduating from academic programmes. The result is a tree of progression routes that can be sorted to reveal the most likely prediction of the curriculum structure. This approach of machine learning is further pursued by evaluating student success in the light of the deduced curriculum structure with the intention of developing a model of student progression behaviour. Hence, by obtaining the curriculum structure and model of student progression behaviour, it becomes possible to optimize the curriculum with regard to maximizing the number of graduates from an academic programme.*

Keywords : *Machine Learning, Artificial Intelligence, Curriculum Structure*

INTRODUCTION

Paragraph Times New Roman, size 11 : Establish the context, background and/or importance of the topic; indicate a problem, controversy or a gap in the field of research.

OBJECTIVES

Paragraph Arial, size 11 : Indicate the primary purpose of the research.

METHODS

Paragraph Times New Roman, size 11 : Provide a description of the research design (qualitative or quantitative), data sources, subjects/participants, data collection and analysis.

RESULTS

Paragraph Times New Roman, size 11 : Provide a summary and discussion of the results.

CONCLUSION

Paragraph Times New Roman, size 11 : A statement of the study's conclusions and/or implication of the results should in particular show the extent to which the research can be translated into action as a strategy to address the health divide.

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Mo_IT_2*_2

INTRODUCING RESPONSIBLE RESOURCE MANAGEMENT TO THE ENGINEERING EDUCATION

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Abstract : *The article encompasses the results of Tomsk Polytechnic University research on principles of Responsible Resource Management; underlines the approach implemented at TPU for enhancing engineering education in line with these principles and fostering students' sustainability competences and mindset.*
Keywords : *Responsible Resource Management, engineering education, Sustainable Development.*

INTRODUCTION

Education, namely the engineering education, plays a key role in understanding and responding to the environmental and societal challenges through fostering specific competences, attitudes and actions of future engineers that will serve for the purpose of Sustainable Development of the society.

There is a strong need for universities to respond to the grand challenges of the modern day, among which are, first of all, the severe shortage of resources and their inefficient utilization. It is necessary to enhance the quality of resource management, to create mechanisms for its clear assessment both from the point of its economic efficiency and its impacts on ecology and society, i.e. its responsibility.

Russian industry pays insufficient attention to the need of introducing sustainability principles to its design, production, operation, and utilization processes, therefore, modern engineering education in Russia does not specifically aim at training new era professional with high level of engineering ethics and profound competences in adequate and responsible management of natural, material, human, intellectual, time, financial and other resources.

OBJECTIVES

The core objectives of the on-going applied transdisciplinary research "Responsible Resource Management (RRM) : Educational Perspective" executed by TPU are to create the scientific basis for RRM encompassing ideas and methods of Technology Assessment and Responsible Research and Innovation (TA & RRI) and to apply the RRM concepts to the educational and research activities of students, faculty and staff of TPU.

By developing specific professional competences in field of RRM and providing certain ch environments at the University students will be able to enhance their professional competency and bring it to the new level of responsible engineering.

METHODS

The research part of TPU project encompasses a profound analysis of the existing methods of TA & RRI widely disseminated by Prof. Dr. Armin Grunwald and his team of The Institute for Technology Assessment and Systems Analysis (ITAS), and a close collaboration with the team on development of methods and models for the design and evaluation of responsible interdependent resource utilization.

The educational part of the project is aimed at formation and enhancement of specific competences of engineering graduates; it includes best practices analysis of the sustainability-driven university education in developed countries; analysis and expert assessment of the advanced teaching and learning methods introduced by top technical universities; analysis and modernization of the existing Russian competences model of future engineers; development of technical and educational basis for introducing RRM to the training process; and modernization of the educational process of TPU.

RESULTS

1. A list of specific educational environments that foster sustainability mindset of staff and students and allow to learn, experience and apply the principles of RRM to the professional activity; an action plan for creation and/or development of these environments at TPU;
2. An updated graduates' competences profile of a responsible engineer addressing RRM competences; a model for monitoring and assessment of students' competences level;
3. A set of teaching and learning methods that will allow fostering of the identified competences (including Project-based and Problem-based learning, practice-oriented learning, interdisciplinary projects, expert seminars, smart-education, gamification, etc.);
4. Specific training programs for faculty members and administrative staff aimed at fostering their sustainability mindset and advancing their teaching and learning methods;
5. Development and introduction of specific courses on RRM for undergraduates' and graduates' curriculum of all TPU study programs and a new master program on RRM;

CONCLUSION

An ability to foresee the consequences of taken professional decisions and act responsibly is one of the core competences of a professional engineer demanded by modern society. The concept of Responsible Resource Management and its introduction to the basis of engineering education will serve as a driver for Sustainable Development of engineering and society as a whole.

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Mo_IT_2*_3

RECOMMENDING EXERCISES IN SCRATCH : AN INTEGRATED APPROACH

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Abstract : *Although the visual programming language named Scratch has shown to be a very efficient tool for learning to program, it is still susceptible to optimization. In that sense, in the present paper a method is tested to recommend exercises (problem statements) in Scratch for college students in order to enhance their learning process. To this end, an integrated approach is proposed that is composed by a Web application including Scratch as project editor along with a recommender system. The implemented recommended system advices exercises by adopting a collaborative filtering approach. From a pedagogical point of view this system can be considered as a mediator between formal and informal learning approaches. Preliminary results obtained from college students at the (Ecuador) show the impact of our proposal.*

Keywords : *Scratch, Recommender systems, Technology Enhanced Education, Autonomous learning*

INTRODUCTION

Knowing the benefits of merging both formal and informal learning, we have included Scratch[1] as educational resource for teaching the subject of Foundations of Computer Programming in the State Milagro (UNEMI) (Ecuador). This experience, which started in 2015 until now, has contributed to increase both, motivation and academic performance in the students. However, some issues regarding the Scratch usability were also noticed : 1) there is a gap between the employed learning approaches since professors are constrained to classroom activities, and 2) certain students feel unmotivated because they are faced to programming exercises that do not fulfil their individual expectations (e.g. too easy/complex exercises). This latter issue has been previously experienced in [2].

OBJECTIVES

In order to solve the above-mentioned issues, this research has as main goal to develop an integrated system (Scratch+ERS) for improving the learning process with Scratch in college students. This approach consists in a simple Web application, including Scratch as a project editor along with a recommender system [3] for exercises (problem statements).

METHODS

The exercises are created by the professor and included in the system. Hereby the student can access the exercises, solve them with Scratch and evaluate them according to two criteria : taste and complexity. Using the record of evaluated exercises, the system recommends new exercises to the student by applying a collaborative filtering approach. Our assumption is that students with similar evaluations over a given set of exercises are a good source for recommendation. From a pedagogical viewpoint this proposal can be considered as a mediator between formal and informal learning approaches. In other words, it not only fills the gap between professor lectures and student interaction with Scratch, but also it helps to develop the autonomous learning.

RESULTS

With aim to assess the proposed system, we conducted a real life testing methodology [4]. After using the system during three months we asked to 64 students from two different careers, their opinion regarding 9 assertions. The assertions were oriented to measure the satisfaction degree regarding three general goals : 1) recommender system performance, 2) user-centric effects and 3) learning effects. The overall results are shown by Figure 1. We observe a high satisfaction by the students with Scratch+ERS.

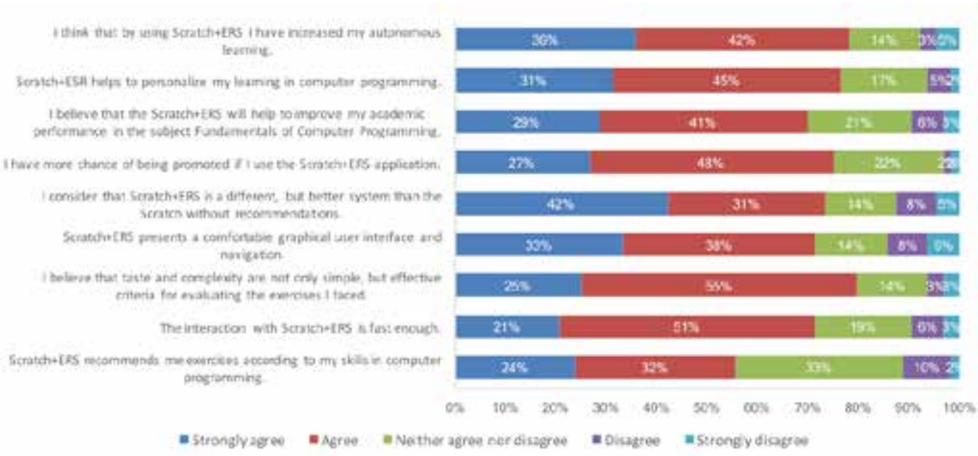

Figure 1. Satisfaction perceived by the students about the proposed system.

CONCLUSION

From the results obtained we can concluded that the proposed system contributes to enhace the autonomous learning of computer programming in college students. Specifically, it helps to solve two important issues : 1) the current gap between the formal and informal learning approaches, and 2) to personalize the student interaction with Scratch, by proposing exercises according to his/her levels of knowledge.

However, we consider that this is a first step towards the obtaining of a better system. Future works will be oriented to improve both recommender system performance and Web application usability.

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Mo_IT_2*_4

FRENCH ENGINEERING UNIVERSITIES : HOW THEY DEAL WITH ENTREPRENEURSHIP AND INNOVATION

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Abstract : *The French Ministry for Education and Research has launched a call for projects named PEPITE so as to develop Innovation, amongst the students and particularly the engineers. This paper presents the manner that Polytech Orleans answered to this call to develop innovation and entrepreneurship.*

Keywords : *Innovation, Entrepreneurship, Fablab, PEPITE*

INTRODUCTION

In France, many engineers recently graduated do not have the wish to create new activities. The reason is that it is very easy for engineers to get a job in a company but also that risk's culture is not very present in the French education culture. So, the French government, aware of those facts as all European governments decided to create opportunities for Higher Education Institutions so as to help them to convince (and form) students of the opportunity of entrepreneurship. Amongst those opportunities a specific HEI can choose the more pertinent as a function of its size and territory.

OBJECTIVES

The more visible issue, which is common to all French HEIs, is the new status created in 2014 for students that together with their studies can engage in the creation of a new company : they can elaborate a real project becoming in such a way both students and managers. Together with their diploma such student gets the opportunity to work on their own project instead of making an internship and to be coached by specific tutors (both academic and professional). Most of French Engineering Universities developed such an opportunity for their students.

METHODS TO INCREASE INNOVATION

But this is not enough, a specific surrounding must be put in place and many components are part of it :

- Creation of specific courses : besides engineering curriculum, Polytech Orléans has created in 2012 a specific Master "Creating companies both innovative and socially responsible", that Polytech's students can follow
- The possibility for Polytech's students to follow the courses of Master of Institute for Administration of Companies together with their engineering curricula
- The partnership with School of Design and Art in Orléans, that allows students to make their projects with designers, which opens their mind
- The course «Skills for Companies" 100 hours) that can be followed by PhD students and will help doctors to be able to transfer skills into innovations as in some European Universities

- The fact that the school has partnerships with Technological Resources Centers, for Polytech both in mechanical and electrical domain.

The second point is the real will of the direction of the school to develop local entrepreneurship innovation with an indicator which is the number of companies created in the Région Centre (the location of Polytech Orléans) by the engineers of Polytech

ACTIONS TO SUPPORT INNOVATION

Create a pre-incubator inside the school

Motivate engineers to the development of innovation valuing engineer as progress vector, for such it is absolutely necessary to raise awareness of teachers to innovation.

Value innovative ideas in teaching or research

Encourage actions of companies created by students (junior companies)

Develop innovation amongst PhD students in Polytech by developing PhD counsellors

Employ students to verify the feasibility of dormant projects in small companies (missions in companies)

Coordinate Polytech's actions with those of the whole territory and university

Develop actions with competitiveness clusters that are well developed in France

CONCLUSION

Two actions already began :

- Polytech Startup Lounge has been created in January 2015, it is a pre-incubator, situated inside Polytech. It includes both material and human resources. A start up mentor has been engaged, he is responsible of the actions of the school concerning entrepreneurship
- A Fab Lab has also been created, it is situated very near to the Start Up Lounge.

These two initiatives show a strong commitment of the direction and are easy to use by students, so their motivation is growing.

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Mo_IT_2*_5

RESEARCH ON THE CONTENT AND STRUCTURE OF ENGINEERING ETHICS' CODE IN CHINA

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ABSTRACT : *Based on the analysis of some documents that the author has referred to, this paper generalizes the relevant contents and items related to the ethics' codes for engineers. It also makes empirical research on the contents and structure of engineering ethics' codes by the questionnaire survey and quantitative analysis. The research results show that the contents and structure of engineering ethics' codes consist of four dimensions, namely "work ethos", "conduct features", "work goals" and "responsibility quality". Meanwhile, according to the variation analysis of the independent samples test and importance ranking result, there is an obvious difference between the ethical educators in university and engineers in selecting the engineering ethics' codes.*

Keywords : *Codes of Ethics, Content and Structure, Engineering Ethics, Engineering Education*

Mo_ED_2_1

EFFECTS OF TEAM COMOSITION ON PROJECT OUTPUT FROM A DIGITAL MAKING CAMP

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Abstract : *The effect of team composition on the quality of the project from a digital making camp was analyzed. The major, the academic years and the total number of team members were the elements that affected the project quality. Self-formed teams with preselected members produced better quality outputs. There was no gender role division observed in the coed teams. The female-only teams produced work in which the design elements were emphasized compared to coed teams.*
Keywords : *Digital Making Camps, Team Composition, Gender*

INTRODUCTION

The Women in Science, Engineering, and Technology (WISET) Seoul Regional Center offered digital making camps for three weeks during summer and winter vacations. The camp was designed to provide female engineering students with the experience to operate and utilize the digital tools to construct working objects. The participants learned to operate 3D printers, laser cutters, laser millers, and Arduino systems for two weeks and had a week to design their own working system as a team. Both male and female students participated, but the teams consisted of at least 50% females, if not all females. The best project was awarded at the end of the camp.

OBJECTIVES

The objective of this paper is to investigate how team composition affects the quality of the project output. The team composition variables that we studied were gender, majors, academic years, and self-formed vs. assigned teams.

METHODS

The team participants and project outputs from the four camps from December 2014 to June 2016 were analyzed. The characteristics of the top projects and those that failed to demonstrate were compared in terms of team composition and capabilities.

RESULTS

The effect of gender composition : We analyzed the gender of the role each team member played, for example, planning and designing, procuring materials, constructing, programming, reporting, and presenting. There were no particular patterns of gender in the task division. Each member took up the role that her or she could do well. For example, the member with the best coding skills took charge of the Arduino programming. This was different from the pattern often observed in the teams for classroom group projects in which females tend to play more supportive and nontechnical roles.1,2 The difference may be

because women were no longer a minority in the team structure, and the camp emphasized equal participation of all team members. Project work also showed gender characteristics. The work by all female teams had more emphasis on the design, such as in the doll house (2016), tumbler (2016), and starlight music box (2014) projects, while the coed team with a male leader emphasized functionality more, such as in the alcohol counter (2015) and disguised digital safe (2015) projects. It was also interesting to note that male students showed a higher level of satisfaction in the camp than the female students, despite the fact that the program was more geared toward female students.
Self-formed teams vs. assigned teams : Students could apply to the camp as an individual or as a team. The teams with self-selected members produced better quality outputs. Such teams often had a goal of winning the final award and selected the members with strengths in specific areas, such as programming, hardware knowledge, or artistic talents.

Major : The students' majors also affected the quality of outputs. Mechanical engineering majors did the best, probably due to more experience in design and fabrication. Chemical engineering and materials sciences and engineering majors had the most difficulties. The best project in 2015 had all mechanical engineering majors, and the two camps in 2016 had half of the team members in mechanical engineering.

Academic years : Lower division students had more difficulties in planning and fabrication steps than upper division students. Some planned the project to be too complicated for a three-week camp, and one freshmen team had difficulty finding the balance for a moving object. Several teams could not demonstrate their projects, even though they worked during test runs. The level of program satisfaction increased as the academic year advanced. However, freshmen showed a high level of satisfaction at 4.25 out of 5, compared to 4.32 for seniors, showing that freshmen also had rewarding learning experience in the camp.

Number of team members : The team had to learn to operate the digital tools and complete the project in three weeks. Each team started with four members, but some had a member dropping out or not all members participating in all phases of the project. When such instances happened, the team often could not finish the project before the deadline.

CONCLUSION

The teams that participated in the WISET Seoul Digital Camp had different experiences depending on the team composition. The design and fabrication experience of some majors, such as mechanical engineering and upper level students contributed to producing quality projects. The number of team members was also an important factor, contributing to project quality. The camp provided opportunities for female students to reveal the esthetic elements in the project. More guidance and consulting were needed for the lower division students as well as some majors to provide them with a more rewarding experience of completing the projects.

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Mo_ED_2_2

GRAND CHALLENGE TECH+ INNOVATOR PROGRAM OF SUNGKYUNKWAN UNIVERSITY HUB CENTER

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Abstract : *Sungkyunkwan University (SKKU) Hub Center for Innovative Engineering Education initiated the GCTI program in 2012 to nurture holistic engineers who can solve Grand Challenges for Engineering problems and create future industry for the sustainable growth of economy in the 21st century. The GCTI program is a multi-disciplinary team based, multi-university, extra-curricular program with three phases : envisioning, empowerment and experience. Even though the educational effects of the GCTI program has not fully analyzed yet, the current status of the program will be discussed with some initial successes.*
Keywords : *Grand Challenges of Engineering, Multi-disciplinary, Multi-university, Extra-curricular*

INTRODUCTION

The Grand Challenges for Engineering (GCE) defined by US National Academy of Engineering (NAE) in 2008 is composed of the 14 most challenging problems to be addressed by the engineering community in the 21st century (National Academy of Engineering, 2008). The GCE problems are closely related to global issues about energy, environment, health, safety, and sustainability. Solving these challenges is crucial for the sustainable growth of society and the economy. They are very difficult and highly complex so that the solutions must be found by creative innovators with multidisciplinary approaches in a collective intelligence network. The Grand Challenge Tech+ Innovator (GCTI) program nurtures GCTI students who can solve these problems and cultivate new start-up enterprises based on the solutions. The GCTI students need to have not only a very deep knowledge in engineering but also sound understanding of humans and society. In addition, they also able to be invoke creative ideas with their convergence skill. However, the conventional engineering education in Korea is not fitted to nurture these new types of engineering students with holistic talents. To address such a need, the Sungkyunkwan University (SKKU) Hub Center for Innovative Engineering Education initiated the GCTI program in 2012 to nurture undergraduates with its 13 member universities.

OBJECTIVES

Nurturing GCTIs who can solve the GCE problems and create new industry based on the solutions invoked for the sustainable growth of global economy in the 21st century.

METHOD

The GCTI program is a multi-disciplinary team based, multi-university, extra-curricular program with three phases : envisioning, empowerment and experience.

1.Envisioning phase : Exposure to opportunities of solving GCE problems and creating innovative enterprises for the sustainable growth of global economy in the 21st Century. This phase is composed of three major activities; 1) GCTI Vision

Camp where students establish their career paths as GCTIs, 2) GCTI Leadership Camp to build up students' leadership and entrepreneurship for solving GCE problems and cultivating start-up enterprises, and 3) GCTI Global Camp to strengthen the global horizons of the students.

2.Empowerment phase : Introducing NBIC (Nano, Bio, Info, Cogno) convergence technology by short lectures.

3.Experience phase : Performing a team-based, GCTI Creative Research to invoke solutions on small-scale, specific problems (defined by student teams) related to the 14 GCE problems, and writing business proposals for innovative start-ups based on their solutions invoked. This phase is provided an opportunity to carry out multi-disciplinary, team-based, and creative research on GCE problems under very close support from faculty and industry mentors. In this stage, each team composed of students from various disciplines, advisors, and industry mentors forms a GCTI learning community in which multi-disciplinary knowledge and experience are cohered and shared to find solutions for the GCE problem under investigation.

RESULT

Student teams are recruited in the beginning of the fiscal year (in March and April) to carry out their GCTI Creative Research for about 6 months (from May to October) and write the business proposal usually in December. In year 2016, a total of 44 student teams are participated to the GCTI program from 13 universities, under the supervision of 37 professors and 12 industrial mentors. To support students' research, SKKU is providing various rapid prototyping tools (such as 3D printers and laser cutters) equipped in SKKU Learning Factory which is open 24 hours 7 days a week.

CONCLUSION

The GCTI program is a small-scale, experimental program for nurturing holistic engineers who can solve the GCE problems. The educational effects of the GCTI program are not fully analyzed yet, partially due to relatively short period of operation. Currently, SKKU Hub center is carrying out an investigation on the program outcomes, which will be discussed in the near future.

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Mo_ED_2_3

AN M-LEARNING MATURITY MODEL FOR UNIVERSITIES AND HIGHER EDUCATIONAL INSTITUTES

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Abstract : *An m-learning maturity model is put forward in this research to assess the mobile technology adoption rates in universities and higher educational institutes. The model is derived from Capability Maturity Model (CMM), which has been widely used in organizations to gauge the adoption of various new processes. Five levels of m-learning maturity are specified including preliminary, established, defined, structured, and continuous improvement. Each of these maturity levels is gauged through nine critical success factors (CSFs) in assessment questionnaires. The CSFs used in measuring instrument of the model are adopted from three of our previous empirical studies. Using an assessment questionnaire and a rating methodology, the study replicates the model to two universities to gauge their level of m-learning adoption. Thus, two case studies are presented to evaluate the applicability of the model. Hence the model provides a comprehensive approach, while opening new areas of future research.*

Keywords : *e-Learning, Mobile learning, Learning systems, Critical success factors, Capability maturity model*

INTRODUCTION

Mobile technology has become a ubiquitous part of our daily lives by offering innovative ways to communicate, gather and share information, and entertain [1]. At the same time, the unique capabilities offered by smart phones and mobile devices of today, make them a potential learning tool as well. By diminishing the boundaries and limitations of space and time, mobile devices have the potential to enrich the learning experience of learners.

Acknowledging the applicability and potential offered by mobile devices, many educational institutions have started adopting them as a tool to extend and facilitate learning to students. However, unlike various existing maturity models [2], [3], [4], no specific m-learning maturity model is available to date to test the adoption rates in universities and higher education institutes. Since the lack of an evaluation methodology is one of the major hurdles in implementing m-learning across educational institutions, the need for such a model is critical.

OBJECTIVES

Adopting the Capability Maturity Model (CMM) as the underlying framework and making appropriate modifications, this research work puts forward an M-Learning Maturity Model (MLMM) with the aim to gauge the maturity of m-learning adoption amongst higher educational institutes.

METHODS

The model takes into account various critical success factors to enable the assessment of m-learning adoption from different perspectives including university management, students, and instructors [5], [6]. Additionally, the study also offers a rating methodology and assessment questionnaires. To test the model, case studies of two universities are also presented.

RESULTS

The current maturity of an m-learning platform is assessed by this model with assessment methodology of defining and conducting case studies. An integral feature of the MLMM is the methodology for specifically evaluating m-learning platform maturity [7]. This model will help university management perform adoption and assessments of their m-learning projects and boost their upgrading strategies.

CONCLUSION

The proposed MLMM model is based on nine key factors, and we have empirically analyzed and identified them in the three previous studies. The area that is less attractive to the researchers is the CSF assessment of m-learning, and, accordingly, a process that estimates the m-learning maturity is the main contribution of this work. An evaluation questionnaire for four of the five maturity levels is part of composition of the framework of this model, as well as a rating methodology and a performance scale. Additionally, we have also studied the execution of two m-learning projects in two universities and discussed the findings as case studies. Leaving the limitations aside, this work has contributed to setting up an all-inclusive approach for m-learning maturity and addressed the imperative subject of factors of evaluation in m-learning.

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Mo_ED_2_5

THE ROLE OF STATUS OF ENTREPRENEURIAL UNIVERSITY IN TRAINING ENGINEERING STUDENTS

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Abstract : *the article deals with issues concerning the influence of entrepreneurial university status on engineering students' training in Kazakhstan. It gives prospects for development of entrepreneurial universities in Kazakhstan, challenges that they face during development and ways to respond to these challenges. The reason to transform university into entrepreneurial one is to offering educational programs for engineering students in university.*

Keywords : *Entrepreneurial University, educational program, engineering, technical education, quality of education.*

INTRODUCTION

What is Entrepreneurial University? What should be done to become Entrepreneurial University? What is the best response to challenges? These questions are currently central in the educational space of Kazakhstan. It is vital that the model of entrepreneurial university development to become a strategy of development. "Transformation of D. Serikbayev State Technical University into innovative Entrepreneurial University focused on acquiring comprehensive knowledge, introduction and employment of high technologies, training of globally competitive engineers." – is a strategic goal of the university and the strategic plan is aimed at gradually archiving the goal.

OBJECTIVES

The aim of the research is to find solutions for successful development of Entrepreneurial University type in Kazakhstan. The main characteristics of universities of this type are qualitative training of engineering students, competitiveness of not only university graduates but level of commercialization of comprehensive knowledge and scientific research results achieved by the university staff, relevance in funded research and contractual projects. In this case, one can consider the university itself or university's activity as a shareholder of entrepreneurial process, which becomes natural environment for engineering training.

METHODS

Design-experimental and research activities because their commercialization are the base for entrepreneurship in the university. Therefore, it is necessary to have highly skilled, creative scientists, engineers, both specific specialists and economists and managers who understand special nature of innovations. The solution in this case is to develop human resources by lifelong learning, global joint educational projects as well as recruitment of gifted researchers on contract base in the frame of academic mobility, in the frame of agreements on scientific collaboration between goverment and international institutions of high education and by attracting gifted young people to study at the university. Besides, infrastructure is needed. It should conform the conditions and demands of scientific and practical researches, actual operating conditions, adequate and safe equipment.

Some basic elements already exist; they are shared republic centers – research-engineering laboratories with unique equipment.

One of the most important aspects of Entrepreneurial university development is close connection and cooperation with production, which is the main consumer of university product : both specialists and up-to-date technical and various methods engineering. The connection is not always effective. It is important for the university to find its own "niche", establish scholarly traditions in critical technologies demandable not only today, but also in the nearest future and very long term. To achieve that it is essential to have joint (university and business) strategic planning which allows university to form portfolio of projects able to commercialization sought-after technologies and projects.

Active global collaboration has essential importance in competitiveness of the university too.

The above mentioned aspects of entrepreneurial university form the basis to train engineers, who are able to solve manufacturing and economic issues.

RESULTS

The article attempts to define features of entrepreneurial university, prospects of development of entrepreneurial universities in Kazakhstan, Entrepreneurial University allows the implementation of engineering training educational programs.

CONCLUSION

The model of Entrepreneurial University has such advantages like : possibility to commercialization of research and design projects; gain and demonstrate comprehensive knowledge due to educational programs. This kind of university model is the most effective in competitive engineers' training.

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Mo_ED_2_7

IMPROVING THE EFFECTIVENESS OF MULTIDISCIPLINARY TEAMWORK IN AN ENGINEERING CAPSTONE DESIGN COURSE

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Abstract : *This study aims to identify students' characteristics of multidisciplinary teamwork and to derive a set of feasible teaching and learning strategies to improve problem solving skills. To do this, we will explore students' collaborative problem solving skills and individual roles through completing tasks. Consequently, we can suggest effective teaching and learning strategies to improve collaborative problem skills in a engineering capstone design course. In this qualitative study, five students with different major have been participated in an engineering capstone design course along with design thinking process. Authors will use several different measures to explore students' collaborative behaviors, such as classroom observation with colleagues, self-reporting, interview, or tests. To analyze data, authors analyzed students' behaviors based on the design thinking process model. Authors expect results to show featured characteristics in a multidisciplinary small group. Secondary research suggests how to promote and engage students to teamwork tasks. Another important result we expect to see from this research is a connection between real world problems and University classes.*

Keywords : *Teamwork skills, Multidisciplinary approach, Capstone design course, Design thinking*

INTRODUCTION

Teamwork or collaboration has been recognized by educators and scholars as one of the major skills comprising workforce readiness in the 21st century [1]. Recently reformed curriculum and instruction approaches have focused to a large extent on teaching and assessment [2, 3]. Teamwork is defined as "an ability to function in multidisciplinary teams" [4], and the Accreditation Board for Engineering and Technology (ABET) has emphasized teamwork skills among the criteria for accrediting both computing and engineering programs. Both potential employers and ABET expect students to gain competencies in teamwork skills through experiential learning. Moreover, teamwork based projects challenge the student to apply the technical knowledge they gain in school to solve meaningful and complex problems. Despite the perceived importance of teamwork in education, with teachers frequently assigning projects that require student collaboration, students seldom receive any specific training on how to function collaboratively before such assignments are given, and little attention is given to how teams are formed [5]. Consequently, teams often fail to function effectively. More importantly, reliable assessments of teamwork based on project learning are scarce, making it difficult for teachers to evaluate students' teamwork skills.

Capstone design courses seek to prepare engineering students for the industry by challenging student teams to solve real-world problems. To improve this preparation, university programs have recently focused on creating multidisciplinary teams [6]. However, there is limited quantitative evidence showing that multidisciplinary student engineering teams develop higher quality projects or are better prepared for the work force. The evidence for their effectiveness is also mixed, and the degree to which they have been absorbed into practice varies widely across conditions and settings.

OBJECTIVES

This study aims to identify students' characteristics regarding multidisciplinary teamwork and to suggest a set of feasible teaching and learning strategies to improve problem solving skills. To do this, we will explore students' collaborative problem solving skills and individual roles through completing tasks. Consequently, the overall goal of this study is provide recommendations for effective teaching and learning strategies to improve collaborative problem skills in an engineering capstone design course.

METHODS

Five students participated in this qualitative study. Each student represented a different major: as information technology, new material engineering, computer science, mechanical engineering, and civil engineering. Students participated in an engineering capstone design course along with a design thinking process. Authors will use several different measures to explore students' collaborative behaviors, such as classroom observations with colleagues, self-reports, interviews, or tests.

To analyze data, authors analyzed students' behaviors based on the design thinking process model. Starting with understanding people within the context of the challenge, students as human-centered problem solvers will define problems, generate the broadest range of possibilities, build to think and test to learn, and test the prototypes they created. The analysis will be done over the course of a single course of capstone design at University level.

This study is currently on going. Students are researching social and interpersonal issues in Cambodia. This experience requires students to go through problem solving processes. Once becoming human-centered problem solvers, they will have opportunities to interview the Cambodian people and test their prototypes and physical objects, within the real context of the user's life. To do this, we have been working with Cambodian non-governmental organizations (NGOs) and local communities to identify details of local situations. We also have plans to visit Cambodia for ten days in July to apply students' ideas. The analysis will be conducted by September.

EXPECTED RESULTS

The authors expect results to show distinct characteristics in a multidisciplinary small group. We believe that different leadership types will be shown through problem solving processes. Another important result we expect to see from this research is a connection between real world problems and University classes. By analyzing qualitative data, this study hopes to develop more effective teaching and learning strategies and improve our understanding of students' difficulties when completing tasks.

EXPECTED CONCLUSION

Authors expect that the interdisciplinary teams' holistic performance in innovation, utility, analysis, proof of concept, and communication skills will be superior to that of their mono-disciplinary counterparts, thus improving their employability.

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Tu_EE_1*_1

AN ONLINE INTERVENTION TO IMPROVE SPATIAL SKILLS

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Abstract : *A well-established link exists between spatial visualization skills and academic and professional achievement in STEM fields. It is also widely documented that men outperform women on tests of spatial ability. This disparity puts women at a relative disadvantage for academic success in STEM disciplines. Previous work has shown that spatial visualization ability can be improved relatively quickly through practice; interventions have successfully improved student scores on spatial skills tests as well as grades and retention in postsecondary STEM courses. This paper describes an online intervention to improve the spatial visualization ability of first year engineering students. Spatial ability was measured using two standard psychometric instruments for measurement of spatial visualization.*
Keywords : *spatial visualization, mental rotation, academic success, retention*

INTRODUCTION

The link between spatial skills and academic and professional success in STEM fields is well documented [1-5]. A longitudinal study of 400,000 followed high school students for eleven years after graduation to demonstrate that tests of spatial ability can predict group membership in various engineering and physical science occupations [1]. Research conducted at Michigan Technological University in the United States demonstrated that spatial skills were a strong predictor of academic achievement and retention in engineering [3].

Gender differences in spatial ability, favoring men, are broadly reported in the literature [7-11]. The differences are mainly limited to mental rotation ability [11, 12], which is also the ability most predictive of success in engineering and physical sciences [6, 13, 14]. Sorby and co-authors [3, 15, 16] reason that poorly developed 3-D spatial skills may be a hindrance to success in engineering programs that disproportionately affects women. The removal of such barriers to academic success is of particular interest in the context of current efforts to increase the number of engineering graduates entering the workforce and to increase the participation of women in the profession.

Fortunately, there is evidence that spatial skills can be improved in a relatively short time through appropriate instruction and practice. Targeted spatial skills interventions have resulted in substantial gains in spatial skills test scores, eliminate the gender gap in spatial skills test scores, improved student academic performance in engineering courses, and increased retention of students at the university [3, 17].

OBJECTIVES

This study examines the effectiveness of a novel, software-only intervention to improve the spatial visualization ability of engineering students.

METHODS

A pretest-posttest experimental research method with a comparison group was used on a large cohort of students to evaluate the effect of using a software-only teaching module as an intervention for increasing the spatial abilities of first year engineering students. The sample group comprised approximately 350 first year engineering students in their first term at Rowan University in the United States. The Revised Purdue Spatial Visualization Test : Rotations was administered during the first week of class in the fall term and again at the end of the term in December. The training was offered as part of the Freshman Engineering Clinic introductory course, which had 16 sections. The training was optional and was conducted at the discretion of the instructor of the course, with 8 sections completing the training and 8 sections opting out, forming an experimental group and a comparison group. This study focuses on the students who had weak spatial ability initially (a PSVT : R score of 60% or lower). Statistical methods employed to analyze the results included Welch two sample and paired t-tests, two- way Anova, and Cohen's d effect size estimates.

RESULTS

A total of 285 students participated in the study. 70 students achieved a pretest score of 60% or less. Of those who failed, 26 were in the experimental group (Population 1). These students completed an average of 127 minutes of software intervention. 44 students who failed the pretest were in the comparison group that received no intervention (Population 2). 81% of the students who failed the pretest and completed the training passed the posttest, in comparison to 50% of the students from the control group.

Students who failed the pretest and were in the experimental group that completed the training achieved a mean pretest score of 14.9 out of 30 in comparison with 15.1/30 correct for the students who failed the pretest and received no training. The difference between pre-test means for these two populations was not significant (p=0.75). Students who failed the pretest and received training achieved a mean posttest score of 21/30, in comparison with 18.3/30 for the students who failed the pretest but received no training. This difference between means was significant (p=0.005). An effect size (Cohen's d) of 0.735 was computed for the gain between the two groups.

Of all the students who failed the pretest, 24.4% were male and 39.6% were female. Women who failed the pretest and took the intervention had a significant increase in mean test score from 14.7 on the pretest and 21.0/30 on the post test (p=.009). Women who failed the pretest and did not participate in the training showed a smaller gain between pretest and post test. Their mean pretest score was 15.92/30 and the mean posttest score was 18.31. A similar trend was observed with the men who failed the pretest. The experimental group showed a gain in mean test score from 15/30 on the pretest to 21/30 on the posttest. The mean score of the comparison group increased from 14.8/30 to 18.3/30. Of the students who failed the pretest and completed the training, men and women performed equally well on the posttest.

CONCLUSION

A software-only intervention successfully increased the spatial visualization ability of first year engineering students as measured by the Revised Purdue Spatial Visualization Test : Rotations. Students who failed the pretest and completed about two hours of software-based intervention using an online training program showed significant gains in spatial skills test scores. There was no difference between the mean posttest scores of men and women in this group.

The software intervention offers several advantages over conventional classroom interventions. Because the training is available online, it may be completed independently by students at their own pace. This mitigates many of the logistical difficulties of offering a conventional for-credit classroom intervention, such as instructor time, classroom scheduling, and student scheduling. The intervention required an average of only two hours of student time, in comparison with a full semester of class time and homework time required for a conventional course-based intervention.

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Tu_EE_1*_3

Interest and Perception of Value of Multinational Projects Among Engineering Students : A Comparison Based on Geographical Location and Class Standing

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CONTEXT

The rapidly growing information technology capabilities are facilitating the creation of multinational teams as one strategy for global competitiveness. As a result, there is a growing demand to prepare professionals to be ready to perform in those global environments. Consequently, the authors started introducing multinational collaborative projects in engineering courses as an educational approach to expose students to an international experience where they can start developing the necessary competencies required by this new global order. However, the effectiveness of this practice had not been rigorously evaluated until recently when the authors started studying different aspects of this practice with the aim of improving the learning experience to attain the desire goals. Initially, the interaction among the participants was identified as a critical issue for the success of the practice and was studied by the authors. That work let to new questions to better understand the behavior of the students during their involvement and interaction in the collaborative project. One of these questions is related to the motivation that students have about this practice. Motivation is an important factor that triggers interest which is an important construct that contributes to the learning experience. In the particular case of engineering, some efforts have been done to evaluate and enhance motivation in the students with the aim not only of succeeding in specific topics but also to enhance students' self-efficacy and self-confidence in the field.

This paper presents the results of an evaluation to determine the level of interest and perception of value of students participating in an engineering multinational collaborative project. This comparison is based on geographical location and class standing, demographic characteristics that were used to evaluate the students motivation when giving the opportunity to participate in a multinational project. The evaluation was based on a survey administered to more than 200 students in 6 different countries, and 5 levels of college experience. Results indicate a high level of interest and perception of value in the multinational experience, with no significant differences due to specific geographic location or class standing.

PURPOSE

Based on the literature search, it can be stated that motivation is an important factor that triggers interest which is an important construct that contributes to the learning experience [1]. In the particular case of engineering, some efforts have been done to evaluate and enhance motivation in the students [2] with the aim not only of succeeding in specific topics but also to enhance students' self-efficacy and self-confidence in the field [3]. Results from previous work [4] led the authors to believe that motivated students will (a) have the interest necessary to get immerse in the project, (b) have the disposition to overcome difficulties in the development of the project (including broken communication, level of commitment, and cultural barriers), and (c) recognize the value of the experience. If those elements take place, then, it is expected that students will enhance their confidence when undertaking multinational projects, perform better in the task at hand (including effective teamwork and communication), and appreciate the global experience. Therefore, the aim of this work is to evaluate the interest and perception of usefulness of multinational project in engineering students at different locations in the US, Latin America and Italy, and with various class standings. The purpose is to have an understanding of those critical factors to answer the following research questions :

1. Do students enter into the multinational collaborative project with a high level of interest and a high perception of usefulness for this activity?
2. Are there significant differences on interest and perception of usefulness among the students based on their geographical location, or class standing?

APPROACH

In this study, a survey based on the Intrinsic Motivation Inventory (IMI) [5] was used to capture students' perception before their participation in a multinational collaborative project. The first four questions in the survey were about demographics. Then, 27 statements are given and students are asked to give their personal level of agreement. Their answers were based on a Likert scale from one to seven, where one is "not at all true" and seven is "very true". Those 27 questions are distributed into five constructs for motivation : interest/enjoyment (7 items), perceived competence (5 items), pressure/tension (5 items), perceived choice (5 items), and value/usefulness (5 items).

From a total of 218 surveys submitted, 182 were completed correctly. Students completed the questionnaire before they started the project. The survey was designed to be completed online. Students were told that their participation was anonymous, voluntary, that their participation would not affect their academic evaluation, and that all information would be confidential.

The data was collected from students participating in the global collaborative project. Descriptive statistics were performed using standard statistics software. There was a higher percentage of participation from first, second and fourth year engineering students (Figure 1). The gender of participants follows the standard breakdown in engineering [6] (Figure 2), and the distribution per country can be seen in Figure 3.

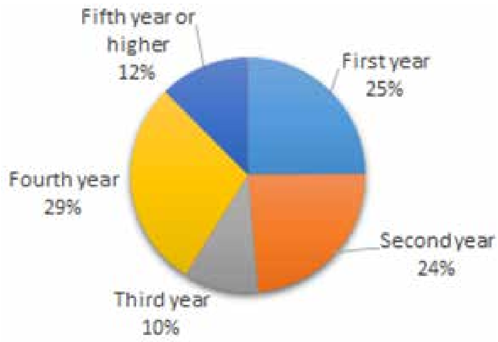

Figure 1 : Class standing distribution

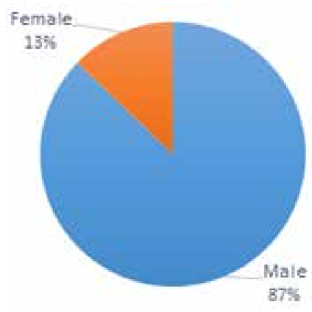

Figure 2 : Gender distribution

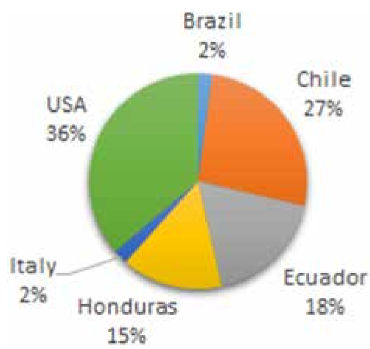

Figure 3 : Geographical location distribution

RESEARCH QUESTIONS ANALYSIS

For the first research question (i.e., level of interest and perception of value), according to the performed evaluation, students displayed a high level of intrinsic interest towards their participation in the multinational collaborative design project, and the majority of students expected this experience to be very useful and of great value for their education. This is concluded based on the overall scores collected from the survey (74% of the maximum possible score in the interest construct and 83% of the maximum possible score in the expected usefulness). It was also notable the low level of pressure they expected to experience for participating in the program (54%) and the high level of preparedness (competence) they felt they already had to undertake the collaborative project (73%).

For the second question (i.e., effect of geographical location and class standing), in the case of the geographical location, the interest of students towards the multinational collaborative project and their belief regarding its value for their professional career show no significant differences in all countries involved. In the case of class standing, the students' perception of value and their anticipated interest show significant differences between students from different class standings, with a decrease as the students have higher class standing. Of interest is to note that even when not statistically significant, there is a higher perceived pressure based on class standing, particularly between third year students compared to first and fifth year students. Additional conclusions have been drawn, and will be included in the final manuscript. The goal with these evaluation is to have a good representation on the students' level of motivation when facing participation in a multinational project.

The responses to those questions will allow the research team to determine the intervention actions that might be needed to enhance the overall experience including pre, during and post project learning activities.

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Keywords : *Multinational Project, International Collaboration, Interest, Value, Motivation*

Tu_EE_1*_4

A PRODUCTS LINES REQUIREMENTS ELICITATION APPROACH WITH APPLICATION TO A FAMILY OF UNIVERSITY MODELS

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Abstract : *In any activity field or domain, organizations with the same purpose have a set of common invariable features and a set of variable ones. All features are represented in the domain model. Each one of these organization models belongs to a line or family of organizations models. In a line or family of Universities appears intuitively the common and variable characteristics, due to inherent institutional and academic similitudes, and variable features represented in the education domain model. The accelerated change in the society, in the knowledge, and in the technologies, as well as the economic globalization and interdependency of communities and persons demand rapid, economic, and effective creation or adaptation of organization to new and increasing exigencies. In order to face these challenges, this article introduces a Requirements Elicitation approach for a family o Line of organizations models, considering problem-based goals definition and the establishment of processes for accomplishing these goals. In our research the introduced approach for Requirements Elicitation of Product Lines is adapted to the creation or modification of University Models based on the Minerva University Model (MUM).*

Keywords : *Product Lines Requirements, Requirements Elicitation, Goals-Centered Domain, Line of University Models, University Models Implementation.*

INTRODUCTION

In the development of solutions in organizations of all economic sectors and social activity fields is used the domain modelling as a way to organize the knowledge involved in those solutions. All organizations of a particular domain use a common part of this knowledge and of the other part of domain, each organization takes optionally knowledge necessary for attaining its objectives. Domain knowledge concepts may be materialized in multiple ways. From different existing options for representing the domain models, in this work, the Characteristics Model is adopted. This one constitutes a good expression of reusability and variability, as well as it accepts the introduction of goals to be accomplished by the Organizational model.

The Product Line approach is applied to enterprises of each economic sector. In this sense, the creation of University models follows, in a natural way, the approach of Product Lines. In a line or family of Universities appears intuitively the common and variable characteristics, due to inherent institutional and academic similitudes, and variable features represented in the education domain model. The accelerated change in the society, in the knowledge, and in the technologies, as well as the economic globalization and interdependency of communities and persons demand rapid, economic, and effective creation or adaptation of organization to new and increasing exigencies. In order to face these challenges, this article introduces a Requirements Elicitation approach for a family o Line of organizations models, considering problem-based goals definition and the establishment of processes for accomplishing these goals. In our research, the introduced approach for Requirements

Elicitation of Product Lines is adapted to the creation or modification of University Models based on the Minerva University Model (MUM).

OBJECTIVES

In our research project centered in improving of the academic knowledge management and the adoption of University Models, the adaptation of university models to particular characteristics of an institution and the implementation of the model constitute an essential objective.
In this article the purposes is to introduce a Requirements Engineering approach for Products Lines, illustrated in the adaptation and implementation of Minerva University Model according to particular Requirements of a University.

METHODS

The proposed Requirements Engineering Approach defines big areas and strategic Areas of the Organization. In each strategic area, problems are identified, problem-based goal are established, and agents involved in the solution are identified. For each goal an accomplishment process is formulated. Then, it follows the construction of the domain model, and the elicitation of solution requirements, using the agents' actions and interactions of the goals accomplishment processes. With the requirements, solution Functionalities are defined, Functionalities Units and required Information Structures are organized, and a logic model of the solution, integrating Functionalities Units and Information Structures is constructed.
Appling this Requirement Approach for the adaptation and implementation of the MAM, the defined big activity Areas are : EDUCATION (TEACHING AND LEARNING), RESEARCH, SERVICES FOR THE SOCIETY, ORGANIZATIONS, AND PERSONS, CREATION, DEVELOPMENT, AND DIFFUSION OF CULTURE). The strategic areas, named action axes, in MUM, are : Educational-Academic Model, Curricular Structure, Research and its Integration to the Model, Management of the Model, Social Integration Model, and Regionalization. Equally, in MAM implementation, a Features Model headed by the big area and the strategic areas is adopted as Domain Model.

RESULTS

Our research on University Models introduce a Requirements Elicitation Approach for a Lines of University Models based on Minerva University Model. Many adaptations of the MAM to particular exigencies of Universities are obtained. Effective and manageable implementation processes of goals and functionalities a contribution of this work.

CONCLUSION

The introduced requirements elicitation approach is a way to construct a line of solutions for organizations of any domain, and adjust these solutions to the situation of each organization. The Requirements Elicitation Approach allows to adapt and implement effectively the MAM to the characteristic of any University. Accomplishment processes for University goals are included too.

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Tu_AE_1*_1

PROMOTING LEARNING MOTIVATION AND EMOTION IN INQUIRY-BASED LEARNING ENVIRONMENT THROUGH IN-CLASS QUESTIONS WITH INTERACTIVE RESPONSE SYSTEM

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Abstract : *Positive emotiona can arouse positive learning. Serval instruction can lead positive emotion and learning motivation, such as inquiry-based learning. Inquiry-based learning is a complex learning process. Some learner were feel difficult with complicated tasks and decrease their motivation and arouse negative emotion. This study proposed an in-class questions with interactive response system (IRS) in the inquiry-based learning environment. The Achievement emotions questionnaire and motivated strategies for learning questionnaire were collected in this study for evaluating the effectiveness. In the results, achievement emotions and learning motivation were measurement in the learning activity. Overall, achievement emotions can be elicited, and learning motivation can be increased through the IRS supporting inquiry based learning activity. It would promote learners' learning desire and learning effectiveness.*

Keywords : *Learning motivation, Achievement emotion, Inquiry-based learning, in-class question, Interactive response system.*

INTRODUCTION

Positive learning is an ideal learning environment that provides learning persistent [1]. Learning status affect learning emotion and then influence learning motivation[2]. For facilitating learning achievement, some instructions were used in the education program, such as Inquiry-based learning. Inquiry-based learning was implemented in Taiwan for serval subject[3, 4]. For the inquiry-based learning activity, learners need to collect the relevant source, integrate content. It's a complicated process of learner that may be depressed learning motivation and achievement[5, 6]. Therefore, eliciting positive emotions and promoting learning motivation were being emphasized. The in-class question is a common instructional in learning activity which can be improve the interactive between learners and the participation[7]. This instructional support does not always have a positive learning impact on students. [8] and [9] noted that most students who are asked in-class questions may suffer from high levels of anxiety. Through the educational technique with information technology development, the interactive response system can be facilitated learning motivation and emotion[10].

OBJECTIVES

This study thus uses Interactive response system (IRS) to reward students for answering an in-class question in the inquiry-based learning environment, and this is intended to arouse 'feelings during a class. It is predicted that the IRS will increase students' positive emotions, focus them on the course content, and increase their learning confidence, so as to enhance their learning motivation. Based on the above prediction, three studies were conducted to answer the following questions :

1. Do questions using interative responsed system (IRS) elicit greater positive emotion states as compared to questions that do

not have IRS?

2.Do questions using interative responsed system (IRS) promoting better learning motivatioas compared to questions that do not have IRS?

METHODS

In the research design, inquiry-based learning approach in the learning activities was implemented with the IRS. The application of the IRS, which applied in this study is Plickers. The learning activity progress took a total of 8 weeks, including two stages. First stage, normal inquiry-based learning was used in the instruction for 4 weeks. In the second stage, the inquiry-based learning with IRS took after the first stage. Each stage took 20 tasks for learning activity. The aim of this study was determined the influence of an inquiry-based learning approach with regard to improving vocational high school students' achievement emotions and learning motivation. For evaluating the effectiveness, 35 participants ages 15-16 completed the learning activity used in this study. The topic of the learning activity was a mechanical drawing practice course in vocational high school. When learners finished the learning activity, the achievement emotions and the learning motivation questionnaires were taken. The instrument of achievement emotions and learning motivation were developed by [11] and [12]

RESULTS

The paired t-test analysis was used to evaluate the achievement emotions and learning motivation. Both two variables are significant differences in the learning activity. The result indicated that achievement emotions can be elicited and learning motivation can be increased with the IRS. Furthermore, the analysis result presented positive achievement emotions in the learning activity. Otherwise, The result of learning motivation point out that IRS supporting inquiry based learning is higher than without IRS.

CONCLUSION

An inquiry-based learning approach is implemented with an interactive response system (IRS) in vocational high school. Overall, learning motivation can be increased through the IRS supporting inquiry based learning activity. It would promote learners' learning desire and learning effectiveness. Most learners hopefully can be performed inquiry-based learning with IRS in their future learning activities.

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Tu_AE_1*_2

THE EVALUATION OF A GESTURE-BASED ANNOTATION E-BOOK SYSTEM FOR ELEMENTARY SCHOOL STUDENTS

Yu-Cheng Chien

Abstract : *E-book learning systems provide a range of benefits to both teachers and students, which create a novel integrated learning environment. The applications of e-book can not only promote the different reading habits, but also support educators to integrate with some teaching activities and strategies. Traditionally, when a learner read an e-book, his/her manipulations with e-book learning system to do annotations are complex processes of learning. Therefore, this study aimed to develop a gesture-based annotation e-book system to provide a novel way of doing annotations. Learner can easily complete actions to do an annotation by using his/her finger to drag and drop a shape on touch screen. Moreover, the annotation operations can be translated into a learner's reading rates and reading disfluency, and be used to help teacher to observe student's learning situation. Finally, a comparison of simple experiment and an interview were adopted to ensure the effectiveness of proposed approach in this study. Overall, using proposed system can accurately calculate the student's reading rate, and the result of interview also came out several important usefulness and suggestions of gesture-based annotation and readability analysis mechanisms in order to improve this e-book system in the future.*

Keywords : *e-book learning system, gesture-based annotation, reading behavior analysis, reading rate, reading disfluency*

INTRODUCTION

Due to the development of information technology, learning was no longer confined to paper-based presentation. The development of modern e-book systems changed the way of teaching[1] and learning[2]. Several researchers thus have paid much more focus on developing and designing the user interface of e-book learning system[3], in other words, they attempted to modify the operations to improve usefulness of an e-book[4]. On the other hand, to combine with the Internet and mobile technologies, an e-book system became not only a reading device but also an integrated learning environment[5]. When a learner reads an article on e-book, his/her manipulations with the user interface of e-book system can be recorded as detail as possible[6]. These operation records will be stored and analyzed, and then, the results can be feedbacked to the learner or teacher[7], even the parents. However, the traditional text selection mechanism on touch screen is difficult to manipulate, which maybe lead to those un-accurate records[8]. Hence, it's necessary to provide a more convenient operation of annotation for reading on e-book system.

OBJECTIVES

This study thus develops a gesture-based annotation e-book system, which changes the way of annotation unlike in the past, and those operation records will be stored and analyzed. It is expected that this system can provide much easier, faster, and more accurate than traditional text selection mechanism. Meanwhile, this system also could detect learner's reading disfluency to help teacher to observe learner's reading situation. Based on the above argumentations, two studies were conducted to answer the following questions :

1. Does using this system have capable of promoting more convenient operation to reading?

2.Is using this system effectively to detect learner's reading disfluency?

METHODS

A gesture-based annotation e-book system was constructed by combining the benefits of touch screen on the mobile device with an e-book learning system. When learner reads articles or materials on this system, he/she can use his/her fingers to drag and drop a shape on touch screen, which is named gesture. If this shape surrounds words or sentences, then they will be annotated. And then, the annotation operations can be translated into a learner's reading rates. Moreover, this study further presented a readability estimation approach to analyze learner's reading behaviors, which can calculate learner's reading disfluency for teacher observing learner's reading situation. On the other hand, student's reading rate collected by our proposed system was analyzed in order to better understand the usability of this system. The elementary school teachers and students tested the proposed system and gave suggestions to improve it. Totally, five teachers and twenty third-grade students in elementary school in southern Taiwan were enrolled in this interview. The evaluating processes included the practice of e-book system (15 minutes) and interview (15 minutes).

RESULTS

In this study, the accuracy of reading rate was compared with system rate and video rate in an e-book reading task. The result of reading rate indicated that the student's reading rate has no significant difference between using system record and using video record. Moreover, the interview was involved to confirm the usability of a gesture-based annotation e-book system. The result also showed that the gesture-based annotation has positive usefulness in the learning activity. Therefore, those result meant that our proposed system could accurately record students' reading rate when they read e-books, and the readability analysis mechanisms also could effectively detect learner's reading disfluency.

CONCLUSION

This study presented a gesture-based annotation e-book system providing an innovated mechanism to do annotations that is much easier, faster, and more accurate than traditional text selection mechanism. Furthermore, a learner's reading disfluency can be detected from this information and feedbacked to the teacher. Therefore, these feedbacks can also provide an opportunity for teacher to observe learner's reading situation when he/she previews or reviews what he/she learnt or will learn.

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Tu_AE_1*_3

VERSATILE AND AGILE SOCIAL MEDIA PLATFORM FOR CREATING, SHARING, EXPLOITING, AND ARCHIVING PERSONAL LEARNING SPACES, ARTIFACTS, AND TRACES

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Abstract : *Nowadays, students bring their full ecosystem of social media platforms and their own devices to school, while teachers benefit from and contribute to local or global repositories of educational resources. As a consequence, educational institutions have to better align their digital infrastructures and support schemes with these personal ecosystems and social practices. They also have to offer resources at a level of granularity aligned with targeted activities rather than full-fledged courses to ease personalization. Institutions finally have to ensure control of learning traces and persistency of learning outcomes. In order to cope with these needs, this paper presents Graasp.eu, a social media platform supporting digital education from primary and secondary school to higher education. Its participatory design, fitness for active learning, and adoption are discussed.*

Keywords : *Collaborative Learning, Inquiry Learning, Personal Learning Environment, Social Media, ePortfolio, Learning Analytics, Participatory Design*

INTRODUCTION

In the framework of three consecutive European initiatives in Technology Enhanced Learning (TEL) aiming at defining online support for communities of practice (CoPs) [1], personal learning [2] and inquiry learning at school [3], the need to provide a versatile and agile social media platform strengthening digital education has emerged. The main features of such a platform mimicking the social media solutions people are using daily include the ability (i) to create online spaces targeting dedicated learning activities by aggregating resources from various cloud or local sources, (ii) to share these spaces with peers (either teachers or students), (iii) to exploit these spaces by interacting with the integrated resources, available tutors, and collaborating peers, as well as (iv) to archive these spaces together with the learning outcomes (produced artifacts) for later use or as proof of personal achievements in lifelong learning. Such features are usually offered by different platforms in typical academic infrastructures. However, to provide control of the full life cycle to the end-users, it appeared that offering a single platform increase adoption, efficiency, and effectiveness.

OBJECTIVES

This paper will present the trends in the design and the deployment of learning environments for science and engineering education from primary and secondary school to higher education. A special attention will be put on solutions enabling teachers to design and personalize themselves the resources they need for their own teaching activities and to equip students with solutions enabling them to carry out active and collaborative learning activities for the acquisition of core and transversal competences.

METHODS

Requirements elicited from participatory design activities carried out with users at various school levels and with various digital skills will be presented together with the solution developed and validated following agile development approaches, i.e. graasp.eu. Activity traces generated by more than 8'000 users will also be exploited to understand usage patterns and adoption level.

RESULTS

The core resource fulfilling the objectives mentioned above is an online learning space (OLS). An OLS can be seen either as a personal learning environment (PLE), if it is kept private, or as an interactive open educational resource (OER) [4], if it is shared under a creative commons license. Such a space combines a container (an interactive Web page with a built-in pedagogical structure), content (including documents, links or apps), activity traces (stored in an embedded activity stream), and learning outcomes (hosted in an embedded vault). In the framework of the ongoing Go-Lab EU project, such online learning spaces have been adopted by teachers to support inquiry learning activities. In this paper, the features which have been designed and implemented to trigger and sustain large-scale adoption and exploitation will be detailed and discussed, including the integrated heterogeneous resources aggregation, privacy enforcement scheme and learning analytics support [5]. Features fulfilling the broader set of requirements proposed by the IMAILE initiative to deliver the next generation of personal learning environments will also be presented.

CONCLUSION

Successful active learning activities at school or in higher education require empowering teachers to create, personalize and share their own rich interactive resources. They also require enabling students to interact with dedicated online resources to acquire core and transversal competences, while producing meaningful learning outcomes that can be shared and kept for lifelong exploitation.

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Tu_AE_1*_4

DESIGN AND DEVELOPMENT OF A BOOLEAN LOGIC SIMULATOR BASED ON QUINE MCCLUSKY ALGORITHM

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Abstract : *This paper presents the design and development of an educational simulation tool for solving Boolean logic equations by simplifying redundancy in the elements of the equations using Quine McCluskey's algorithm. This was done using the Unity3D development environment which provided an interface for the design of the front end of the software. A custom built version of Javascript was used to write the back end code that drives the algorithm. Based on the output parameters decided on by the user for either sum of product (SOP) or product of sum (POS) approaches, the software provides an interactive user interface with three scrollable panels displaying : (i) the truth table with a maximum of six inputs (ii) the Karnaugh Map as well as the generated corresponding simplified logic equation and (iii) the generated logic circuit diagram respectively. The results of the simplified Boolean expressions and logic circuits generated by the developed tool were compared with manually calculated solutions and available html and console based implementations and were found to be accurate. This tool has an edge over previous implementations because it provides a more robust graphical user interface suitable for easy visualisation and multitasking needed for educational purposes.*

Keywords : *Design and Development, Boolean Logic Simulator, Logic Circuit, Quine McClusky Algorithm, Karnaugh Map, Minimization, Digital Electronics*

INTRODUCTION

Electrical and Electronic Engineering Students all over the world at some point in their undergraduate studies, take a compulsory course on Digital Electronics (Petrescu et al., 2015). The course teaches Boolean logic expressions, their simplification, their representation in truth tables and how to plot functional logic circuit diagrams based on a desired predetermined result. Further down the course, several methods of logic simplification for the reduction of more complex expressions are introduced. The process generally involves the dissolution of redundant components of the expressions with the use of Boolean arithmetic or graphical methods like Karnaugh maps.

Typically, the complexity of the raw expressions derived from truth tables and in most cases, the final decomposed algorithms, increases exponentially with the number of variables in question. Because of this, the manual computation of systems with higher variable counts is extremely tedious and cumbersome even with the use of simplified methods like the Karnaugh map. Lecturers and students alike have a hard time simulating larger systems in class during teaching sessions due to the time constraints of typical University teaching sessions. Thus, examples in class only border around simplistic circuit designs with no more than four variable inputs and most students of the subject never get to fully understand the concepts of Karnaugh mapping, or grasp the correlation between the key elements in Boolean logic simplification.

OBJECTIVES

The objective of this work was to create a learning tool which assists both students and their teachers without the need for manual calculations to : (i) easily and effectively simulate simple and complex Boolean equations (ii) visualize both the simplified logic equation and the Karnaugh maps solution. (iii) visualize the final logic circuit diagram.

RESEARCH METHOD

The design used Unity3D development environment (an interactive design engine) which provided an interface for the design of the front end of the software. A custom built version of Javascript (Unityscript) was used to write the back end code that drives the algorithm. The software provides an interactive user interface with three scrollable panels displaying : (i) the truth table with a maximum of six inputs (ii) the Karnaugh Map as well as the generated corresponding simplified logic equation. (iii) the generated logic circuit diagram respectively. The logic conditions can be varied either on the truth table or on the Karnaugh Map panels while the logic equations and circuit diagrams of the simplified expressions are automatically generated from the output parameters decided on by the user for either sum of product (SOP) or product of sum (POS) approaches. The software tool is capable of working on multiple solutions on different tabs at the same time.

RESULTS

The results of the simplified Boolean expressions and logic circuits generated by the developed tool were compared with manually calculated solutions and available html and console based implementations and were found to be accurate and with a better user friendly graphic User Interface (Huang, 2014; Habib, 2004).

CONCLUSION

The developed logic simulator tool has an edge over previous implementations because it provides a more robust graphical user interface suitable for easy visualisation and multitasking needed for educational purposes.

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Tu_ED_3_1

DEVELOPING OF QUALITY-MANAGEMENT APPROACH BASED ON EFQM EXCELLENCE MODEL FOR HIGHER EDUCATION : THE CASE OF QATAR UNIVERSITY

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Abstract : *The European Foundation for Quality Management (EFQM) business excellence model is globally recognized as an organizational support theory to achieve sustainable success through continuous improvement. The prominence of the EFQM Excellence Model within a Higher Education context emanates from its crucial role in achieving and maintaining operational excellence in teaching and learning process. The EFQM excellence model has been widely applied and proven successful in self-assessment of core operational functions of many of universities worldwide. The EFQM excellence model applied in Sheffield Hallam University is one of the successful paradigm of the EFQM extension to the higher education context. Motivated by this example, and others, we propose a quality management approach based on the EFQM Model of Excellence for systematic management and assessment of quality in higher education in College of Engineering, Qatar-University, Doha-Qatar. The fundamental concepts and guidelines of incorporating EFQM Excellence Model in higher education programs are introduced in order to provide depth understanding and guarantee successful implementation of the proposed approach.*

Keywords : *Quality Management, EFQM Excellence Model,*

Tu_ED_3_2

STUDENTS VOICE AS KEY COMPONENT IN CONTINUES IMPROVEMENT OF ENGINEERING GRADUATE PROGRAMS

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Abstract : *Higher education institutions have placed more emphasis on students' voice as a way of improving education and student learning experience. Students' voice has the potential to redefine quality assurance and enhancement processes in higher education. This paper describes the process for continuous improving the quality of engineering graduate programs through students' engagement in quality assurance process. The main purposes of this paper are to map graduate students' view on teaching and learning, and thesis/project supervision, and to use effectively the students feedback for developing graduate thesis supervision model for continuous improving the quality of supervision at graduate programs. In this paper, an online student satisfaction survey was conducted to capture students' voice regarding the graduate teaching and learning, and thesis/project supervision. Engineering graduate programs at Qatar University has been taken as a case to propose graduate supervision model. Descriptive statistics and interpretative qualitative analysis were used to assess students' viewpoints. 29 graduate students participated in the survey. The results reflected that about majority of and half of graduate students appeared to be satisfied with the quality of teaching and learning, and with the supervision they received, respectively. The proposed graduate supervision model includes all the phases and components needed to achieve successful supervision and ensure successful completion of graduate student's research.*

Keywords : *Quality assurance, Graduate programs, Feedback, Supervision model*

Tu_ED_3_3

ON THE ASSESSMENT OF SUSTAINABILITY OF ENGINEERING EDUCATION

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Abstract : *In this work SMART indicators are developed to measure the sustainability of engineering education. The indicators are applied to assess the sustainability of engineering education delivered by the Faculty of Engineering at King Abdulaziz University with its 14 ABET accredited programs. After applying the indicators to measure the sustainability of the present engineering education system, a process is developed to maximize the sustainability and minimize its vulnerability. The assessment detects the drawbacks in the strategic plan as well as the design of the curricula of the engineering programs using typical gap analysis techniques. Although there are environmental, social and economic diversities around the globe, the aim of this study is to establish a clear process of assessing the sustainability of engineering education systems using measurable sustainability indicators.*
Keywords : *Sustainability, Engineering Education, Assessment, Indicators*

INTRODUCTION

Sustainability has become an increasingly important consideration for the society in general as well as for the engineering profession [1]. Although the origins of the debate about sustainable development is usually associated with the publication of the report entitled "Limits to Growth" by the Club of Rome in 1972 [2] and to the 1972 UN Stockholm conference on the Human, the origin of the concept can be traced back 300 years to the work of Hans Carl von Carlowitz on sustainable forestry in 1713 [3]. Nevertheless, there is a general agreement among researchers that the World Commission on Environment and Development report of the year 1987 [4] has mainstreamed the concept of Sustainable Development (SD) and its best known definition : "SD is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

The concept of Education for Sustainable Development (ESD) started being institutionalized in 1992 with the international recognition of Agenda 21 and its specific chapter 36 about education at the UN Earth Summit in Rio de Janeiro [5].

The engineering education for sustainable developments is not only the act of orienting the engineering curricula to cover sustainability topics, but it also requires sustainability measurement for the engineering education approach toward facing current and future challenges that affect the sustainable development [6-8]. It requires a synergy between curriculum developments, and market, social, and environmental needs. Consequently, the assessment of sustainability of engineering educations is a challenge that requires creation of indicators to help in measuring different aspects of sustainability.

Currently, there has been a proliferation of sustainability indicators initiatives worldwide, such that some authors consider that they are part of an "indicator industry" [9].

In the field of engineering education for sustainable developments, the indicators should reflect a sustainable process for curriculum development as well as a sustainable process for achieved student's outcomes. These indicators for curriculum development and student's outcomes should be in good agreement with market needs, social needs and environmental requirements for short-term and long-term sustainable development. The indicators either measure the sustainability or the vulnerability of the system under consideration. Vulnerability indicators are used to measure the weaknesses in some elements such as week points in a strategic plan adverse effects that reduce sustainability. The existence of the vulnerability indicators help to create a measurable baseline rather than seeking perfection without a datum. As an example, it is easy to measure the green house emission, and reduce it below the permissible limits, rather than setting a goal to minimize it without datum. In other words minimizing the vulnerability will maximize the sustainability related to one indicator.

In the present work, indicators are summed up into groups such that each group integrates with other groups to reach a final indication of the sustainability of the educational system. These groups are then cascaded into university, college and program responsibilities. The driving forces for these responsibilities are social, economic and environmental targets. Inside each category responsibilities are cascaded once again from the university top management to the course designer.

OBJECTIVES

The primary purpose of this work is to develop measurable indicators to assess the sustainability of engineering education. The indicators are applied to the engineering education delivered by the Faculty of Engineering at King Abdulaziz University.

METHODS

Based on the five pillar model of sustainability that envisions economic, social, environmental, institutional and cultural dimensions, engineering education indicators are derived to address not only the footprint on the five dimensions but also indicators to keep the system sustainable by minimizing its vulnerability. The application of these indicators on the case of a large size university is then tackled as test case to introduce sustainability targeted modifications.

RESULTS

Practical and universal SMART sustainability indicators for engineering education are derived. The applicability of these indicators to introduce sustainability targeted modifications is demonstrated.

CONCLUSION

A set of sustainability indicators is derived that can minimize not only the footprint of an engineering education system on economic, social, environmental, institutional and cultural dimensions but also the vulnerability of the system itself.

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Tu_ED_3_4

A COST-BENEFIT ANALYSIS OF A QUALITY FRAMEWORK FOR HIGHER EDUCATION IN AN IT UNIVERSITY

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Abstract : *in this paper we conduct a cost-benefit analysis of quality management activities at Innopolis University, Russia. Innopolis University uses a quality framework based on the Educational Quality System developed by the European Association for Quality Assurance in Higher Education. The cost-benefit analysis is achieved by comparing the quality cost to the costs of defects. We do such a comparison by translating the process definitions of quality assurance activities in the university into the required effort in working hours and comparing this figure both to the effort of fixing discovered defects as well as to the estimated cost of fixing prevented defects. We use the results of the cost-benefit analysis to evaluate the adequacy of the quality budget and to produce recommendations on how to better address quality issues of different levels.*

Keywords : *ENQA, EQS, cost-benefit analysis, CBA, quality management, assessment of quality, higher education*

INTRODUCTION

Innopolis University is a newly established university in the Innopolis city, Russia1. The university was established by major Russian IT companies with the mission to reduce a deficit of IT engineers on the Russian labor market. As a newly established academic institution, Innopolis University strives to create visibility and build a positive reputation by providing higher education of exceptional quality. As a part of this effort, Innopolis University adopted a quality management framework, Education Quality System (EQS), designed by the European Association for Quality Assurance in Higher Education.

We believe that education quality can not by achieved by a single task force and requires holistic approach and effort of an educational organization as a whole. Our quality management framework involves the participation of students, teaching and administrative staff, and senior management. Quality assurance includes both short and long term activities. In the short term, we conduct course and teaching staff evaluation by course participants, feedback loop through student organizations, faculty peer reviews, and monitoring of teaching process and regular analysis of the LMS data by the administrative staff. For long-term quality management, we use course and teaching staff evaluation data, final reviews, strategic sessions with industry stakeholders, and so on.

OBJECTIVES

The main goal of this cost-benefit analysis is to estimate the return on investments in quality and the adequacy of the quality budget. In addition to assessing the effectiveness of the quality management framework, we are also evaluating the effectiveness of each specific quality assurance activity in order further to tailor the quality management process.

METHODS

In this section, we give a brief introduction to our quality framework and then address each quality assurance activity from short-term (addressing quality in one year perspective or less) to long-term (over one year) activities. Each activity description includes the following parts :

- Activity process definition
- Estimation (in working hours) of the effort required to implement this activity
- History of the defects discovered by this activity
- History of the defects not discovered by this activity
- Estimation (in working hours) of the effort required to fix both discovered and non-discovered defects

The following quality assurance activities will be analyzed :

- Feedback loop though student organizations
- Course quality monitoring by the Education (twice a semester)
- TA and teaching staff evaluations by students on a semester basis
- Course evaluation by students on a semester basis
- Yearly assessment of faculty staff
- Yearly self-assessment of faculty staff
- Hiring process for the new teaching staff
- Course management
- Program management
- Strategic planning workshops with industry players
- Strategic plan - provost, board of trustees

This section will be concluded with an overall estimation-of-quality budget, the cost of prevented defects and defects that were not discovered by the quality assurance.

RESULTS

As a result of the conducted cost-benefit analysis, we conclude that the cost of quality is significantly less than the cost of defects. This is true even for a relatively expensive, process-oriented quality framework that involves organization members on all levels.

The evaluation of specific activities comprising the quality framework revealed that short-term quality assurance activities also have positive return on investments. We also found that we can not directly apply this technique to evaluate long-term quality activities due to a lack of historical data on defects at a strategic level.

Despite a positive return on investments in quality, a further increase of quality budget is unlikely to improve the quality. From historical data, we can see that the defect prevention rate is close to possible maximum, i.e. we discover most of the defects before they become a problem.

CONCLUSION

The conducted cost-benefit analysis directly supports the paradigm "Quality is Free" by Phil Crosby2. This fact is indicated by an positive return on investment overall and for each specific activity for which we have enough historical data.

With certain limitations, the technique used in this study can be extended to other education fields. This technique requires the educational organization to have a formalized process for quality management, a clear definition of quality, and objective criteria for quality measurement. Presumably, these criteria are easier to achieve in a technical engineering education.

In a situation with a diverse set of stakeholders and multiple quality aspects, attributing each quality assurance activity to a particular stakeholder allows us to better address their needs and balance their concerns within the quality budget.

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Tu_CI_1*_1

Inter-Floor Positioning Algorithm using Sensors of Smart-phone and Fingerprint at a Multi-Floored Building in Wi-Fi Environment

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Abstract : *In this paper, the algorithm based on the normal distribution, and the acceleration sensor and a gyro sensor that are the embedded sensors in smart-phone is proposed for solving the degradation problem of the positioning accuracy according to some environmental factors of fingerprint technique. The Multi Floor Wall (MWF) model is used for the inter-floor positioning at a multi-floored building in Wi-Fi environment. By the results, it can be seen that the performance of the proposed algorithm is superior than the dead-reckoning and the fingerprint techniques. Therefore, the proposed algorithm might contribute to achieve more highly qualified performance than other two techniques in indoor localization environment.*

Keywords : *Localization, Normal Distribution, Dead-Reckoning, Fingerprint, Path Loss Model*

INTRODUCTION

The positioning techniques using Wi-Fi, Radio Frequency Identification (RFID), Bluetooth, and Ultra- Wide Band (UWB) have been widely researched in the world according to the development of wireless technologies since 2000. Moreover, the positioning techniques have been also applied in various fields such as logistics automation, disaster management, healthcare, military defense, security, children care fields and etc. The Global Navigation Satellite System (GNSS), one of typical outdoor positioning techniques, estimates the user location by Global Position System (GPS). However, the technique shall be unsuitable for the indoor positioning environment, because the positioning functions cannot be executed due to weak GPS signals from satellite, and the accuracy ratio of the positioning technique may be greatly decreased. Therefore, the particular techniques for indoor positioning are absolutely required for indoor localization environments. Finally, most of localization techniques are not well executed and cannot be adapted to the indoor localization environment.

The RFID requires more expensive than other techniques on launching cost of fundamental positioning infrastructure, though the RFID has been estimated to high positioning accuracy and low error rate. On the one hand, the Bluetooth cannot be guaranteed due to the short signal transmission distance range, though the launching cost of fundamental positioning infrastructure is relatively rower than other techniques. On the other hand, Wi-Fi has the longer transmission range than Bluetooth, and the launching cost of fundamental positioning infrastructure using Wi-Fi is more inexpensive than other techniques. The positioning technique using Wi-Fi can be defined that while the mobile devices having the Wi-Fi modem receive the signal from Access Points (APs) located in neighborhood, and it estimates the user location using the signals strength using just received signals.

The fingerprint method is a typical positioning technique for the localization of smart-phone user in indoor Wi-Fi environment. Even though the performance of the location estimation accuracy of the technique is high in Line Of Sight (LOS) environment, the map searching time is especially more required under the large scaled fingerprint map environment.

OBJECTIVES

In this paper, the algorithm based on the normal distribution, and the acceleration sensor and a gyro sensor that are the embedded sensors in smart-phone is proposed for solving the degradation problem of the positioning accuracy according to some environmental factors of fingerprint technique. The Multi Floor Wall (MWF) model is used for the inter-floor positioning at a multi-floored building in Wi-Fi environment.

METHODS

Performance analysis of the proposed algorithm is executed at the region of the horizontal and vertical scale such as 2.5m x 10m in the 1st~3rd floors of the engineering school building at Tongmyong University. The experiments are tried under a scenario that a user starts from the original location, 1st floor, and goes up to 2nd and 3rd floors, and returns back to the original floor. As a result, the accuracy ratio of a user location using the MWF model in the inter-floor positioning by the proposed algorithm is measured to 100%.

RESULTS

The performance of the proposed algorithm can be summarized as follows. The average/maximum error distances of the proposed algorithm are more highly decreased than the dead-reckoning and the fingerprint techniques as 13cm/16cm and 13cm/32cm, respectively. However, the minimum error distance of the proposed algorithm is similar to the dead-reckoning and the fingerprint techniques.

CONCLUSION

By the results, it can be seen that the performance of the proposed algorithm is superior than the dead-reckoning and the fingerprint techniques. Therefore, the proposed algorithm might contribute to achieve more highly qualified performance than other two techniques in indoor localization environment.

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Tu_CI_1*_2

AN INTERDISCIPLINARY CAPSTONE COURSE ON CREATIVE PRODUCT DEVELOPMENT WITH CROSS-COLLEGE COLLABORATION

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Abstract : *In this paper, we present an interdisciplinary capstone course for creative product development with cross-college collaboration in a research-intensive university. The primary focus of this course is to give an experience that undergraduate students own their problem through finding and defining a non-existing problem by themselves. Then, they solve the problem by realizing the corresponding product in an interdisciplinary team manner. To accomplish this goal at Seoul National University, a teaching team is formed with cross-college faculty from electrical, mechanical, information, industrial, and architectural engineering departments. We report how to integrate this course into a research-intensive engineering college, where both students and faculty are possibly unsympathetic or skeptical to this top-down education approach.*

Keywords : *Capstone course, creativity education, project-based learning, undergraduate research*

INTRODUCTION

In this paper, we share our experience of how to develop and integrate an interdisciplinary product design course into a research-intensive engineering college at Seoul National University.

OBJECTIVES

- Problem owner : Encourage students to seek and define their problem by themselves, under which the problem owner is intended to be the students,
- Completeness : Experience whole engineering process from ideation via product planning and hands-on prototyping to even marketing,
- Diversity : Collaborate with various students and faculty from all different departments including non-engineering colleges, and
- Persuasion : Practice persuasion through team and public communications, because finding a new problem entails a long continuation of persuasion.

METHODS

To accomplish these ambitious objectives, this course was designed for two semesters with three credits per semester, where the first one focuses on developing a new product idea, and the second one focuses on realizing the idea by prototyping and testing. An assessment method was developed through discussion among faculty to evaluate a student's work in relation to creative and interdisciplinary learning, which are intended to guide student learning toward the goal of this course.

Table I. Project evaluation criteria

Assessment area	Assessment Criteria
Innovativeness	Has the project or idea been already solved before?
Independence	Is the project or idea a result of opinions in one way from users?
Interdisciplinary	Does the project or idea reflect interdisciplinary aspect?
Concreteness	Is their design and plan specific enough to be implemented? Is their product realistic and feasible?
Impact	Can the project or idea give the important impact on the real world?

RESULTS

This interdisciplinary engineering design course has started with students from design art, fashion, agriculture, medicine departments and six different engineering departments. A survey was administered to students to collect their opinion on this course using a Likert scale of 1-5 (1 : strongly disagree, 5 : strongly agree), as presented in Table II. Overall, student feedback on this course is overwhelmingly positive. All criteria exceed to the average over college and University. Students who took this course have received awards in several competitions.

Table II. Student evaluation on this course

Question	This course	College	University
Was this lecture generally satisfactory?	4.71	4.11	4.19
Were this preparation and the contents adequate?	4.43	4.17	4.23
Was the teaching method effective?	4.57	4.02	4.09
Did the lecturer proceed faithfully w/o cancellation?	4.71	4.24	4.24
Did this lecture help me enhance my capabilities?	4.57	4.22	4.22

Some students confessed that this course was a first course that gave a valuable chance to be able to see a big picture of engineering. Before taking this course, most students have studied engineering science as lectured in a bottom-up manner. Through taking this course, they could connect what they have learned to the real-world, which would motivate why they do engineering.

Table III. Project evaluation results (0-5).

	1st evaluation	2nd evaluation	3rd evaluation	4th evaluation
Innovativeness	3.60	3.94	4.53	4.41
Independence	3.79	4.21	4.52	4.82
Interdisciplinary	3.98	4.39	4.55	4.70
Concreteness	3.73	4.14	4.49	4.70
Impact	3.82	3.98	4.49	4.29
Total	3.79	4.13	4.51	4.59

Another aspect that students liked is the tight collaboration with students and faculty members from different departments. At an early stage of this course, students were surprised at how different each perspective and approach are according to their background. A number of students mentioned that they had their own story by physically realizing their idea from a white canvas with various colleagues through this course.

CONCLUSION

In this paper, we reported on the cross-college collaboration to integrate interdisciplinary capstone course on creative product development in a research-intensive engineering school. From the academic results, the faculty feedback, and the student feedback and achievements, the teaching goals were achieved and students had chances of interdisciplinary teamwork, problem owner, and defending their ideas and solutions in front of a panel of experts. Students who took this course have won several awards in engineering design competitions and startup competitions. Our lessons learned and recommendations were provided. The authors have a plan to extend this course to global scale.

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Tu_CI_1*_3

CURRICULUM INNOVATION : INCORPORATING THE ENTREPRENEURIAL MINDSET INTO ONLINE DISCUSSIONS

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Abstract : *The purpose of this paper is to demonstrate how to incorporate the KEEN (Kern Engineering Entrepreneurial Network) framework into the engineering classroom with a focus on online discussions. The KEEN framework was developed with the undertaking that combining the entrepreneurial mindset with engineering education will result in a more valuable, strategically prepared engineer, rather than simply an "obedient engineer". The KEEN student outcomes that drive the entrepreneurial mindset include Curiosity, Connections, and Creating Value (commonly referred to as the 3 C's). Incorporating the 3 C's through online discussions, even when being used in the face-to-face classroom, will result in more entrepreneurially minded engineers, a necessary asset for a successful corporation, government agency, or start-up organization.*
Keywords : *Curriculum, Online Discussion, KEEN, Entrepreneurial Mindset, Engineering Education*

INTRODUCTION

The entrepreneurial mindset is a "growth-oriented perspective through which individuals promote flexibility, creativity, continuous innovation, and renewal" [1]. While the entrepreneurial mindset can be useful in starting a new company, such a mindset is also critical to existing organizations to ensure competitiveness and survival. In recent years, the entrepreneurial mindset has increasingly been recognized as important within the engineering arena [2]. Engineers need to design new products and services with the value proposition and user needs in mind, and not simply based on technical and functional concepts taught in the traditional engineering classroom. A recent survey of engineering students found two-thirds of the students thought entrepreneurship education could broaden their career prospects and choices [3]. Yet, rather surprisingly, few resources exist that help engineering instructors to effectively teach the entrepreneurial mindset. This is important because few engineering instructors have a background or formal educational training in entrepreneurship. Thus, the purpose of this paper is to demonstrate how to incorporate the KEEN (Kern Engineering Entrepreneurial Network) framework into the engineering classroom with a focus on online discussions. The KEEN framework was developed with the undertaking that combining the entrepreneurial mindset with engineering education will result in a more valuable, strategically prepared engineer, rather than simply an "obedient engineer". The KEEN student outcomes that drive the entrepreneurial mindset include Curiosity, Connections, and Creating Value (commonly referred to as the 3 C's).

OBJECTIVES

The primary purpose of this research is twofold. First, it will provide quantitative and qualitative support for incorporating the entrepreneurial mindset in the engineering classroom, from the perspective of industry, faculty, and current students. Second, it will provide insight into how to create and deploy an online discussion grounded in KEEN's 3 C's. The online discussion development process and resulting discussion prompts will be provided for an Environmental Engineering class.

METHODS

The research design used a quantitative approach. A survey was completed by 363 students, 21 engineering faculty, and 19 industry representatives. The survey required participants to consider what types of entrepreneurial-minded skills employers are hiring for, in addition to what types of entrepreneurial-minded skills participants would like to see taught in Marquette University engineering classrooms.

RESULTS

The survey and focus group results provide evidence for the need to increase EML in the engineering classroom. In particular, it was determined that online class discussions (even for traditional face-to-face lecture courses) would provide an ideal starting point for incorporating the entrepreneurial mindset with limited classroom disruption. Online discussions provide many benefits in comparison to in-class discussion. First, it provides students the necessary time to provide a thought provoking response and to consider other potential research or recent news media. Second, it provides students the opportunity to read and gain insight from other student's posts. And finally, it provides instructors the chance to provide immediate student feedback and ask further questions to dig deeper into the subject at hand. Example student discussion questions are provided here.

CONCLUSION

The survey and focus group results provide evidence for the need to increase EML in the engineering classroom. Incorporating the 3 C's through online discussions, even when being used in the face-to-face classroom, will result in more entrepreneurially minded engineers, a necessary asset for a successful corporation, government agency, or start-up organization.

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Tu_CI_1*_4

FLEXIBILITY IN ENGINEERING EDUCATION CURRICULA : BREADTH EXPERIENTIAL COURSES ALIGNED WITH PROFESSIONAL OUTCOMES

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Abstract : *It is recognized that non-technical courses are to enhance engineering student enthusiasm. Breadth courses can reinforce some learning outcomes and student self-confidence, fully aligned with engineering profession requirements. To this end, this paper reflects, via a qualitative and quantitative analysis, on a sea navigation and risks week-based course, aimed for future engineers in a generalist and integrated programme.*

Keywords : *Engineering education, breadth courses, decision skills, integrated programme model, quantitative and qualitative analysis, navigation.*

INTRODUCTION

In the French engineering education model, generalist curricula are a tradition in the classical and highly selective Grande Ecole system [1], with a separation of engineering from other Science programmes. Alpay [2] indicates that a general engineering programme is highly attractive to students who are considering an engineering degree, and also to some students who had previously not considered engineering. Including a balance of scientific, technical and non technical courses, Grandes Ecoles more and more consider integrated programme models to align with up-to-date graduate attributes and learning outcomes [3], e.g. as proposed in the CDIO educational framework [4].

OBJECTIVES

Aside from semester multidisciplinary team-based projects [3] and classical core courses, breadth subjects are integrated since 2003 via so called inter-semester week courses at a ranked Grande Ecole in France. Engineering students have to select two of these courses each year after their Winter exam sessions. The offer evolves each year, mainly depending on the dynamic context, student engagements and faculty motivations. In January 2016, those proposed, among 30, included : Deep Learning; Business Intelligence; Risks in Mountain; Leadership; Design with the School of Arts; Geopolitical Energy Crisis; Astronomy; French Political Life; The French Social and Economic Model; Korean Culture; Intercultural Approach to Music; Theatre Techniques; Digital Photography; Musical Composition Tools; Sign Language, a.s.o. Each course is credited (2 ECTS).

Exposures to non-technical courses are to enhance student enthusiasm. To plea the benefits of breadth courses in engineering education, all along a curriculum, this paper presents and analyzes, as an exemplar instance, a one week breadth course on sea navigation and risks. The authors clarify how its teaching and experiential learning activities were aligned at design time with professional engineer work-based outcomes. Based on the CDIO syllabus, they chose a specific class of phenomenon [5] to train students to take decisions in unexpected situations (i.e. nautical scenario with a high level of complexity and time pressure), where specific skills are required, such as risk and priority management, team management where respectful interactions, watchfulness, etc. In these situations, flexibility constitutes the sources of reliability and performance [6]. These in-context experiences are to be useful in an engineer career where responsibilities increase (e.g. decision-makers to face complexity, uncertainty and urgency). A first experience as a non-expert may create a learning-loop for future work-based situations [6] including improvisation [7].

METHODS

For both quantitative and qualitative analysis, data sources come from online questionnaires filled by Bachelor level students one month before and right at the end of the course. This sample (n=20), including Likert scale questions and open questions, is compared quantitatively with questionnaires results of all breadth courses in 2016, embracing all engineering students in the institution (n=350).

RESULTS

The analysis on the specific breadth course sheds light to motivational factors and reflective feedbacks. Thanks to the experiential learning approach taken, including outdoor team based 'Man Over Board' nautical activities, it is worth noting that several students recognized developing self-confidence in their (i) ability to grasp complex situations, (ii) ability to adapt dynamically to unexpected situations, or (iii) ability to act in an uncertain context with judgment. When engineering stereotypes persist and with students still facing career choice indecision, such skills are foundational in the development of a professional engineer, or potential future leader.

DISCUSSION

Offering to engineering students variety and flexibility in the course choices requires some academic control. Graduate attributes in line with most recent accreditation systems are to be met, also in line with national professional body's requirements. Many skills for engineers are not only knowledge-based, neither only scientific nor technical. Keeping a prominent place to breadth courses in curricula, to be recognized with credits, can not only attract student and clear their mind after intensive exam sessions, but also foster transferable skills for the benefit of the future engineer having to navigate in more complex professional environments. Finally, this sea navigation and risks course could be pivotal to define a framework of multi experiential outdoor breadth courses (e.g. underwater, air, mountain, forest) with federated educational contents, and echoes the liberal arts educational model for engineering.

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Tu_ML_1*_1

AN INTERNATIONAL STUDY OF COMMUNICATION DEVELOPMENT IN ENGINEERING EDUCATION

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Abstract : *This mixed methods study of communication development in engineering education explores students' self-efficacy in four capabilities – 1) writing, 2) creating and delivering oral presentations, 3) developing and using visual literacy practices, and 4) participating in teams. Our large-scale, global survey of Student Platform for Engineering Education Development (SPEED) students complements the in-depth case studies of four universities in Asia and in the United States. To be globally competent engineering leaders in our modern workforce, it is crucial for engineers to communicate effectively in a variety of settings. This study will indicate strengths and areas for growth in the four communication areas and identify trends across populations, including level of school, gender, and first language, in terms of their self-efficacy. It also provides a thick and rich description of communication development in four universities and includes pedagogical and curricular recommendations.*

Keywords : *self-efficacy, communication, globally competent, mixed-methods*

INTRODUCTION

Pressing social and economic needs call for engineering schools and departments to produce diverse leaders who can create innovative solutions to the world's most difficult problems. Indeed, as reports by both the National Academy of Engineering and ABET have concluded, the challenges that must be addressed by the next generation of engineers are becoming increasingly complex as society continues to grow more interconnected [1-2]. To be effective engineering leaders in a global workforce, engineers need strong communication skills that will allow them to interact with a wide-ranging audience, including entrepreneurs, policy makers, community leaders, and the general public—most of whom do not necessarily have a background in engineering, science, and technology.

OBJECTIVES

Broadly, the aims of the study are to investigate the value that students place on communication skills, the students' perceptions of themselves as communicators, how those skills are developed within the wider curriculum, how proficient the students are upon graduation, and how these capabilities can be strengthened through improved pedagogical methods.

METHODS

We hypothesize that students at varying stages of their academic journey, as well as in diverse pedagogical and cultural contexts, will report different levels of self-efficacy in communication capabilities. Our specific research questions that guided this portion of the study (i.e., the development and analysis of the student surveys) are :

a. In what ways, if any, do students' self-efficacy for communication capabilities change from their entry to their last semester before graduation?

b. Do students report differences in self-efficacy by communication type (i.e., writing, presenting, visual literacy, teamwork)?

Over the last two years, we have set the foundation for an interdisciplinary, inter-institutional, cross-cultural study of the teaching and learning of communication at four partner institutions. We are in the preliminary phases of the global, large-scale survey of SPEED engineering students that will take place in the next month.

RESULTS

This paper focuses on the results of one international survey of SPEED engineering students and case studies at four universities where we conducted two self-efficacy surveys, indicating changes in self-efficacy between entry and the final semester before graduation. We will report on results from the global SPEED survey and the in depth results of four case study institutions across all four competencies. Currently, we see positive growth trends in students' self-efficacy for communication across engineering programs at the four case study universities. We are in the preliminary phases of the global SPEED survey and will have our findings and curricular recommendations for the final paper publication.

We examine commonalities in students' self-efficacy for those skills, what they perceive their weaknesses to be, and their goals for strengthening their ability to communicate. Since we assert that 21st-century engineers are expected to communicate engineering concepts and highly technical matters to those without an engineering or technical background, we study student self-efficacy for that ability as well.

CONCLUSION

Understanding students' self-efficacy for various types of communication is important if we are to provide them with opportunities within the curriculum to develop those skills. We find that by identifying sub-skills in each of the four communication types, we are able to see more clearly where students find their areas of strength, and where they feel they need more instruction or experience. Students in two of the four universities rated their confidence across communication skills higher than in the other schools, and in both of these universities, there are partnerships between engineering faculty and communications specialists who collaborate on curricular design and who co-teach these skills. We will contextualize communication development in engineering education from a broader perspective by surveying SPEED students from a wide range of universities, countries, and levels of study. This large-scale study and complementary case study of four universities will help identify ways that engineering education can support the development of globally competent engineers prepared for our modern era workforce.

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Tu_ML_1*_2

EXPLORING ISSUES FACE BY CIVIL ENGINEERING STUDENTS WHEN TAKING ENTREPRENEURSHIP COURSE AS REQUISITE SUBJECT IN CIVIL ENGINEERING COURSE

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Abstract : *Since the year 2003, entrepreneurship education in the institute of higher education in Malaysia has been given emphasis to, due to the implementation of Ninth Malaysian Plan. However, the entrepreneurship education offered in the higher learning institution which is deemed as one of the contributing element to the quality of human capital development especially in terms of the competency to apply and explore new skills and technology has been reported to be ineffective. As the American Society of Civil Engineers (ASCE) in their vision 2025 has highlighted entrepreneurship attitude as one of the attitude that is crucial for future civil engineers for effective professional practice, thus in this paper, issues face specifically by the civil engineering students has been be explored. Survey interviews have been conducted with final year civic engineering students. The survey interview has discovered that the main issues face by the final year civil engineering students when taking entrepreneurship course as requisite subject in civil engineering course is lack of contextualization.*

Keywords : *Entrepreneurship Course, Civil Engineering Students, Contextualization*

INTRODUCTION

Since the year 2003, entrepreneurship education in the institute of higher education in Malaysia has been given emphasis to, due to the implementation of Ninth Malaysian Plan [1]. In the Ninth Malaysian Plan, focus has been given to human capital development that is directed towards entrepreneurship in order to move toward a fully developed nation by the year 2020 [1]. However, the entrepreneurship education offered in the higher learning institution which is deemed as one of the contributing element to the quality of human capital development especially in terms of the competency to apply and explore new skills and technology [1] has been reported to be ineffective [2]. One of the factors reported to have caused the ineffectiveness of entrepreneurship education in Malaysia is the low level of knowledge and understanding on the meaning and purpose of entrepreneurship education among Malaysian students[2] which perhaps most highly likely implying the inability to see how entrepreneurship course can be relevant to students who are not taking business-related courses. This scenario may have happened to the civil engineering undergraduates as surveys conducted by the Ministry of Higher Education (MOHE) has discovered that engineering graduates generally has been perceived to be not competent enough in several aspects where one of them is in the aspect of entrepreneurial skills acquirement[3]. Since entrepreneurship education is expected to develop skills, attributes, attitudes and behavior characteristics of entrepreneurial individuals [4], the findings of the survey conducted by the Ministry of Higher Education (MOHE), has clearly shown there could have been some issues face by the engineering students generally that needed to be brought to light. As the American Society of Civil Engineers (ASCE) in their vision 2025 has highlighted entrepreneurship attitude as one of the attitude that is crucial for future civil engineers for effective professional practice[5], thus in this paper, issues face specifically by the civil engineering students will be explored.

OBJECTIVES

This paper seek to explore issues face by civil engineering students when taking entrepreneurship courses as a requisite subject in civil engineering course and to highlight several factors to be taken into consideration when offering entrepreneurship courses to civil engineering students.

METHODS

This study is qualitative in nature where survey interviews [6] with final year civil engineering students in one of the universities in Malaysia, that have went through entrepreneurship course has been carried out and the sampling was done purposively. Data were analyzed by adopting the thematic analysis approach using thematic network as a tool for the analysis [7].

RESULTS

The outcome of the survey interviews have shown that there is several issues face by the civil engineering students when taking entrepreneurship courses as a requisite subject in civil engineering course. The main issue highlighted by the civil engineering students are lack of contextualization of the entrepreneurship courses offered as a requisite subject in civil engineering course mainly due to the content use in the entrepreneurship course that is seen as not closely related to the field of study of the civil engineering students. The content of the entrepreneurship course delivered to them focus highly on the aspect of starting a new business which is perceived by the civil engineering students as not well related to the civil engineering practice unless the practicing civil engineers has the intention to start a new business. Besides that the projects that were assigned to them also do not guide the students to learn entrepreneurship in the context of civil engineering practice. Therefore, since it is very obvious that there is issue of lack of contextualization in delivering entrepreneurship courses to the civil engineering students, changes to how entrepreneurship courses being delivered to the civil engineering students may need to be taken into consideration to improve the effectiveness of entrepreneurship courses offered to the future civil engineering graduates.

CONCLUSION

The issues faced by the civil engineering students may have shed some light to why there is issue of low level of knowledge and understanding on the meaning and purpose of entrepreneurship education among Malaysian students generally. In the case of these civil engineering students, the main issue as discussed is mainly the issue of lack of contextualization of the entrepreneurship course offered to them which has caused them to perceived entrepreneurship course as a subject that they cannot relate to their field of study. This issue somehow is a very complicated issue as entrepreneurship education by itself often faces difficulties in terms of developing the courses and methodologies for teaching[4]. This difficulty is subjected to conceptual and contextual difficulties which affect the development of the body of knowledge and limit its applicability[8] as can be observed in the issues face by the civil engineering students and potentially causing ineffectiveness. Therefore, as a whole, it can be pointed out that in developing the body of knowledge of the entrepreneurship course to be delivered to the civil engineering students, contextualization is a factor that should be further explored in order to make entrepreneurship course as a course that is not foreign to the civil engineering students.

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Tu_ML_1*_3

JUMP-START TO MULTIDISCIPLINARY LEARNING FOR ENGINEERING COLLEGE FRESHMEN STUDENTS

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Abstract : *This paper deals with how an engineering college freshmen student can find, conceptualize, and specify new multidisciplinary problem which he/she never heard about. And, by this process, how the students can jump-start to multidisciplinary learning is the main objective of this study. For this purpose, three steps of educational method are proposed including (1) finding a new multidisciplinary problem by forced connection method and survey-based critical thinking, (2) conceptualizing the multidisciplinary problem by technical survey, problem definition in engineering sense, and ambiguous factor extraction, and (3) specifying the multidisciplinary problem by expert interview, questionnaire, and creating logical block diagram. And the proposed method is evaluated with engineering college freshmen students*

Keywords : *Basic Design Education, Multidisciplinary Learning, Forced Connection Method, Idea Conceptualization, Idea Specification*

INTRODUCTION

Design capability is one of the most important competences in engineering education of the present age. As the period of new technology appearance grows shorter and the required learning depth of science and technology grows deeper, teamwork, presentation skills and open mind on multidisciplinary learning become more and more important. The developmental process of a student's competency also has some kind of inertia like other physical objects so that most of students undergo difficulties to overcome this inertia later and solve multidisciplinary problem after maturing his understanding level of major study. More efficient way to overcome this inertia is starting multidisciplinary learning education from early stages. In this paper, an effective way of jump-start to multidisciplinary learning for engineering college freshmen students is addressed.

OBJECTIVES

In this paper, an efficient way of jump-start to multidisciplinary learning is addressed for engineering college freshmen, especially for the basic design education classroom students in the computer science and engineering. More specifically, the objective of this paper is to find an effective way on how an engineering college freshmen student can find, conceptualize, and specify new multidisciplinary problem which he/she never heard about.

METHODS

The proposed method basically consists of three steps. The first step is to find a new multidisciplinary problem by engineering college freshmen students. Forced connection method and survey-based critical thinking are proposed and mainly used for this step. And, some introduction of case studies to find new multidisciplinary problem were developed and educated to the students before starting of this step. The second step is to conceptualize new multidisciplinary problem by engineering college freshmen students. Technical survey, problem definition in engineering sense, and ambiguous factor extraction are main components of this step. And, the final step is to specify new multidisciplinary problem by engineering college freshmen students. For this step, expert interview, questionnaire, and creating logical block diagram are done.

To check the effectiveness of the proposed method, a qualitative comparison research between two classroom students, control group and comparison group, is done.

RESULTS

Not all teams have succeeded up to the enough quality but most of teams can make new multidisciplinary problem and can deal with it logically without big difficulties after this education.

CONCLUSION

In this paper, a method to jump-start to multidisciplinary learning for engineering college freshmen students is addressed by performing three steps; to find a new multidisciplinary problem, to conceptualize the multidisciplinary problem, and to specify the multidisciplinary problem by engineering college freshmen students. Even though their level of understanding on major study is not enough good, students can make new multidisciplinary problem and can deal with it logically without big difficulties.

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Tu_ML_1*_4

Exploring Designer Activity Experience Audit : Reflecting from Blind User Elicited Emotions

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Abstract : *The relationship between user and designed products go beyond utility. Design elements that embodied the whole product principally evoke feelings and emotions. Blind user especially rely spesifically on their Physio-Pleasure in determining product affectivenes. Although there are studies conducted on how objects were being explored to have affecting and effecting the emotions of the users; it is however only few discussion reflecting on how designer commenced in continuation of the whole proces. It is an important discussion to revise back through designers' perspective and experience especially when it comes to special need group, like the blind user themselves, 'does designer gauge the same language and cognitive understanding to what have been elicited by blind user before?' This pilot study will then look into the significant pattern drawn in elucidating knowledge transfer through structural design task briefing.*

Keywords : *Designer, Blind User, Design Experience, Design Audit, Design factors, Emotions*

INTRODUCTION

Previous study of product usefulness may have been directly explained through the deliberation of user experiences on the abstraction level looking through the re-direct force of phenomenon model which transcribed through product semiotics, Krippendorf and Butler (1984) and further improved by Vihma (1995) and Mono (1997). The issues of human feelings towards product designed however are much greater than just to understand users expressions from mediating product. Constructive design activity planning through dinamic design task briefing enable researcher to replicate blind user scenario and giving opportunity for designer to dive into blind user perspective to conduct exploration

OBJECTIVES

The aim of this experiment is to further stucture designer activity in building up relationship of knowledge enhancement from blind user experience of a product. To further cater the aims, 3 objectives have been identify : -

1.To drive early stage of designer awareness stimulated from blind user and product involved.

2.To challenge designer sense and awareness in developing product with consience; looking through blind user difficulties.

3.To bring into realistic meaning of blind user experience performance for designer to confirm.

METHODS

Data were collected through reviewing videotapes of respondent's participatory activities. 5 designers participate for the pilot test. In this experiment, we addressed questions and task based on 3 progressive design activity briefing. Each activity will be consisting of 15 minutes time. Two identical products as mediating tools however differ in design were used as aster control to trigger the influence in designning process as well as during the activity process.

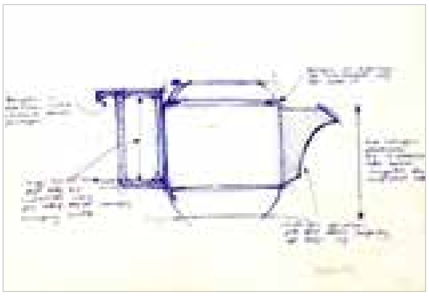
Activity 1 – OBJ 1

Activity 2 – OBJ 2

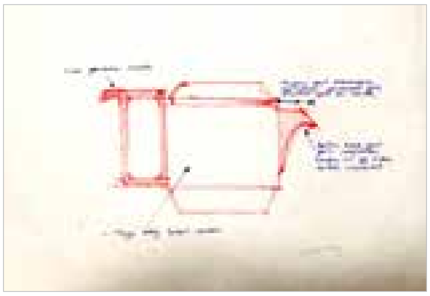
Activity 3 – OBJ 3

RESULTS

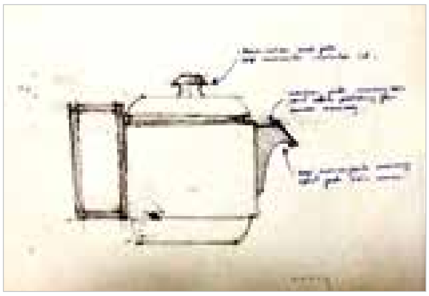
Data were collected and all the respondents shared explanation and description of their experience through their design sketches and design statement on the sketches. 15 sketches of product were explored. Verbal explanation however contributes in confirming what is happening before the skethcing process. Affective reactions were also noticeable through body language and tone when respondent verbalising their thoughts and reactions through the activity. Design below states the differences design results on each properties.



Activity 1 – OBJ 1



Activity 2 – OBJ 2



Activity 3 – OBJ 3

CONCLUSION

As a conclusion, products are experienced more than their physical properties. Studying them will not only associate them to how they were used but also how to develop them in a consistent way. Illustration below indicates the possibility of controlling designer design activity in product development through replicating lines of technical design. Thus, its also provide shorter time for designer to sketch back for the design.

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Tu_ML_1*_5

METACOGNITION DEVELOPMENT IN ENGINEERING STUDENTS THROUGH COOPERATIVE PROBLEM BASED LEARNING (CPBL).

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Abstract : *Metacognition is a skill set that has been identified to aid in the regulation of learning and problem solving. To achieve the metacognition, constructivist learning approaches are reported to address the development of the required skills. Cooperative Problem Based Learning (CPBL) is the integration of principles of cooperative learning into problem based learning. The implementation of CPBL for engineering students allows them to acquire supporting metacognitive skills among engineering students. The purpose of this research is to investigate engineering students' metacognitive skills development while experiencing CPBL. It investigates the significance of the CPBL activities and the influence of these activities on the development of engineering students' metacognitive skills. The constructivism worldview perspective is selected for this study. In this study, three students that undergo the CPBL in Introduction to Engineering course are selected as the participants. An exploratory study method was used to investigate the metacognitive skills that students engage using CPBL and the development of metacognitive skills. Qualitative data in the form of semi-structured interviews were analyzed to see whether metacognition expressed in CPBL. Then these data were used to get complete picture of the students' metacognition development.*

Keywords : *Metacognition, Cooperative Problem Based Learning, Engineering Education*

INTRODUCTION

The 21st century is challenging for the engineers from various aspects. The future engineers are required to have high competitiveness on quality of knowledge and skills as the globalization come across in all industry. Engineering programs should focus on building the skills needed by students as listed in Accreditation Board for Engineering and Technology (ABET), United States and Engineers Canada Accreditation Board (CEAB), Royal Academy of Engineering (RAE), and Engineering Accreditation Council (EAC). However, most of the engineering programs focus more on content rather than skills [1]. The skills required in a 21st century for future engineers should include fundamental process skills : how to think, how to learn, and how to cope with new situations and problems in a rapidly changing world [2]. It is important to identify skill sets that students need to regulate their own learning processes while engaging in their undergraduate education. One such skill set that has been identified to aid in the regulation of learning and problem solving, is metacognition [3, 4, 5]. Cooperative Problem based Learning (CPBL) is the integration of principles of cooperative learning into problem based learning [6]. Downing et al. [7, 8] and Hmelo [9] claimed that problem based learning can develop metacognition. The implementation of CPBL (a modification of PBL) for engineering students also allows them to acquire supporting sub-skills such metacognitive skills among engineering students [10, 3].

OBJECTIVES

The purpose of this study is to investigate engineering students' metacognitive skills development while experiencing CPBL.

In addition, it will investigate the significance of the CPBL activities and the influence of these activities on the development of engineering students' metacognitive skills.

METHODS

Qualitative data in the form of semi-structured interviews were explored to see whether metacognition expressed during CPBL. The exploratory study is used to investigate the metacognitive skills that students engage using CPBL and the development of metacognitive skills using CPBL. In this exploratory study, three students from first year Chemical Engineering program were chosen randomly for the interview. Thematic analysis [11] technique was used to analyze the data.

RESULTS

CPBL implementation is expected to enhance metacognitive skills among engineering students. This is done by infusing series of CPBL cycles and appropriate scaffolding framework, thus enhancing the students in developing the metacognitive abilities. Metacognition abilities will help student enhancing the problem solving skills as required by the board of accreditation and industries. The research hypothesized that the approach will contribute to the development of our future engineers in their metacognitive ability.

CONCLUSION

Previous researchers [7, 8, 9] has provided significant evidence that metacognition can be enhanced through proper implementation of PBL. By incorporating CL with PBL through CPBL, the metacognitive skills can be exponentially enhanced [10, 1]. As this study is conducted among first year engineering course, the output of this study represents the entry level metacognitive process for engineering students. Metacognitive skills help students become aware of their strengths and weaknesses as learners. Those who know their strengths and weaknesses will be more likely to actively monitor their learning strategies and resources and assess their readiness for particular tasks and performances. This study is significant because we know that engagement in metacognition positively impacts learning but we do not know if engineering students actually engage in metacognitive skills while they study.

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Tu_ED_4_1

ENGINEERING GRAPHICS REDESIGN FOR COMMUNITY ENGAGEMENT

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Abstract : *During the spring 2016 semester, an engineering graphics course at a fully accredited engineering, aviation, and aerospace university in the United States of America was redesigned to include a community engagement design project. The overall goal for this redesign was to improve and enhance student learning and engagement in engineering graphics. Upon the completion of the design project, students completed a 15-item survey design to measure their attitudes and perceptions of community engagement in engineering graphics. The results of the survey and implications for future work are discussed in this paper.*
Keywords : *Engineering Graphics, Community Engagement, Course Redesign*

INTRODUCTION

Studies have shown that socially engaged engineers are needed to broaden participation in the engineering discipline and improve diversity1. Service Learning Engineers are increasingly being called on to fully embrace their responsibility as professionals to serve the public and consider the societal implications of their work5. Service learning provides an enriching experience for students that allow them to consider societal implications in engineering. Studies show that engineers that participate in service learning enhance technical skills, adaptability, creativity, global competency, cross-cultural communication skills, teamwork skills, and also, interpersonal skills3. In comparison to students who have not participated in service learning activities, students who have participated show that their metacognitive skills are more advanced. The service learning participating students also had better task analysis skills along with better strategic planning skills. In the same study, the students were shown to better understand client needs and discriminate useful information from information that is insignificant4.

In addition to developing invaluable skills for students, service learning also affects the attitudes that the students have towards their traditional coursework and their social responsibility1,2. Participation with service learning has shown to increase positive attitudes towards the engineers' social responsibility. There are a large number of students who have decreased in social responsibility over their first two years of college. Service learning within those two years is substantial because it has shown to benefit professional social responsibility attitudes within that age group1. In a study conducted by Carberry, Hee-Sun-Lee, and Swan1, the students reported that 45% of what they learned about technical skills and 62% of what they learned about professional skills, they learned through their service learning activity as opposed to other sources of learning such as traditional courses1. Students reported that they learn professional skills from their service learning activities because traditional coursework is very likely to overlook the professional aspect of engineering1. The traditional coursework is more geared towards the theoretical perspective instead of the practical approach. Sometimes traditional coursework can fail to make connections to the real world1. As a result, service learning is very substantial in order for students to maximize their learning experience while in college.

OBJECTIVES

The purpose of this work is to promote community engagement in engineering graphics. The goal of the course redesign is for students to develop a creative engineering design that would benefit disabled veterans. Student teams of 3 or 4 modeled the components of their design explicitly in a detailed assembly. Each part and assembly included detailed drawings, and each team submitted one printed drawing package and binder including a cover page, statement of work, and background research on disabled veterans. Lastly, student teams presented their project in front of a panel of community leaders. If successful, a standardized community engagement design project will be developed to share to the global community of educators teaching engineering graphics.

METHODS

On the first day of class, students were placed in 3-4 person teams in a unique way. Each student completed the "Five Minute Personality Test2" to determine their personality traits :

- Lion – Leaders, good at making decisions and goal-oriented.
- Beaver – Social creatures, enjoy influencing and motivating others.
- Otter – Loyal, not risk takers.
- Golden Retriever – Organized, problem solvers.

Team members were instructed to exchange contact information (name, e-mail, phone number) and to spend 20 minutes in class brainstorming ideas for their final project.

SAMPLE

Twenty-six students enrolled in the engineering graphics course participated in the course redesign. Four of the students were female. Table 1 provides a demographic breakdown of the course participants by major.

Table 1. Demographic representation of sample

Major	n
Mechanical Engineering	3
Aerospace Engineering	17
Civil Engineering	2
Engineering Physics	3
Homeland Security	1

RESULTS

As this study is still being conducted, the results will be made available in April at the conclusion of the course.

CONCLUSION

This course redesign allowed students to see the human side of engineering, thereby increasing engagement in the engineering graphics course. Students were responsible for designing a model from start to finish. They learned how to hand sketch the model by hand and to create the model in a computer aided design program. The project allowed them to gain experience using the engineering design process and engaging the community.

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Tu_ED_4_2

GETTING CLOSER WITH FAMILY : CONSTRUCTING A SPORTS TUTOR SERVICE FOR HEALTHY SOCIETY WITH WEARABLE DEVICE

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Abstract : *Following the development of digital technology, there are more and more media developed for family. Sport is an importance one of them, and had been proofed could enhance the interactive relation between people. Besides, wearable device are developing in these years. Users could use the same functions as computer program and smart phone when wearing on those kinds of devices. Through analyzing the multiple users' data collected from wearable device, service provider could provide more valuable services, such as improving functions of product, understanding customers' needs, making service plans to solve health or social problem, etc. When more data collected, medical practitioners or health service providers could understand customers' state of health much deeper. Wearable device and the service from collecting and analyzing customers' data will be a great revolution in the future of medical and health research. Health enthusiasts are the main consumer group of wearable device. For these reasons, sports and leisure have already become life necessities for people.*

Keywords : *Sports Tutor, Service Design, Wearable Device, Family Relation, Wii*

To improve the health and interactive relation between family members, this study designs a sports tutor service with interactive media of sport for family. Firstly, 153 flesh college students has sport habits are invited to answer a questionnaire to understand how many family members they have, what are the activity they joint, how they interact with each other, and what is the habit their family member has. Secondly, according to the result of questionnaire, this study constructing three types of Personas :

(1) Social type : sport has already become an important interactive way between family members. They need a service to plan more interesting family sport activities.

(2) Connecting type : user and his/her family members have sport habit, but they didn't execute with each other. Thus, they need a service to connect family members with sport activities.

(3) Catalytic type : user is the only one member who has sport habits; they need a catalytic type service to form a sport habit between family members.

Thirdly, according to three kinds of user's needs, this study constructs a Sports Tutor Service (STS) for family members to join sport activities with each other. Besides, most of wearable device for sport and fitness are designed as smart watch or bracelet. Although this kind of wearable device is not as accurate as smart clothes in collecting data, but it is more convenience for user needs to keep moving in sport and fitness. For this reason, smart watch, ASUS ZenWatch 2, is chosen in this study. Family members could set STS up on their smart watch provided by this study. This service will help member to evaluate their healthy condition and plan a series suitable course for each member as well as a training goal needs all member to reach cooperatively. And all the sport activity will execute with interactive media – Wii.

The forth, this study invites 15 users in the questionnaires stage, 5 users in each type, to join sport activity with family member following the STS journey for two weeks. They are also asked to record the interactive behavior and phenomena during the two weeks. Finally, this study also discuss these types of users could or couldn't improve interactive relation with family member following the STS journey.

Tu_ED_4_3

The system of certification of engineering personnel in the Republic of Kazakhstan : problems and prospects

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Today one of the most important problems of engineering education is creation of system of certification of engineering shots. Absence of tradition of certification and not understanding of this problem from the Government complicate acceptance effective the decision. Haven't found due judgment and questions the concerning certification forms : whether there has to be the state certification, or public and professional. If public and professional who has to carry out that : employer, professional community or the enterprises. Not taken place market mechanism doesn't allow defining the main stakeholder. Unfortunately, there is no accurate awareness of need of certification of engineering shots. There is no clear understanding of gradation and level of competence, there is no conceptual approach that complicates creation of domestic system of certification of engineering shots. In this article authors offer the vision of the solution of these problems.

Tu_ED_4_4

INFORMATION SYSTEM OF UNIVERSITY SITUATIONAL-ANALYTICAL CENTER

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Abstract : *The paper discusses the development of an information system for the situational-analytical center of the university. The system is designed for collecting and accumulation data of a variety of sources in order to assess the current state, detect deviations from planned targets and to propose corrective action to eliminate the deviation. The analytical component of the system is built with the use of ontology knowledge base.*

Keywords : *Analysis, monitoring, ontology of knowledge bases, management, information systems.*

INTRODUCTION

University management is focused on achievement of the University's strategic objectives. The complex strategic problems is achieved by the implementation of actions to ensure the goals. Important tools in the management of the university are analysis and monitoring of the activities. The results of analysis and monitoring allows evaluating the level of achievement of the objective and the factors influencing this achievement. In D.Serikbaev EKSTU, monitoring and analysis of the current state of the university is carried out through situational-analytical center. The aim of the center is to provide relevant information, analysis and visualization of information for decision-making.

OBJECTIVES

The objective of this study is the design and development of situational-analytical center information system. The system should be able to perform the following functions : to integrate disparate data base of the University in a single repository; to extract the necessary data for analysis; perform analysis of compliance of the current values of the key planned indicators; perform forecasting and signal the possible deviations from the plan; depending on the analysis results to make recommendations.

METHODS

One of the main documents that regulates the activity of the university is a strategic development plan, containing the basic plan of action that defines the priorities of strategic tasks, resources and sequence of actions to achieve the strategic objectives, indicators and assessment of their achievement.

Providing information support for decision-making is oriented on : operational management, strategic management, crisis management, modeling and forecasting.

In such information systems there is a necessity to store a large amount of knowledge, in such cases, the ontology are applied best. Ontology as a way of knowledge representation has the advantage of a formal structure that facilitates their computer processing.

RESULTS

The paper contain an attempt to build an ontology of the university's knowledge base, describe the strategic plan of the university in terms of the ontological model. Ontology of the university's knowledge base is implemented in the OWL DL notation.

CONCLUSION

The model of knowledge representation based on the ontological approach has advantages such as : the possibility of re-usable knowledge; increasing knowledge model professional designer without the involvement of the analyst or developer information system by knowledge representation in a convenient and understandable form; implementation models describe the various components of knowledge in different languages, without prejudice to the semantic content; automation of knowledge extraction, formalization of knowledge, storage and further use. This approach is the most effective for the development of systems to analyze situations and make decisions.

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Tu_ED_4_5

Women graduates in engineering : their roads and struggles to being engineers

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Abstract : *Engineering has been important and influential in making and leading of 20th century and it is now the case in 21th century. During the time, engineering knowledge and its product have changed gradually, sometimes dramatically and we need new kinds of engineers and accordingly new university education. In a future smart society, it seems to be critical to organize various abilities in engineering and lead to drawing creativity. It is women in engineering that has been the critical area, having the potential for creativity. However, women in engineering have been known for under-representation and sexual segregation almost every country. This issue becomes so severe that any nation and industry could not survive and develop with women in engineering left behind. Some policies with gender cognitive perspective have been introduced into educational system in engineering and they make a clam that engineering and its profession should be understood in the context of gender. The engineering for a long time is considered to have suppressed the influence of gender and to proclaim it gender-free area. However, women in engineering reveal how the area works in gender specific ways, men dominated ways of learning and doing in particular. This study tries to test the general understanding that engineering profession is free of gender effect and it only values high abilities in science and technology. Focusing on the women graduates in engineering at a research oriented university, the ones who are survivors in undergraduate program in engineering and now professional career seekers in the graduate one, it will show what experiences they have in a real research lab. In comparison with the dominant mechanisms in seeking engineering career, this study will emphasize how the women define and recognize engineering work and we will see various layers of engineering work, which has potential for creativity in a smart society. Two dimensions seem to be important for women to combine gender and professional career, women's identity as women and/or engineer and their relation with men graduates and professor in the research lab.*

Keywords : *Women graduates in engineering, Relation with men graduates and professors in engineering, Men-dominated ways of learning and doing, women's experiences in a real research lab.*

INTRODUCTION

Engineering has transformed from something like factory machines and efficiency to the one embedded into everyday life and seeking its happiness and satisfaction. In a smart society coming to us, we expect that engineering and other academic disciplines will get converged into the point where people and their life are understood in terms of science and technology. The keywords of everyday life, sensitivity and being relatedness are so naturally leading to women and their quality, femininity, that we have higher expectation for women engineer and their outcomes. However, what we know about them is that they had invaded into men's area, 'engineering', and not sure about how they learn and develop into professional engineers by relating their knowledge into job and work. We only guess from statistics and many case studies that their studying and working as an engineer is still not easy and they keep struggles with men-dominated ways of learning and doing.

OBJECTIVES

This study tries to diversify the system surrounding engineering. Engineering is under many challenges and difficulties and need fundamental changes for the survival in the coming smart society. On the same vein, this study tries to revive the meaning of gender in engineering through women's involvement into research and work. It will show us various layers of engineering job including from private to public, from personal to cultural, the layers that are related to the coming smart society. With the outcomes, we can see how gender works when women's involving into engineering research and work and so we might reveal and solve many kinds of gender discrimination problems. We can go further with the result into the direction where we can see where engineering has been challenged and what could be alternatives to it and what changes we should make.

METHODS

This study is about women graduates in engineering and will focus on how and what they do with engineering job by conducting in-depth interview with the women, their colleagues (mainly men) and the professors involved. While proceed with open ended questions, the interview will be guided by the questions such as how they are involved into research and work, what they do within a team, and what outcomes they make and what evaluation they have within a team and out of a team. The women graduates are so specific a group in a sense that they seek engineering studies to be a professional engineer and they still maintain higher abilities in science and technology and higher expectation for social status through job. And they have somehow survived in the men-dominated environment of engineering university. Their research and work in graduate course is based on their relation with their (men) colleagues and professors. It is important to see how they understand the women's positioning and how they justify their understanding. Through the interaction with colleagues and professors, this study will show what happens in the women's confidence in abilities and being professional and how they are being involved into research and work.

RESULTS

The result will show how and what women graduates in engineering do with research and work. Their ideas and values on engineering job and its image seem to cause some crack or difficulties in their identity. The identity has been constructed with reference to "women" and/or " engineer". It will highlight the women's being in a double conflicting positioning in which they are a special group of women within women and simultaneously a group of women different from men. It is important that their compromising in the identity seems to lead to different engineering world of job. Meanwhile, the women graduates will lead to different view on engineering job through their relation with others, that is, the colleagues and the professor. Depending on the focus on the relation, work itself or being relational, they seem to introduce into various layers of engineering job, from private meeting to public presentation, from personal issues to organizational culture. Additionally, the women's introduction and experiences into engineering job seem to be influenced by the recognition and the appreciation by the significant others (that is, men colleagues and professor). With that, women's involvement into engineering research and work would be legitimized and encouraged.

CONCLUSIONS

This qualitative study on the women graduates in engineering is very unique since it does not presume the general stereotype on them that their sex, female, will make them women but in spite of that difficulties they will become an engineer by overcoming with higher intelligence and capacities. Rather, it tries to revive the meaning of gender in engineering through women's involvement into research and work. In the same line, it tries to investigate various layers of engineering job including from private to public, from personal to cultural, the layers that are related to the coming smart society. With the outcomes, we can see how gender works when women's involving into engineering research and work and so we might reveal and solve many kinds of gender discrimination problems. We can go further with the result into the direction where we can see where engineering has been challenged and what could be alternatives to it and what changes we should make.

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We_ML_2*_1

PRACTICE EXPERIENCE AND MULTIDISCIPLINARY COLLABORATION IN PROJECT MANAGEMENT EDUCATION

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Abstract : *This paper formulates an insight into the importance of practice experience and multidisciplinary collaboration in project management success and the apparent lack of emphasis placed on this within the context of university education. Against the background literature, a review will be conducted into how well university education prepares the future project managers in the area of the practical project learning and multi collaborative approaches.*

The paper provides examples models, strategies and of effective practices applied in Qatar University through multidisciplinary collaboration between courses, for embedding enterprise and employability in higher education, in respect to the specific project experiences that are mandatory for the management of the running projects in Doha, Qatar.

Despite the fact that previous studies on interaction between theory and practice offered various degrees of value to the research field, some limitations and debates remain awaiting further investigation, as do the significant changes associated with the construction industry and project management. The research concludes that the efficiency of interaction between theory and practice in the construction industry needs to be further examined, and a possible research method is also proposed for carrying out future studies.

Keywords : *Collaboration, Multidisciplinarity, Practice, Awareness, Road Safety, Project Management*

INTRODUCTION

This paper introduces an approach currently being implemented in the Architecture and Urban Planning at College of Engineering in Qatar University. It describes the primary components of the theoretical research including the course program in Construction and Project Management, its integration with other courses, the cooperation required to support the interdisciplinary emphasis, and the establishment of an innovative academic/industry partnership to provide a state-of-the-art physical and technological infrastructure to support the program goals.

OBJECTIVES

Projects often comprise of people and organizations from different nationalities and disciplines such as architects, engineers, clients, contractors, suppliers, and banks which generates complexity in the managerial procedures, due to different multidisciplinary approaches inside multicultural teams, foreign managers, and international partners. In the literature it is easy to see that different disciplines can influence a variety of project management issues such as : teams (Binder, 2007) leadership, communication, performance (Laufer, A., Tucker, R., 1987), risk assessment (Zwikael and Ahn, 2011), business negotiations (Hurn, 2007), international project management (Lane et al., 2005) and planning. In Qatar there are many complex projects performed in collaboration with foreign companies and local partners such as Doha Metro, Lusail City, Hamad International Airport, Education City in which a proper managerial approach is fundamental for the success of these initiatives. Project managers face numerous challenges, which include multi-disciplinary factors such as managing mixed teams pertaining to different disciplines and additionally many cultural differences within the same team. Professionalism starts at the first steps of a student's education in university. Different disciplines, from their initial stages of training, can model and affect the student's attitude and behavior in collaborative work, and the way they act and perform as the new Professional Managers (PMs) of the future.

METHODS

In Qatar University, in Doha a multidisciplinary research project has been proposed and developed to involve students and instructors specializing in diverse disciplines and aspects of Architecture and Urban Planning (AUP) and Industrial and Systems Engineering (ISE). The aim is to get them to focus on a common assignment as part of their courses (a class project in this case), using the tools of project management to investigate and develop the students' capabilities and attitudes when working in a multidisciplinary project.

The project topic was linked to the active competition of the Qatar Road Safety Studies Center (QRSSC), which is a prominent research center in Qatar University, in the form of prize money to be provided to the winning team. The multidisciplinary research project title is "Project Management tools and techniques for the development of a multidisciplinary project on Road Safety in Qatar".

RESULTS

Many groups of students interacted collaboratively for the whole duration of the project, not only demonstrating their ability to work in interdisciplinary teams and with other multidisciplinary groups to successfully complete their projects. Particularly for the QRSSC competition, the submitted videos addressed objectives such as raising awareness about the danger of speeding on the road, the importance of wearing seat belts, the importance of using baby car seats (booster) and other measures relevant and useful to road safety in Qatar.

Students provided conclusions and recommendations, demonstrating their ability to recognize the dialectic relationship between Project Management and the multidisciplinary approach to recognize the diversity of needs, values, behavioral norms, and social patterns as they relate to the creation of the safe built environment of roads in Qatar.

CONCLUSION

In this paper we have set out to show how the multidisciplinary collaboration between students can enhance research practice in a field dominated by the theoretical approaches of different disciplines. We have also described the methodology used and some of the issues which have arisen in developing this approach and how the research is still facing an initial phase of development, to be further investigated.

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We_ML_2*_2

Blind User Experience Audit: Revealing Underlying Invisible Factors in Design

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Abstract : *Through experiences, user gauge cognitions of perception shaped by many factors. The process of perceiving, understand and remembering explains the significant time constraint of knowledge building that involves input transfer within user-artifacts-designer. User experienced audit seizes critical user protocols of why is it necesarry, what do they think and use how do they normally do as they complete a task that sets in achieving directed goal. The methods explained on this pilot study features how researchers observe blind user used their experiences to reflect on the experiment trial; mediated from two mediating object of same types however differ in design features, which is the coffee pot. 5 respondents with a B1 class of blindness have been selected for this experiment and each one of them draws interesting patterns of behavior. Within contextual enquiry, researcher able to dialogue and frame feedback to summarized the experiences. The significance of this research underlines the design factors pattern draws out through 5 blind user representation highlights during trial performances and supported through their verbal explanation of their inner voice. The results of the experiment generates the User-Designer consensus within the respondent's awareness which invisible to product designer enabling researcher to look into gaps and articulate product performance according to the blind user perspective.*
Keywords : *Blind User, Contextual, Design Experience, Design Audit, Design factors, Protocol Analysis*

INTRODUCTION

This pilot experiment inspired on knowing the underlying invisible design factors of product within Blind User's (BU) experiences. The main aim of this research is to explore potential (BU) product factors through their experience. Result of this research is an early contribution of (BU) knowledge transfer to cater procedural product design verbal protocol analysis audit in generating constructive designer brief for (BU) product development. When designer generate design, they create physical representations of their concepts and ideation. It is difficult to address product experiences in a systematic way in the design process, further knowledge is needed on what constitutes these experiences, how users describe them and how they relate, for example how product functions according their practices. Dagman, J., Karlsson, M. A. K., & Wikström, L. (2010) on their research describe theres lack of research conducted on addressing human product experiences. Gibson (1962), Lederman and Klatzky (1987), Klatzky, Lederman and Matula (1991) and Klatzky, Lederman and Matula (1993) provides an important basis for understanding how people explore products and the role of haptics in recognizing and judging the properties of objects such as their size, shape, texture and hardness. However, they never describe how product experience collectively being discussed especially in relation to (BU).

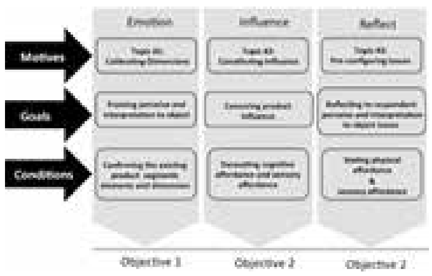
OBJECTIVES

Through the directed study of literature to reveal underlying invisible factors in design; the Blind User experience audit embarks through 3 following progressive objectives which are : -

1) To ascertain the existance of designed product partitions identification through blind user perceiving and interpretation controlled activity. 2) To open and having several possible meanings or interpretations of product funtional protocol performance. 3) To amplify blind user inner voice experience towards conscience in design performance.

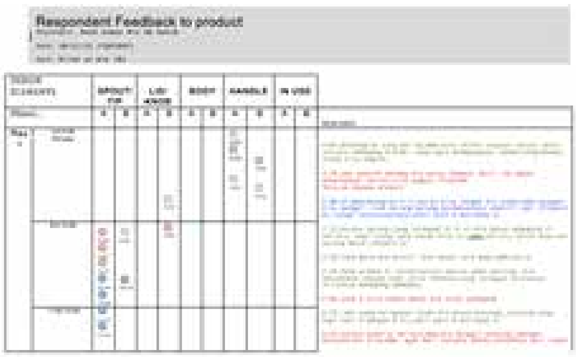
METHODS

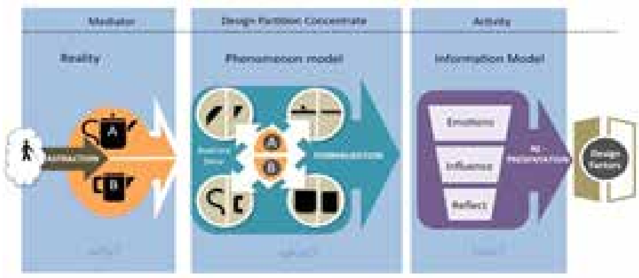
In this experiment, we addressed questions and task to the respondents and exposed them to two identical products as mediating tools however differ in design and allowing them to explore the products haptically as well as to describe their experiences verbally. The experiment has been segregated to 3 progressive topics and each of the topics developed was in accordance to the objective of the research.



RESULTS

Overall, the agreement between the main researcher and the reviewers' classifications was approximately 90%. Remaining 10% are through discussion and consensus decision within the main researcher and the reviewers. The video recordings from the sessions were examined, transcribed and the analysed. The usability explaination on each topics imply within mediating object design partition. This creates a dominon representation standard of (BU) product parameter on each design partition feature being discussed.





CONCLUSION

Respondents gradually explaining design factors according to their conscience within the mediating products. The explanations however detailed to each partition design of the product. The ability for them to verbalize the inner voice confirms 'what is working and not working 'or 'need some improvement' which important for designer to look into when comes to the development of blind user product. This organize a fundamental understanding for the designer on "how design really works for the blind user?" or "the way blind user see design"…This state of activity drives a product focus assessment as well as drawing a User-Designer paradigm for special need group in the realm of excavating design development and contribution of design activity within their society.

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WE_ML_2*_3

PICKING LOW HANGING FRUITS – INTEGRATING MULTIDISPLINARY LEARNING IN TRADITIONAL ENGINEERING CURRICULA BY INTERDISCIPLINARY PROJECT COURSES

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Abstract : *Setting up integrated interdisciplinary studies programs is expensive. The paper presents specific interdisciplinary project courses of a German technical university as an alternative practice for integrating multidisciplinary learning in traditional engineering curricula. Relying on the experience from 23 interdisciplinary project courses for freshmen and 22 interdisciplinary advanced design projects for master students, the authors exemplify that a sequence of interdisciplinary projects in the bachelor's and master's program leads to a systematical development of interdisciplinary competences : competency in multidisciplinary team work and problem solving in the bachelor's projects and actual interface expertise for interdisciplinary design tasks in the master's projects.*
Keywords : *multidisciplinary and interdisciplinary learning, problem-based and project-oriented learning,*

INTRODUCTION AND MOTIVATION

Faced with the complex and multi-faceted challenges for smart societies, e.g. climate, energy, population, nutrition, water, health and safety, and the requirement for social, ecological and economical sustainability, the need for multi- and interdisciplinary engineering education is indisputable. But setting up integrated interdisciplinary studies programs such as information systems technology studies is expensive. Relying on five years of experience with interdisciplinary project courses for freshmen and interdisciplinary advanced design projects for master students, we present the interdisciplinary project courses at a German technical university as an efficient alternative for integrating multidisciplinary learning in traditional engineering science curricula.

OBJECTIVES AND METHODS

In this paper, we exemplify interdisciplinary project courses for multidisciplinary learning in the bachelor's as well as master's program of the mechanical and process engineering studies at a German technical university. In the bachelor's project, we have analyzed the effect of project-oriented multidisciplinary learning on the development of a disciplinary identity and formation of professional competences including communication, intercultural and social skills as well as a cooperative mindset. The advantageous effects of multidisciplinary project teams are underpinned by a comparison of mono- and multidisciplinary project teams based on evaluation data of four project courses with 1400 participants in total in 2012/13. For the master's project, we illustrate the impact of multidisciplinary learning on the development of professional interface competencies and integrated technical knowledge. The case study is based on two project courses with a total of 119 participants in the years 2014 and 2015.

RESULTS : SYSTEMATICAL DEVELOPMENT OF INTERDISCIPLINARY COMPETEN-CIES IN BACHELOR AND MASTER PROJECT COURSES

According to the principles of evidence-based teaching and learning, the compulsory introduction of project courses as a specific form of active learning [1] in the bachelor's program in 2007 was grounded on comprehensive empirical evaluations [2]. The extension from monodisciplinary to interdisciplinary project courses in 2012 (bachelor) and 1995 (master) started as trial educational development project. Today, we can show that this sequence of interdisciplinary projects leads to a systematical and gradual development of interdisciplinary competences : competency in multidisciplinary team work and problem solving in the bachelor's projects and actual interface expertise for interdisciplinary design tasks in the master's projects.

Acquisition of interdisciplinary competences in the interdisciplinary bachelor's projects

The overall didactic concept of interdisciplinary study projects for bachelor students has been described in [3]. Typically, freshmen from engineering, natural science, and arts and humanities departments form project teams of about 12 people to work on a complex set of tasks for one week. The task focuses on a real-life problem with societal relevance such as the global refugee problem, energy efficiency or urbanization. Multidisciplinary learning is ensured by a task assignment which forces students to make joint interdisciplinary decisions [4]. Due to the different ratio of students in engineering and other studies, not all project teams are interdisciplinary. A comparative evaluation of mono- and interdisciplinary teams have shown that interdisciplinary teams reported more often insights into specialist methods as well as into common scientific methods. They identified more frequently with their chosen field of study and clearly valued interdisciplinary and intercultural teamwork higher than students in monodisciplinary teams. Additionally, they perceived a higher growth in their readiness and ability to communicate within the team, across both disciplines and academic hierarchies. The acquisition of these multidisciplinary teamwork and methodical competencies builds the foundation for the advanced design project in the master's program.

Acquisition of interdisciplinary competences in the interdisciplinary master's projects

The overarching didactic approach to the master's projects is an Advanced Design Project (ADP) with two main learning objectives : the development of professional skills through team work and design skills through application. The teams are diverse and interdisciplinary including students from chemistry, mechanical and process engineering, and chemical engineering from a applied science (Fachhochschule in German) in 2014 and additionally, American chemical engineering students in 2015. ADP is a bridge between typical course design projects and "real" industrial design projects. The project topic (typically a chemical plant) is developed with and supported by an industrial partner with real plant data. Analysis of the two projects have shown that teams with higher professional qualities produce higher quality design work. These professional qualities are interdisciplinary interfaces competencies : the ability to work cohesively in an interdisciplinary group and design a plant that requires the knowledge and skill of different disciplines. The more diverse the group was (in terms of discipline), the higher their overall competencies in interdisciplinary teamwork and design skills.

CONCLUSION

We have demonstrated that the combination of interdisciplinary project courses in the bachelor's and master's program of mechanical and process engineering at a German technical university leads to a gradual development of interdisciplinary competences. Therefore, we see in this model an effective way to incorporate multidisciplinary learning in engineering science curricula. Next steps include the extension of, specifically, the interdisciplinary advanced design projects to the entire mechanical engineering department and other engineering science departments such as electrical engineering, civil engineering and computer science.

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We_IE_2*_1

ACADEMIA-INDUSTRY COURSE CO-DEVELOPMENT : DEVELOPING AN INTERNET-OF-THINGS (IOT)-BASED DESIGN COURSE FOR ENGINEERING UNDERGRADUATE STUDENTS

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Abstract : *This paper describes the co-development of a design course for 3rd year engineering students that teach the concepts and skills of the emerging Internet of Things, with real application in an emergency department. The design course is co-developed by a faculty member and an industry partner using the technological pedagogical content knowledge. An analysis of the co-development of the design course is presented, along with a qualitative study using in-depth interviews of students, faculty member, and industry partner.*

Keywords : *design course, Internet of Things, industry partner, technological pedagogical content knowledge*

INTRODUCTION

Smart society has emerged around us and is in need of competent engineers with relevant expertise. While the technology to support smart society has developed very rapidly, structured courses to teach relevant concepts and skills have only recently been developed (Conrad, 2014). These are done in-house with no or very little involvement of external parties such as the industry.

On the other hand, project-based learning has been recognised as an enabler for meaningful and effective mode of the teaching of design courses (Dym et al., 2005). Real projects provide connection to the real world (real-world element) as well as opportunity to contribute to the society (service learning element); two qualities that engender and sustain student interest and motivation (Bell, 2010), as well as drive students' learning (Hanney and Savin-Baden, 2013). Collaboration with the industry provides a means to bring in the real-world element and service learning element into learning.

This paper describes our endeavour to address two challenges : (1) how might we develop a design course to teach the abovementioned concepts and skills, and (2) how might we develop a design course that brings in real-world element and service learning element.

We address these challenges through course co-development with the industry. We have developed a design course centred on the theme of developing an Internet-of-Things (IoT)-based system for an emergency department, and we will use this as a case study.

OBJECTIVES

The objectives of our work are : (1) to develop a design course for 3rd year engineering undergraduate students that straddles two semesters (equivalent to 26 weeks) that will teach students the concepts and skills pertaining to IoT-based systems, and (2) through this process, distill good models of academia-industry collaboration.

METHODS

To meet the first objective, the development of the design course is based on the framework of technological pedagogical content knowledge, commonly known as TPCK (Koehler and Misra, 2009). This framework also drives the academia-industry collaboration.

To meet the second objective, a qualitative study (Denzin and Lincoln, 1994) was done using in-depth interviews of 4 students, 1 faculty member, and 1 industry partner.

RESULTS

The design course run for 26 weeks – equivalent to two semesters – for 3rd year engineering students with backgrounds in mechanical, electrical, computer, industrial system, and environmental engineering. The design course teaches students important IoT design concepts of : (1) product design, (2) data acquisition, (3) data storage and management, (4) actuator manipulation, and (5) networking.

Using the TPCK framework, the faculty member was responsible for the pedagogical knowledge, while the industry partner shared the responsibility of content knowledge with the faculty member. The technological knowledge was left as the responsibility of the students. The students demonstrated the ability to acquire technological knowledge with little guidance; demonstrated by their ability to formulate questions, navigate various forums/resources to explore possible answers, and apply the newly-acquired knowledge to design a working system by the end of the module – all with little guidance from the faculty member or industry partner.

CONCLUSION

A 26-week long (two semesters) design course has been developed, and it has entered its second year now. The students demonstrate the ability to acquire technical knowledge as expected. The real-world element and the service learning element of the module sustain student interest and motivation in the design module.

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We_IE_2*_2

ENGINEERING EDUCATION FOR SMART INDUSTRY AND SOCIETY. THE THERMAL FLUIDS APPROACH

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Abstract : *Since the United Nations Conference Declaration in the Human Environment in 1972, and the subsequent Declaration of Rio de Janeiro in 1992, the topic of Education in Sustainable Development has been into context. This worldwide reflection is creating a new engineering education culture. Engineering educators are observing significant shifts for smart industry and society with expectations of the engineering profession to help address immediate and longer term sustainable development challenges. Sustainable Development is defined as "The technology development that meets the needs of the present for people without compromising the ability of future generations to meet their own technological needs". Society, Economy and Environment are the three fundamental dimensions of Sustainable development. Embedding Sustainable development thinking in Design thinking with a thermal-fluids approach incorporates new mentalities in Engineering Design towards a societal commitment to find an optimal balance of the functional dimensions of Sustainable Development for smart industry and society.*

Keywords : *Sustainable development thinking, smart industry and society, entropy minimization, society, economy and environment.*

INTRODUCTION

Society, Economy and Environment, the three integral dimensions of Sustainable Development need to be balanced for the pressure on the environment, social justice and economic growth for a smart industry and society. Systems thinking is seen as the powerful tool to help incorporating multidimensional analysis with complex interactions between the tree fundamental dimensions in Sustainable Development. The present investigation proposes incorporating sustainable development thinking into complex energy systems design by including society, economy and environment dimensions as subsystems embedded into the energy systems design process engineering education for smart effective industry and society.

OBJECTIVES

In general, entropy generation in a process involving energy, financial and material flows into a system should be minimized so the functionality of complex energy systems in industry become sustainable for the good living of society. Macroeconomic systems in some ways are like thermodynamic systems. They respond to monetary and Keynesian mechanisms and move in the direction of increasing entropy constrained by the inherent conservation principles and government regulations.
The present investigation proposes incorporating sustainable development thinking into complex energy systems design by including society, economy and environment dimensions as subsystems embedded into the energy systems design process in engineering education for smart effective industry and society.

METHODS

Engineering education for sustainable development (EESD) is an interdisciplinary broad area covering technical, social and economic aspects. It is critical in training engineering graduates with the knowledge and skills to address the twenty-first century society challenges for smart industry and society. Energy is a core resource to achieve sustainable development of our global industrial system. The total world production of energy for 2020 is expected to be 630 quadrillion Btu. However, an important portion of this large amount of energy will be lost and deposited irreversibly in the atmosphere as entropy generation which will increase the atmospheric entropy. Using the second law of thermodynamics irreversible entropy generation can be an analytical tool for a sustainable energy system design. The energy lost in the optimal operation of the energy system should be minimized (entropy generation minimization), hence the exergy (useful energy) of the system is maximized. In the same fashion, Entropy generation minimization in a macroeconomic system will deliver the optimal investment return by the activity related to the design of the energy system. In general, entropy generation in a process involving energy, financial and material flows into a system should be minimized so the functionality of complex energy systems in industry become sustainable for the good living of society. Macroeconomic systems in some ways are like thermodynamic systems. They respond to monetary and Keynesian mechanisms and move in the direction of increasing entropy constrained by the inherent conservation principles and government regulations.

RESULTS

The task for the industrial energy system designer is to achieve the optimal equilibrium of the three fundamental sustainable development dimensions (society, economy and environment) found with minimal entropy generation global wise for smart industry and society.

CONCLUSION

In general, entropy generation in a process involving energy, financial and material flows into a system should be minimized so the functionality of the complex industrial system becomes sustainable. All previous analysis lead to the conclusion that incorporating the fundaments of Thermal-fluids systems approach of engineering education for sustainable development can be formally considered in the early undergraduate as well as graduate engineering curricula in response to the time lag dilemma of the modern societal demands for a smart industry and society.

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We_IE_2*_3

A Study on the Educational Effectiveness of the Industry Professional Practice (IPP) Program

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Abstract - *The objective of this study is to examine the effects of the long-term on-site training IPP on the participating students. More specifically, this study intends to examine the effect of the experience on the students' major, career, personal relationships and problem-solving competency. To achieve this, two groups of students were surveyed about the four categories major, career, personal relationships, and problem-solving. The first group consists of 36 students (22 male, 14 female) currently enrolled at a university in Chungnam who participated in the IPP program and have since returned to university. The other group consists of 60 regular students (45 male, 15 female) at the same university who have not participated in the IPP program. The method of analysis included technical analyses, t-tests, and regression analyses.*

First, in the category Major, the students who participated in the IPP program displayed a high score in the first of six questions 'I can understand and analyze my major's theoretical knowledge and data' and demonstrated a statistically significant difference. Second, in the category Career, the students who participated in the IPP program displayed a high score in the average of all 4 questions – with a particularly high score and notably statistically significant difference in question 3 'I have researched an institution and corporation that I am interested in before deciding my career'. Third, in the category Personal Relationships, the students who participated in the long-term on-site training displayed higher scores and a statistically significant difference in question 2 'I can exchange opinions with others and find a compromise'. Fourth, with respect to the category of Problem-Solving, the IPP students displayed a lower score in question 2 'Regarding problems I tend to further develop my initial ideas into better solutions' in comparison to the regular students. But there is no statistical significance. The results of the regression analysis showed that the participation in the IPP program had a positive effect on the entire category Career and on the aforementioned questions of the other two categories. Based on this study's results, long-term on-site training is recommended for future engineering education.

Keywords : *Cooperative education, industry professional practice(IPP), on-site training, major, career, personal relationships, problem-sloving.*

1 INTRODUCTION

1.1 Need for Study

Cooperative education (co-op), a program to gain education and work experience by applying knowledge acquired in school to practice on industrial sites, is in operation at 217 universities around the world under the WACE[1] standards. In Korea, the terminology on-site training was first used for engineering students pursuant to the Industrial Education Promotion Act

1. WACE is an abbreviation of The World Council and Assembly on Cooperative Education. WACE was founded in 1983 to foster Co-operative Education and other Work Integrated Learning programs worldwide. http://www.waceinc.org/history.html

in 1973 and the on-site duration was less than 4 weeks. After that, in 1998, long-term cooperative education first began under the title 'sandwich educational process' with the duration of the work experiences being a semester. To solve the low efficiency of the short-term on-site training and increase the students' practical skills, Koreatech adapted the overseas co-op program to the Korean university education requirements and launched the long-term on-site training program Industrial Professional Practice (IPP). Students in their 3rd or 4th year can participate in the IPP program and can gather work experience for four to six months at a site related to their major.

According to the results of The National Academy of Engineering of Korea's research into the problems of engineering education from 700 professors, students, and industrial works in 2015, the category of 'insufficient cultivation of practical engineering skills' (21.0%) accounted for the highest proportion. Moreover, more than half of the responders indicated the category 'cultivation of practical skills' (58.8%) as the category that requires most improvement.[2] As demonstrated by the results above, it is suggested by the educational world as well as the industrial world that Korean engineering education requires more devoted effort into cultivating practical skills required on industrial sites. Since various cooperative skills are required on-site as well as the skill of applying the theoretical knowledge acquired in a major in practice, it is necessary to exercise the cultivation of such practical skills on industrial sites outside of schools. In this regard, the IPP program contributes to solving the problem that Korea's university education does not adequately raise the students' practical skills. Additionally, it aims to satisfy the companies' need for a workforce with practical skills. Therefore, verifying the IPP program's effectivity in reaching the goal of cultivating the students' major-related and practical skills is essential for the continuation of the on-site training program and the fostering of outstanding workforce.

1.2 Restrictions of Study

This study accepts that the following restrictions to this study exist. First, not all four-year-university students performing long-term on-site training were included in the research, and thus, there are restrictions in standardizing the results. Second, the elements of university and corporations that may affect the effectiveness of long-term on-site training on students were not included in this study. For example the students' mentors who were in charge of the student evaluations at the corporations or the way the program is run by the university may have an effect.

2 LONG-TERM COOPERATIVE EDUCATION PROGRAM : IPP

2.1 Semester-based Quarterly System

It is difficult to separately compose a practical semester for the students participating in the long-term on-site training other than as part of the 8 semesters of the usual four years bachelor's degrees of the Korean academic system. In consideration of the disadvantages of a late entry into the employment market and the financial burden when the term of enrollment increases, the IPP operates a bachelor system that enables the participating students to earn enough credits to graduate within 8 semesters. To achieve this, the existing academic system composed of two semesters per year, i.e., one spring semester and one fall semester, was changed to a quarterly system with 8 quarters in the students' third and fourth year. Currently, there are two tracks A and B for students to participate in the IPP program. For instance, in track A the IPP1 quarter takes place for four months in the fall quarter of the third year with optional two months in the winter quarter and the IPP2

2. Korea Engineering Academy's Next Generation Engineering Education Committee, Next Generation Engineering Education Innovative Plan Study, November 27, 2015. 218.

quarter takes place for four months in the winter quarter of the fourth year. As a student can do up to two IPP quarters the maximum on-site training length is 3 quarters (10 months). The semester-based quarterly bachelor system is shown below in table 1 :

Table 1. Co-op Education Plan

Yr	First Year				Second Year			
Sem	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
Tack A	Class (20)	-	Class (20)	-	Class (20)	-	Class (20)	-
Track B	Class (20)	-	Class (20)	-	Class (20)	-	Class (20)	Class (9)
Yr	Third Year				Fourth Year			
Sem	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
Tack A	Class (20)	Class (9)	IPP1 (9)	Class (20)	Class (6)	IPP2 (6)	-	
Track B	IPP1 (9)	Class (20)	Class (6)	IPP2 (6)	-	Class (20)	-	

*The number in parentheses refer to the required credits

2.2 IPP Credit

Students participating in IPP receive 15 credits for a total of 10 months which is the maximum period in which a student can participate in IPP by receiving 1.5 credits for each month of on-site training. This accounts for 10% of the total number of credits for graduation, and with respect to major-related credits, 3 credits are acknowledged in IPP1, and 2 to 4 credits in IPP2. For example, if a student participates in track A, 120 of the required 150 credits are obtained in the 6 regular quarters and another 15 credits are obtained in the two IPP quarters. The remaining 15 credits can be obtained through e-learning during the IPP quarters and summer school. Therefore, the IPP participants can also graduate in four years time even though they did 10 months of on-site training. For the major-related theory classes which are missed during the regular semesters due to participation in IPP, substitute classes are held during the semester breaks for the students participating in IPP. Thereby, a gap between non-IPP students in terms of understanding of the major and the next semester's classes is avoided.

The assessment of a student's performance during the on-site training is either pass or fail. If at least 70 of 100 points are achieved based on the student's monthly reports, final report and work behavior it is a pass. 30% of the assessment is made by the professor in charge of the student during the IPP quarter, 30% by the student's mentor at the corporation, 20% by the HRD[3] professor and the remaining 20% by his major professor.

2.3 On-Site Training and IPP

The term 'on-site training' is frequently understood as having a similar meaning to 'internship' in Korea.[4] However, the concept of on-site training and internship have slight differences in terms of the range of participation, operating body, relation to the major, and relation to employment. On-site training is also called work-based learning, which has been actively provided

3. HRD stands for Human Resource Development. Cooperative education of KOREATECH is related to the educational goals of KOREATECH's HRD that foster basic ability to be able to design and explore one's own career. So professors in charge of the HRD also evaluate the results of cooperative education. https://cms.kut.ac.kr/user/indexMain.action?siteId=general
4. U. T. Wang (2015), 「A Study on the Effect of Employing Labor Force through the Industry Professional Practice System」, Unpublished Doctorate Dissertation, University of Seoul Graduate School Department of Management, Seoul, 33.

in practical academies, child education, nurseries, and social welfare departments so far. The on-site training in these departments is a part of the curriculum, which must be completed as essential courses in order to obtain a license before graduation. These are mainly arranged near the end of a course.

With respect to engineering departments, the need and demand for practical skills in engineering students increased. This resulted in the introduction of 4-12 week courses of on-site training in 84.6% of four-year engineering courses as of 2015. However, according to the results of the study by Choi, A. K.(2010), although most of the students generally displayed a positive response toward internships conducted for 4 to 6weeks, the lack of specific work and non-systematic work instructions were indicated as problems, and the need of work-related mentors was displayed.[5] Since existing internships and on-site trainings are merely on-the-job-trainings (OJT) in order to adapt to the site and obtain knowledge of the work, it is difficult to carry out any actual work of note. Due to this, the students are given simple tasks, and thus, the students are not provided with the opportunity of directly participating in work related to their major, regardless of their participation in on-site training. Therefore, it is difficult to expect the effect of the four to six weeks on-site training to be more than a slightly prolonged visitation of an industrial site. In contrast, the features that distinguish the long-term program from existing on-site trainings in Korea are as set forth below.

First, according to the Canadian national association for on-site training, on-site training programs provide relevant work based on the academic curriculum of a major to the students through a job description. This is developed and approved by the on-site training institution. Second, the on-site training institution and the corporation systematically manage and evaluate the enhancement of the students' competencies through their performance at work. Third, the students receive suitable rewards for their work. Fourth, the students' work performance is inspected by the on-site training institution.[6] Because of these features, long-term on-site training is understood as an educational program where the cultivation of the students' capabilities in their major, social skills, determination of career, and problem solving competencies can be expected. The IPP program was designed in the sense of the aforementioned long-term on-site training, not the previously existing short-term on-site training.

3 PRIOR STUDIES

Numerous studies exist regarding internships usually conducted during the summer break, the model at practical academies where during a semester periods of 4-6 weeks length alternate between practice and classes, and the efficient operation, improvement measures and connection of practice and career of on-site training at colleges with four-year-programs. With respect to on-site training in engineering departments, there are studies related to the operation and improvement means of cooperative education, but there are not many studies related to the effectiveness of the practical experience on students who have completed such cooperative education. Kim, S. G., Cho, D. H. & Lee, S. H. (2000) researched the effects and improvements of third year students in engineering departments who participated in site training for one semester in terms of the operation of cooperative education.[7] It was reported that 78.9% of the students who responded in this study displayed

5. A. K. Choi (2010), "Current Status and Task of Corporate Internships by University Students," 「Commercial Education Study」, Vol. 24, No. 2, 23-47.
6. Y. Tanaka (2015), The Economics of Cooperative Education, Routledge, Oxon, 14.
7. S. G. Kim, D. H. Cho, & S. H. Lee (2000), "A Study on the Efficient Operation and Improvement of the Semester Sandwich System," 「Thesis Collection: Natural Science, Human Science, and Social Science」, 17, 457-480.

a positive response on the need for cultivating practical skills and cooperative education. Kim, S. G. (2000) researched the value recognition of students in engineering departments who participated in cooperative education and reported that although they agree that cooperative education may enhance practical or occupational skills, cooperative education is passive in educational values, i.e., the obtainment of knowledge in the major field, development of leadership skills, and the establishment of life values, which are features obtained from long–term cooperative education.[8]

4 STUDY PROCEDURE

This study conducted a survey on fourth year male and female students currently enrolled at a university dividing them into the two categories of those that have never participated in IPP and those that have participated in IPP. This sample of students was randomly selected. The survey took place from December 2015 to January 2016 and there was a total of 96 respondents - comprising 36 IPP participants (37.5%) and 60 non-IPP participants (62.5%).

4.1 Analysis

After the survey research, technical statistics and an element analysis of the SPSS program, t-test, and regression analyses were used to statistically process the results.

4.2 Properties of the Participants

A total of 96 respondents participated in the survey, with both the IPP students and non-IPP students selected from the fourth year at random. With respect to the gender of the students, among the IPP students 21 were male (58.3%) and 15 were female (41.7%) and from the non-IPP student category 46 were male (76.7%) and 14 female (23.3%). With respect to the percentages of departments, more than 30% of both the IPP students and the non-IPP students were in the industrial management department, followed by 6 IPP students (16.7%) and 11 non-IPP students (18.3%) from the mechatronics engineering department. The department with the lowest number of participants included 1 IPP student (2.8%) from the design engineering department, and 1 non-IPP student (1.7%) from the architectural engineering department. However, students from all of the 8 departments were included in both categories of respondents.

Table 2. Properties of Participants

		Total		IPP Students		Non-IPP Students	
		Amount	Percent	Amount	Percent	Amount	Percent
Gender	Male	67	69.8%	21	58.3%	46	76.7%
	Female	29	30.2%	15	41.7%	14	23.3%
Department	Mechanical Engineering	9	9.4%	3	8.3%	6	10.0%
	Mechatronics Engineering	17	17.7%	6	16.7%	11	18.3%
	Electric, Electronic, Communication Engineering	13	13.5%	4	11.1%	9	15.0%
	Computer Engineering	4	4.2%	2	5.6%	2	3.3%
	Design Engineering	7	7.3%	1	2.8%	6	10.0%
	Architecture Engineering	5	5.2%	4	11.1%	1	1.7%
	Energy and New Material Engineering	11	11.5%	4	11.1%	7	11.7%
	Industrial Management	30	31.3%	12	33.3%	18	30.0%
Total		96	100.0%	36	100.0%	60	100.0%

8. S. G. Kim (2000), "A Study on the Recognition of Value of the University Semester Sandwich Education System," 「Higher Education Study」, Vol. 11, No. 1, 1-23.

5 RESULTS

5.1 Verification of Measurement Tools

This study conducted a factor analysis to verify the validity of the four categories major, career, personal relationships, and problem solving in the survey. In all four categories, the KMO value was higher than 0.6, and the significant probability of Bartlett's test of sphericity was lower than 0.05, and thus, it was displayed that the selection for variables for the factor analysis were suitable. The variance explanation power was less than 50% in some cases, but the difference was minor, and thus, validity was obtained overall.

Table 3. Validity Test of Survey Questions

	KMO	Bartlett's Test of Sphericity	Eigen Value	% of Variance
Major	.714	.000	2.774	46.241
Career	.683	.000	1.982	49.543
Personal Relationship	.804	.000	3.081	51.358
Problem Solving	.791	.000	2.968	49.467

In the credibility analysis of the survey questions, the Cronbach α coefficient was above 0.6 in all categories of major, career, personal relationships, and problem solving, as displayed on the credibility analysis results in <Table 4>. Generally, credibility is evaluated based on whether the result is above or below 0.6, and thus, the categories of the factors composing of this study are deemed to be credible.

Table 4. Credibility Analysis of the Survey Questions

Variables	Number of questions	Cronbach's α
Major	6	.741
Career	4	.640
Personal Relationships	6	.786
Problem Solving	6	.795

5.2 Technical Statistics Analysis

Looking at the score of each question in the four categories between the IPP students and non-IPP students, the greatest difference was seen in the understanding and analysis of Q1 : I can understand and analyze my major's theoretical knowledge and data. A score of 4.03 was displayed in IPP students, and 3.58 in non-IPP students, with a difference of 0.45 between the IPP students and non-IPP students' average, followed by 3.58 in IPP students and 3.37 in non-IPP students in Q5 : My motivation for my major's studies are high, with a difference of 0.21 in the average scores.

With respect to the category career, the difference between the average scores between the two target groups were the greatest in Q3 : I have researched an institution and corporation that I am interested in before deciding my career. Specifically, 4.22 was recorded among IPP participants and 3.68 in non-IPP participants, displaying a difference of 0.54 between the two groups.

With respect to personal relationships, the average of IPP students and non-IPP students was 4.11 and 3.85 respectively Q2 : I can exchange opinions with others and find a compromise, and the difference between the two target groups was 0.26.

For problem-solving capacity, the average score of IPP students and non-IPP students was 3.81 and 3.47 in Q2 : I tend to further develop my initial ideas regarding problems into better ideas, with a difference of 0.34 between the two target groups.

Next, the question that displayed a noticeably high difference in the average between the two target groups with respect to problem solving capacity was Q6 : I can develop and carry out a plan to solve problems, which displayed an average of 3.95 in IPP students and 3.70 in non-IPP students, resulting in a difference of 0.24.

A t-test was conducted to apprehend whether there is a difference between the averages in the two target groups with respect to the survey questions. The results of analysis are as displayed in <Table 5>.

A statistical significance was displayed in the difference between the average of the two target groups in Q1 in the category of major, Q3 in the category of career, Q2 in the category of personal relationships, and the total average in the category of career among the 22 questions of the 4 categories.

Table 5. Relationship between Participation in IPP and the four Categories

Q.		Total		IPP students		Non-IPP students		t-test	
		Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	t	p
Major	Q1	3.75	0.754	4.03	0.560	3.58	0.809	3.174**	0.002
	Q2	3.44	0.765	3.56	0.695	3.37	0.802	1.173	0.244
	Q3	3.55	0.819	3.69	0.822	3.47	0.812	1.324	0.189
	Q4	3.57	0.764	3.61	0.766	3.55	0.769	0.378	0.707
	Q5	3.39	0.910	3.58	0.841	3.27	0.936	1.665	0.099
	Q6	3.52	1.036	3.56	0.969	3.50	1.081	0.253	0.801
	Average	3.54	0.559	3.67	0.497	3.46	0.583	1.852	0.067
Career	Q1	3.65	0.821	3.75	0.732	3.58	0.869	0.963	0.338
	Q2	3.61	0.887	3.83	0.845	3.48	0.892	1.897	0.061
	Q3	3.89	0.983	4.22	0.797	3.68	1.033	2.685**	0.009
	Q4	3.99	0.761	4.00	0.756	3.98	0.770	0.103	0.918
	Average	3.78	0.601	3.95	0.547	3.68	0.614	2.155*	0.034
Personal Relationship	Q1	3.45	0.832	3.47	0.654	3.43	0.927	0.240	0.811
	Q2	3.95	0.587	4.11	0.319	3.85	0.685	2.532*	0.013
	Q3	3.96	0.631	4.08	0.439	3.88	0.715	1.697	0.093
	Q4	3.46	0.905	3.33	0.894	3.53	0.911	1.049	0.297
	Q5	3.94	0.723	3.94	0.583	3.93	0.800	0.073	0.942
	Q6	3.67	0.749	3.75	0.604	3.62	0.825	0.910	0.365
	Average	3.74	0.518	3.78	0.356	3.71	0.596	0.762	0.448
Problem Solving	Q1	3.74	0.771	3.72	0.741	3.75	0.795	0.170	0.865
	Q2	3.59	0.828	3.81	0.856	3.47	0.791	1.970	0.052
	Q3	3.81	0.772	3.83	0.737	3.80	0.798	0.204	0.839
	Q4	3.77	0.801	3.92	0.770	3.68	0.813	1.388	0.168
	Q5	3.73	0.852	3.86	0.762	3.65	0.899	1.178	0.242
	Q6	3.79	0.739	3.94	0.791	3.70	0.696	1.582	0.117
	Average	3.74	0.558	3.85	0.531	3.67	0.569	1.472	0.144

*Between group difference ($p<.05$) **Between group difference ($p<.01$)

Major
Q1. I can understand and analyze my major's theoretical knowledge and data
Q2. I can apply the knowledge from my major in the work environment
Q3. I can plan and execute an experiment/a program/a project
Q4. I am aware of my practical skills
Q5. My motivation for my major's studies are high
Q6. I select my elective classes considering my career goals

Career
Q1. I have a plan what I will do after graduation
Q2. I know what to do in order to achieve my career goals
Q3. I have researched an institution and corporation that I am interested in before deciding my career
Q4. I am aware of my shortcomings regarding my career and profession choices

Personal Relationship
Q1. I have leadership skills to persuade team members
Q2. I can exchange opinions with others and find a compromise
Q3. I can cooperate with people of different backgrounds through forming cooperative relationships
Q4. I have knowledge and understanding of other cultures and I am aware of the globalization
Q5. I understand my organization, contribute to the community spirit and act responsibly
Q6. I can manage and control personal conflicts

Problem Solving
Q1. I have tried to solve a problem with my own, new solution method
Q2. I tend to further develop my initial ideas regarding problems into better ideas
Q3. I analyze the cause or meaning of a problem on several levels
Q4. I can approach problems in a rational and critical way through gathering knowledge
Q5. I can propose and evaluate solutions to problems
Q6. I can develop and carry out a plan to solve problems

5.3 The Results of the Regression Analysis

Based on the results of the t-test displayed in <Table 5>, a regression analysis was conducted on the 4 categories, which displayed statistically significant differences based on the participation in the IPP program. The research hypotheses for this are set forth below.

Hypothesis 1 : 'Participation in IPP' has a positive effect on the 'category career'.
Hypothesis 2 : 'Participation in IPP' has a positive effect on 'Q1 Understanding and Analysis of the Theory and Data of a Major'.
Hypothesis 3 : 'Participation in IPP' has a positive effect on 'Q3 Finding Information regarding an Institution and Corporation of Interest'.

Hypothesis 4 : 'Participation in IPP' has a positive effect on 'Q2 Exchange of Opinions and Deduction of Compromises'.

A regression analysis was conducted with 'participation in IPP' as the independent variable and the 'category career' as the dependent variable. The significant probability of p=0.034 was smaller than 0.05 and thus, deemed a suitable regression formula. Furthermore, the significant probability of the dependent variable, 'category of career' was 0.034, which is smaller than 0.05, and the t value was a positive value. Therefore, Hypothesis 1 is confirmed. However, R2, which displays the explanation power of the independent variable with respect to the dependent variable, is very low at 0.047.
Moreover, conducting a regression analysis having 'participation in IPP' as the independent variable and Q1 of Major as the dependent variable, the significant probability, 0.005, was smaller than 0.05 and thus, deemed a suitable regression formula. Furthermore, the significant probability of the dependent variable, Q1 of a Major was 0.005, which is smaller than 0.05, and the t value was a positive value. Thus, conclusively, Hypothesis 2 is confirmed. However, R2, which displays the explanation power of the independent variable with respect to the dependent variable, is very low at 0.082.
From the regression analysis applied to having 'participation in IPP' as the independent variable and Q3 of Career as the dependent variable, the significant probability, 0.009, was smaller than 0.05, and thus deemed a suitable regression formula. Furthermore, the significant probability of the dependent variable, Q3 was 0.009, which is smaller than 0.05, and the t value was a positive value. Therefore, conclusively, Hypothesis 3 is confirmed. However, R2, which displays the explanation power of the independent variable with respect to the dependent variable, is very low at 0.071.
Upon conducting a regression analysis with 'participation in IPP' as the independent variable and 'Q2 of Personal Relationship as the dependent variable, the significant probability, 0.034, displayed to be smaller than 0.05, and thus, is deemed a suitable regression formula. Furthermore, the significant probability of the dependent variable, the Q2 of Personal Relationship was 0.034, which is smaller than 0.05, and the t value was a positive value. Conclusively, Hypothesis 4 is confirmed. However, R2, which displays the explanation power of the independent variable with respect to the dependent variable, is very low at 0.047.

Table 6. Regression Analysis of the Categories that display statistically significant Difference

Independent Variable	Dependent Variable	B	Std. Error	β	t value	Sig.	Statistical Amount
IPP-participants	Constant	3.683	.076	-	48.365	.000	R=0.217 R2=0.047 Adjusted R2=0.037 F=4.646 p=0.034
	Category of Career	.268	.124	.217	2.155	.034	
	Constant	3.583	.094	-	38.228	.000	R=0.287 R2=0.082 Adjusted R2=0.073 F=8.430 p=0.005
	Major Q1. I can understand and analyze my major's theoretical knowledge and data	.444	.153	.287	2.904	.005	

IPP-participants	Constant	3.683	.123	-	29.967	.000	R=0.267 R2=0.071 Adjusted R2=0.061 F=7.208 p=0.009
	Career Q3. I have researched an institution and corporation that I am interested in before deciding my career	.539	.201	.267	2.685	.009	
	Constant	3.850	.074	-	51.759	.000	R=0.216 R2=0.047 Adjusted R2=0.037 F=4.621 p=0.034
	Personal Relationship Q2. I can exchange opinions with others and find a compromise	.261	.121	.216	2.150	.034	

6 DISCUSSION AND CONCLUSION

This study's objective was an examination whether long-term on-site training affects the categories major, career, personal relationships, and problem solving of the participants. The discussions and implications related to the results of this study are as follows :

First, it was noted that the IPP experience has a significant effect on the category career. Through the impulses in a real working environment, the IPP students had the chance for personal growth. The IPP students realistically understood the skills required in the job or career desired by themselves while performing specific tasks at an industrial site. They also simultaneously recognized their own personal deficits in this regard. Through the experiences and consideration raised during the on-site training, the IPP students displayed improved competencies in preparing their own career, including researching information concerning the career of interest, rather than just vaguely preparing.

Second, certain professors had apprehensions as to whether long-term on-site training may decrease the students' competencies in their major due to missing major classes during the period of on-site training. However, IPP students evaluated themselves more positive than non-IPP students in the competency of understanding and analyzing theoretical knowledge and data. This is due to their increased self-confidence stemming from their major-related experiences on-site, including design, process management, business support, quality management, laboratory experiment and research and development etc. Accordingly, seeing the real life application of the major-related theoretic knowledge evokes a personal understanding that goes beyond the mere understanding of the theory. Therefore, the companies can expect a shortened adjusting phase and less additional training for their new employees who experienced on-site training. All in all, it can be said that for effective work experiences in the future engineering education long-term on-site training is needed.

Third, the IPP program was seen to have a positive effect on IPP students with respect to the mutual exchange of opinions and the reaching of compromises in the category of personal relationships. In the 21st century's global society, which demands cooperative skills with neighboring domains, communication and cooperation skills are considered significant occupational capabilities, and are just as important as capabilities in one's major. In this regard, long-term on-site training has a positive effect on the participants' acquisition of non-technical soft skills, which is insufficient in university curriculums compared to what is demanded in the occupational world.

Fourth, there was no statistical significance in any of the questions in the category of problem solving between IPP students and non-IPP students. Engineers in an era where the speed of technology is rapidly changing and where new levels of technology are generated by joining technologies of different areas need creative problem solving skills rather than mere answers to given problems. Although industry professional practice is an area limited to its participants, it must allow the maintenance of interest in practical work in order to raise the creativity and knowledge of the participants. To achieve this, the importance of a mentor and professor, who stimulate and lead the expansion of thought during the process of searching for solutions, must be emphasized.[9]

The significance of this study is as set forth below.

First, it was determined that the IPP program has a positive effect on the participants in terms of capabilities in their major. Although Kim, S. G. (2000) reported that the students are passive with regard to the recognition of the educational value of long-term on-site training, i.e., the value of obtaining knowledge in their field of major, IPP actually has a positive effect on understanding and analyzing theoretical knowledge and data and increasing the participants' self-confidence through major-related practice.

Second, it was observed that IPP acts as a positive influence on the behavior of those preparing for a career and determining a career path. Students who have experienced on-site training displayed more activity in preparing their career than non-participants due to their increased career understanding. Herein, it was deemed that industry professional practice is not only effective in allowing the students to gain credits and an income during their period of practice, but also on the preparation and formation of an attitude of determining their future career paths.

Third, it was found that IPP had a positive influence on forming technical and non-technical skills. The experience of practical performance at a site for 6 or 10 months through IPP influenced the students' cooperation and attitudes. Accordingly, the IPP is expected to perform its role as an effective program to nurture the future workforce's major and non-major practical skills which are required on-site and ensure their high site adaptability.

The restrictions of this study and the proposal of a succeeding study are as follows :

First, because this study does not take all long-term on-site training participants at four-year-universities into account the results may differ at other universities. Thus, it is believed that succeeding studies need to examine the differences at other universities. Second, although the elements of the students' corporative mentor and professor managing the participants at the university and at the practicing institute and corporation and the region of practice were not included in the effectivity analysis, it is believed that examining the effect of these variables would is significant.

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We_IE_2*_4

Tec21 EDUCATIONAL MODEL : Semetre i Implementation

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Abstract : *This article refers to the implementation of the Semestre i within the framework of the Tec21 Educatinal Model; we describe the component of tec21 thought Semestre i where students can develop their academic learning outcomes while performing challenge-learning experiences through our Challenge-Based Learning model.*
Keywords : *Challenge-Based Learning, Quality Assurance in Engineering Education, Attributes of 21st Century Engineers.*

INTRODUCTION

The educational model of Tecnológico de Monterrey is composed of a set of structured elements that allows us meet the goals of training students. It describes the purposes of our Vision, those purposes are integrated, defined and linking components involved in the teaching-learning process, and the possibilities of offering students a comprehensive education of international quality advantage. Tecnologico de Monterrey has declared evolve into the Tec21 educational model [1], which aims to improve the competitiveness of students in their field through enhancing the skills of current generations to develop the required skills that enable them to become leaders who facing the challenges and opportunities of the twenty-first century.

OBJECTIVES

In 2013 this innovative educational model (Tec21) adapted to the new times and to the particular characteristics of digital natives was launched. It is based on three pillars :

• learning experiences challenging and interactive
• Flexibility in the teaching-learning process
• Inspiring Teachers

The main objective of this effort is to evolve the educational model to enhance the skills of present generations and improve the competitiveness of students in their field, and thus develop the required skills that enable them to become leaders take on the challenges and opportunities. This training model involves rethinking learning processes in higher education.

METHODS

Tecnologico de Monterrey has been characterized by continuously innovate by implementing strategic actions, such as :

• The redesign of teaching practice, a model teacher-centered to a student-centered model.
• The intentional and programmed in a variety of teaching techniques as part of the instructional design use.
• Incorporating the most advanced technologies of information and communication in support of the educational process.
• The orientation of educational processes towards the development of skills in students.

The conceptualization of the Tec21 educational model is strengthened when considering educational level research top. Among them, [2] identifies seven principles of learning that can be applied by teachers from all areas of knowledge :

1. Prior knowledge of students can help or hinder learning.
2. The way students organize knowledge influences how we learn and apply what they know.
3. The student motivation determines, directs and supports the actions they take to learn.
4. To master the subject, students should acquire skills, practice them and know when to apply what they learned.
5. The practice focused on goals, coupled with a well-directed feedback, improves the quality of student learning.
6. The level of development of the student interacts with social, emotional and intellectual climate of the course, having consequently an impact on learning.
7. To get to learn self-directed way, the student must first learn to monitor and adjust their approaches and strategies for learning.

The Tec21 educational model is focused on the relationship of the student with the environment and their teacher, in which students develop personal and professional skills by solving challenges linked to real problems and demonstrate their mastery through various evidence learning. In this model, the central unit of learning are the challenges.

Challenge-Based Learning [3] is a pedagogical approach that actively engages the student in a real, relevant and relationship with the environment, which involves defining a challenge and implementing a solution problematic situation.

Traditionally level academic degree programs consist of a sequence of courses that make up the curriculum. When making the subjects of the curriculum, students learn fundamentals, technical and practical aspects associated with their profession. When a student successfully concludes its curriculum, the university guarantees that the student possesses a certain level of development to perform satisfactorily as a professional career. In this model, the central unit of learning are the courses that make up the curriculum.

Challenge-Based Learning in our educational model [4] is based on experiential learning that has as its principle that students learn best when actively involved in open learning experiences, rather than passively involved in structured activities. In this sense, the experiential learning offers students opportunities to apply what they learn in real situations, where they face problems, they find themselves, test solutions and interact with other students within a given context [5]. Experiential learning is an integrated holistic approach to learning, combining experience, cognition and behavior [6].

Within the model seeks to deepen, integrate and apply knowledge through different learning modules. These are designed according to the requirements of resolution of the challenge and offered prior to or simultaneously this way.

Assessing the level of performance skills evidence gathering is done through various instruments of observation and measurement, including both partial evaluations as inclusive. In this process, both the reflection on learning as feedback to the student play a key role in its formation.

The teacher's role is critical in exercising different functions designed to accompany the student in the learning process and the development of skills through the experience of the challenges. The functions are : advisor, mentor of challenges, challenges designer, assessor and instructor skills learning modules. The teacher can specialize in one or more of these features.

A challenge is a living experience designed to expose students to an attractive and challenging environmental situation. The challenges contribute to the development of cross-disciplinary and skills of students as they apply them individually and collaboratively their knowledge, skills, attitudes and values. A challenge has the following characteristics :

- Actively involves students in the learning process through discussion, reflection, collaborative work and application of knowledge outside the classroom.

- Demand the approach of innovative solutions that create value to environmental problems.
- Fosters addressing relevant and complex situations involving both disciplinary and multidisciplinary strategies for their solution.
- Lets face learning experiences from a local, national or international stage.
- Poses situations that allow global significance undertake local actions.
- Generates product development and evidence and cross-disciplinary skills.

The challenges can integrate the relationship between student and teacher environment in order to develop specific skills and cross disciplinary raised by the challenge. To solve the same, the student faces a relevant situation related to the environment, which will play their knowledge and skills. An essential aspect in this process is the support and feedback from the teacher.

RESULTS

Semestre i. It is a project or learning experience aimed at addressing a challenging professional real situation, which allows students to develop skills and strengthen cross-disciplinary skills. The experience lasts one semester, integrates learning objectives of a set of materials, as part of the curriculum of the student, whose contents and form of work is organized exclusively from projects that allow students to engage in an experience of challenging learning to develop transversal competences and disciplinary aligned with the exit profile, which are supported by the learning modules.

In the process of making the first implementation of Challenge-based Learning model during the spring semester of 2016, we worked under this scheme with students from the Industrial Engineer Program at Campus Santa Fe. Professors of Industrial Engineering, developed 2 challenges to be performed within a company (Frigus Bohn) where our students solved problems in the area of quality control and production systems. This experience allowed the students to revalidate 6 courses; during the spring semester (Semestre i) students were supervised by teachers who were teaching them learning modules that allow them to learn more in detail the problems of the company and on the other hand we made sure that students have the necessary academic knowledge to revalidate materials selected during the Semestre i.

CONCLUSION

Semester I runs implementing the design of learning experiences in a semester complete with all the elements of the new model (competencies, challenges and modules).

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We_IE_2*_5

De-Genderizing STEM

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Abstract : This paper addresses the concept of genderization of disciplines – in particular the disciplines of STEM (viz., Science, Technology, Engineering and Mathematics) – and, the need to de-genderize the STEM disciplines. These observations presented in this paper would be useful in addressing issues that arise in increasing the participation of women in the STEM disciplines and other related areas.

We_IE_2*_6

AN INTEGRATIVE LITERATURE REVIVEW ON WOMEN IN ENGINEERING

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Abstract : *In this paper, we explore how domestic and international engineering education journals have explored the interplay of factors contributing to recruitment, retention, and persistence in engineering, especially among women. An integrative literature review of engineering education journals will be carried out to identify major issues of women engineering in addition to gaps in research. The findings are expected to show that retention and persistence of women in engineering is closely relevant to issues of institutional culture and vocational identity development. Recommended future research and practice for diversity in engineering will be presented at the end of this paper.*

Keywords : *women, engineering education, institutional culture, vocational identity development, diversity*

INTRODUCTION

Several studies indicate that increased diversity in the classroom and workplace enhances scholarship, achievement and productivity [4, 5]. Unfortunately, women remain a minority in engineering in many parts of the world despite a history of initiatives and interventions to recruit and retain female engineering students [2]. For this reason, issues surrounding student retention and persistence in engineering degree programs and the engineering workforce are of special interest to engineering educators. Particularly, some engineering fields such as computer, game, chemical, and bio-molecular engineering are urged to take woman-friendly policies due to increasing number of female engineering students.

OBJECTIVES

The purpose of this study is to investigate the common issues associated with women in engineering education. By investigating current knowledge and on the state of women engineering education, this study aims to explore effective educational supports for female engineering students to boost diversity and equality in engineering education.

METHOD

This study will analyze articles from European Journal of Engineering Education (EJEE), Journal of Engineering Education (JEE), and Journal of Engineering Education Research (JEER) that had women and gender as a central part of their studies. Review of literature is generally conducted to critically appraise, summarize, and attempt to reconcile the evidence in order to inform policy and practice [3]. Titles, keywords, and abstracts for every article in the journals will be reviewed for the years 2005-2016. Studies that will not be related to HRD (Human Resource Development) practices, work, and higher education will be excluded. The articles reviewed for this study will be grouped into three main areas of interest with relation to women engineering : training & development, career development, organization development. These three areas have served as HRD field's framework of practices and research foci. "HRD focuses on theory and practice related to training, development and learning within organizations, both for individuals and in the context of business strategy and organizational competence formation." [1]

EXPECTED RESULTS

This section will explain the findings of research studies in each group to isolate factors that may contribute to retention and persistence of female engineering students. Analysis of journal articles is expected to reveal that there are common factors related to the women in engineering. For example, as a result of the literature review, each area of interest will be classified into several factors such as self-efficacy, motivation, communities of practice, and career choice.

EXPECTED CONCLUSION

Considering these results, it may be proposed that colleges and universities are required to translate research findings into sustainable policies, programs, and practices in terms of retention and persistence of women in engineering. As a result of literature review, retention and persistence of women in engineering is supposed to be closely relevant to institutional culture and vocational identity development. In addition, this study recommends the directions for future research and practice for diversity in engineering.

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We_EE_2_2

SNU CREATIVE SPACE PROJECT WITH CROSS-COLLEGE AND FACULTY-STUDENT COLLABORATION

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Abstract : *In this paper, we share our experience of how to reform a traditional engineering make space to a creative space through cross-college and faculty-student collaboration.*

Keywords : *Creative space for engineering students, creative education in engineering.*

INTRODUCTION

This paper reports on the effort to create a resonant space in College of Engineering at Seoul National University, which started with the question : 'Is there a place where students can realize their ideas in SNU campus?' At the end of 2014, the student author of this paper should answer "No."

OBJECTIVES

To correct the answer, we were looking for a candidate place where students can do ideation, collaboration with colleagues and faculty, realization, and sharing with friends and the public.

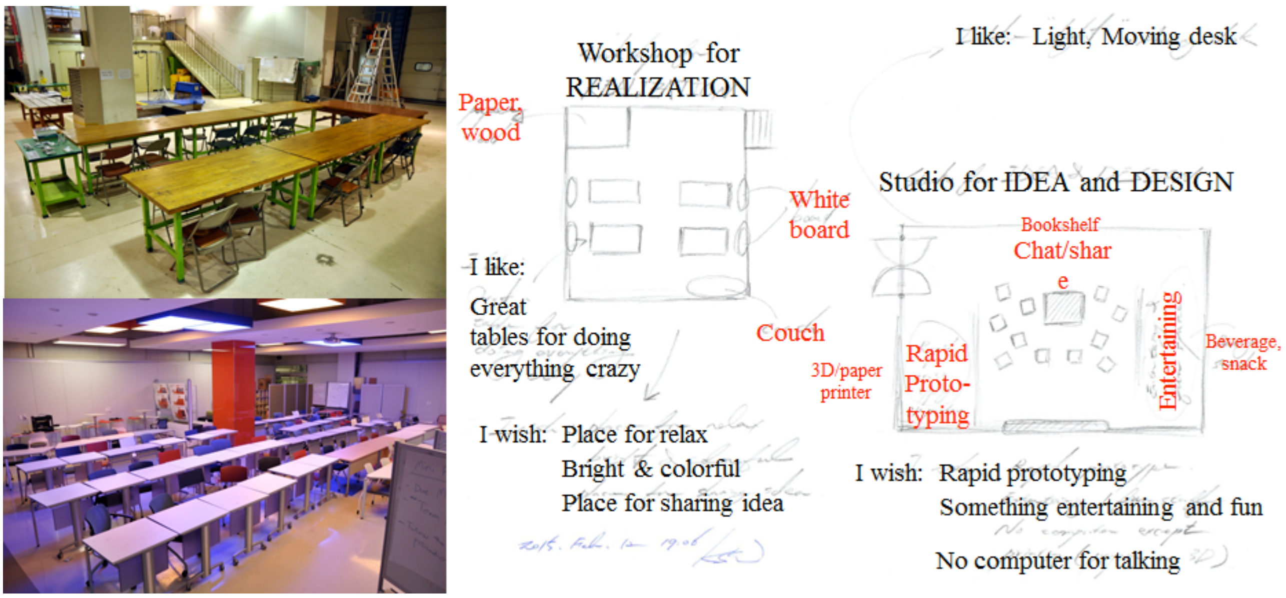

Figure 1. (Left-top) workshop for realization, (left-bottom) studio for ideation and design of SNU Engineering College up to 2015, and (right) sketch for reforming the space.

Figure 1 shows the place that the SNU Engineering College had. The left-most of Figure 1 is the snapshots of industrial factory-looking workshop and traditional classroom for ideation. Based on the early survey and analysis, they set three visions for the space : 1) an interdisciplinary platform to connect ideas from around the campus, 2) a physical space where students can collaborate, and 3) a cross-college system for financial support and education in executing student ideas.

METHODS

To design and specify the space for the objectives, we have pushed this project forward with the following three methods : 1) Field trip, 2) space experiment, and 3) writing a creative space guideline. Firstly, we have visited several great make spaces in Korea such as IDEA FACTORY in KAIST, Daejeon Creative Economy and Innovation Center by Korean government, and Seoul Fab Lab by Tide Institute. Secondly, the faculty authors of this paper newly launched a capstone course for creative product development at the same time with this space project, where space gives the significant impact on the student outcome in terms of creativity. We have conducted space experiments according to the requirement and curriculum of the course. Lastly, we wrote a creative space guideline, mid Sep 2015.

RESULTS

The guideline was finally realized through the donation of Haedong Science and Culture Foundation with the support of Ministry of Trade, Industry and Energy, and Korea Institute for Advancement of Technology. Figure 2 shows the final results reformed based on the creative space guideline with cross-college and faculty-student collaboration for more than one whole year.

Figure 2. SNU Haedong Idea Factory was officially opened on March 17, 2016

CONCLUSION

This space and education systems have become famous nationwide and had hundreds visitors from academia and industry for past three months. Currently, more than one thousand students have been registered to this space and actively used this space for student startup and student-driven projects. We keep trying to make this space an incubator for creative culture and ideas across the campus.

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Visualization Skills of Engineering Students : Action Research Approach, and Comparative Gender Analysis

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Abstract : *The paper reports on Action Research approach investigating enhancement of outcomes of an engineering course. Visualization course learning outcome was systematically scoring lower in students' evaluations than other course outcomes for the Engineering Graphics course. Visualization in particular is a crucial skill for engineers. We investigated the visualization skills of first year engineering students usinga standard mental rotations test. Students were asked to take the test at the start of the semester. Instruc- tions were delivered throughout the course. These included training students with manual skills and the useof software in drawing objects. Students took the same visualization test at the end of the semester. Resultsshow that there was significant improvement in the test scores for both male and female students.*

Keywords : *Engineering Graphics, Visualization, Mental Rotations Test, Engineering Education, Gender Differences, Action Research*

INTRODUCTION

Action research [1] is an established applied research approach in education. In action research, teachers or lecturers take conduct actions and research based on observations they note. The visualization learning outcome of Engineering Graphics course has systematically been lower in students' evaluations over the past few years, this stimulated the first author in this paper to develop teaching actions and interventions, and conduct in-depth analysis to understand the phenomena. Visualization is a fundamental skill that students have to develop to successfully analyze and design devices, systems or processes. We chose the course on Engineering Graphics to investigate the development of visualization skills of engineering students and comparatively analyze differences. The course teaches the fundamental concepts of Engineering Graphics. Students are expected to draw 2-dimensional and 3-dimensional drawings using hand drawing techniques and Computer Aided Design software throughout the course.

OBJECTIVES

This work aimed to determine if the visualization skills of the students can be improved in an Engineering Graphics course, and to analyze gender differences. At the beginning of the semester, the students were asked to take the a visualization of rotations test (Purdue Spatial Visualizations Test [2]). Interventions were provided during the rest of the semester. These included step-by-step demonstrations in class, online tutorials through a private YouTube channel, and the usage of a 4-sided cave automatic virtual environment (CAVE) for visualization. Immediate feedback was also provided to the students. At the end of the semester, students were asked to take the same visualization of rotations test to determine whether the interventions were useful to improve the students' skills in rotating objects mentally.

METHODS

Students enrolled in the Engineering Graphics course in both Spring and Fall 2015 semesters participated in the study. Data were collected (a) from students who completed both the pre-test and post-test, (b) from those who have not taken the course earlier, and (C) taking the course with the one selected lecturer. The course was taught by a single lecturer to remove any variables related to the teaching styles and delivery. Overall, data from 60 students were used in the analysis. Apart from the results from the mental rotations test, the final grades were also used in the study. To determine whether there were differences in the results of the interventions given, we first compared the final grades of male and female students during the spring and fall semesters. Ideally, there should not be any significant differences between the two semesters. To determine whether there are gender differences in the mental rotations test, we then compared the pre-test and post-test results of the male and female students. A 2-way ANOVA was used to analyze the data, which were run using OriginPro (v2016, OriginLab, MA, USA).

RESULTS

To check if there were significant differences due to the instructor or to the course delivery, we compared the final grades attained by the students across the semesters. There was no significant effect between the 2 semesters ($F(1, 56) = 0.3225$, $p = 0.573$) and there was no significant effect of the gender on the final scores ($F(1,56) = 1.0039$, $p = 0.3207$). There were no significant interaction effects found. We then investigated whether there were differences in the mental rotations results of male and female students. There were significant differences found between males (mean = 54.95; n = 72) and females (mean = 40.41; n = 48; $F(1, 116) = 18.33$, $p < 0.0001$). There were also significant differences found in the pre-test (mean = 42.99; n = 60) and post-test results (mean = 55.27; n = 60; $F(1, 116) = 13.0649$, $p < 0.001$). There were no significant interaction effects found.

CONCLUSION

The present study investigated whether the visualization skills of students can be improved. Results from a standard mental rotations test were taken at the start and at the end of the semester. In addition, the students' final grades were also obtained. We first determined whether there were differences in the final grades of the students between the Spring and Fall 2015 semesters, which may be caused by the teaching style of a single lecturer and the interventions provided during the semester. No effect was found. Next, we determined whether there were differences between male and female students. We found differences. Male students scored higher (mean = 54.95) than the female students (mean = 40.41). Earlier published results also showed the gender differences in visualization [3]. Some of the possible reasons given were due to differences in the childhood activities between males and females. Results showed improvements in the pre-test (mean = 42.99) and the post test (55.27) scores, implying that the interventions that were provided to the students were effective. Future studies will focus on developing interventions targeting female students to bridge visualization gap with male students.

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We_EE_2_4

Transformational Journey of an Engineering Institution : A Case Study

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Abstract : *This paper shares a successful transformational journey undertaken by an Indian Engineering college from an institution affiliated to a state University to a well performing autonomous institution and then to it's present (recently acquired) status of a University. The paper explores systemic reforms undertaken by B. V. B College of Engineering and Technology, Hubballi, India, through visioning, strategic reorientation and implementation. The three primary goals envisaged for the strategic transformation : building distinctive educational experience, leading through transformative leadership and governance, and playing generative role in regional development, are discussed. The results and impact of reform process are presented.*

Keywords : *Engineering Education, Outcome Based Education, systemic reforms*

1.INTRODUCTION

Established in 1947, B.V.B College of Engineering and Technology, Hubli (BVB),is one of the premier engineering colleges in the state of Karnataka. The college having remained as an affiliated institution to a state University for six decades, had limited aspirations, impact and brand value. The competitive environment of the new century and change in leadership, made the institution to set higher aspirations and undergo a systemic reform process. As a first step towards reform process the college attained the autonomous status in 2007, from the University Grants Commission, the premier regulatory body of Government of India. But, transforming from an affiliated college to autonomous college has significant challenges.Being part of affiliated system, college had a little experience institutional development, curriculum design, pedagogical innovations and assessment frameworks.

The big game changer for the transformation process undertaken by the college was initiatives of 'Indo Universal Collaboration for Engineering Education (IUCEE)". In 2008, IUCEE conducted a series of workshops in India, by experts around the world to share the best practices in institutional development, curriculum frameworks, teaching and assessment. These workshops became the main learning platforms for senior academic leaders of the college to chart out the new directions. The college undertook a comprehensive reform process based on strategic reorientation with three primary themes; building distinctive educational experience, leading through transformative leadership and governance, and playing generative role in regional development. The success of large-scale internal organizational change and greatly improved brand positioning the college moved on to become a private State University in 2015.

2. OBJECTIVES

This paper presents, focused efforts by institutional leaders to evolve and implement specific strategies to transform an engineering institution to enhance its impact and relevance. The three primary goals envisaged for the strategic transformation are : i) building distinctive educational experience, ii) leading through transformative leadership and governance, and iii) playing generative role in regional development. The learning and experiences accumulated in the transformational journey are being shared

3. METHODS

This section describesstrategic re-orientationas articulated in the earlier section in the form of three primary goals.

3.1 Building distinctive educational experience

The college started adopting 'Outcome Based Education' (OBE) framework from 2008. Over the last seven years through conscious efforts all the programs are able to design curriculum and student experiences that strongly map to graduate attributes. Though Indian accreditation body "National Board of Accreditation (NBA)", made it mandatory to adopt OBE framework in engineering education in 2013, the college had assumed the leadership due to its proactive approach. Faculty were continually trained, encouraged and supported to innovate in the variety of teaching learning practices. The faculty conclaves were used to showcase such innovations and discuss the institutionalizing the good practices. Lot of emphasis was given to create opportunities for experiential and integrative learning in all programs in the form projects, research, fieldwork and internships. A systematic assessment process was developed and adopted to measure the attainment of learning outcomes and continual improvements at course level and program level. To support all these activities a "Center for Engineering Education and Research (CEER)" was established. The academic leaders visited other campuses abroad regularly, to learn innovative practices and adapt them to our institutional context.

3.2 Leading through Transformative Leadership and Governance

The leadership at every level of the organization and governance practices play a key role in the success of a major change effort. In 2010, the college became part of "Technical Education Quality Improvement (TEQIP)" program initiated World-Bank and Ministry of Human Resources Department, Government of India, to improve technical education in India. The good governance practices advocated by the program inspired the college to re-orient its governance practices. The college undertook initiatives of strengthening its governing board by bringing in nationally renowned academic experts and independent members who can stretch the aspirations of the college and set the new direction for the growth. The college leadership along with the other stakeholders developed strategic plan defining next level of achievements, with clear goals and measurement metrics and also continually built internal momentum and capacity required for the change.

3.3 Playing Generative Role in the regional Development

The region in which, the college is located lacks the industrial ecosystem and large migration of the graduates happens due to the lack of employment opportunities. In its new aspirational journey, the college set the goal to build entrepreneurial ecosystem in the region to create and support technology businesses and hence mitigate the talent migration. The initiative led to the establishment of "Center for Technology Innovation and Entrepreneurship (CTIE)". The center has emerged as a pioneering model to develop entrepreneurial ecosystem in Tier-2 cities. Initially, the experienced entrepreneurs, willing to move out of major metro cities, were brought to the campus to establish their companies by creating appropriate value proposition. Further, the presence of these entrepreneurs in the campus was used to drive the student startups. The center has so far incubated 41 companies in the campus which have created more the 400 engineering jobs in the region.

4. RESULTS

Efforts to create a distinctive educational experience have made a big difference to not only the student learning but also their employability. It is reflected in the fact that, in the last seven years the campus placement offers have increased by 300 %. The enhanced student performances helped the college to establish a distinctive identity and brand with the major recruiting industries.

Based on the success of Governance initiatives under World-Bank program, the college was identified as one of the two model colleges in India for Good Governance. The leadership of the college have contributed to the training of board members of other institutions under the TEQIP program.

Apart from creating jobs in the region, CTIE initiative of creating entrepreneurial ecosystem has brought about a great change in the campus culture aspirations of the graduates. In the last two years, 12 student startups have been setup. The presence of companies in the campus has enhanced industry institute interaction, and presently 64 student groups are working with these incubating companies.

5. CONCLUSION

The study explored the transformational journey undertaken by an Indian Engineering College to improve its organizational effectiveness and profile. The institution seeking strategic growth should focus on high impact themes and evolve initiatives with specific goals and implement processes for their achievement. Leadership at every level of the organization is critical to engage all the constituents in the change process. The institution can leverage their strengths and influence the socio-economic growth of the regions in which they exist. The collaborations with individuals and organizations plays a critical role in learning of good practices that can enable an accelerated growth of the institution.

We_EE_2_5

Legal status of a certificate of Russian language proficiency, knowledge of history and fundamental principles of the legislation of the Russian Federation, granted to migrant for obtaining workers to a temporary residence permit, residence permit or work permit

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Keywords : *migrants, residence permit, temporary residence, work permit*

Over the past year, about 14 million foreign citizens entered the Russian Federation; about 77% of them are the citizens of CIS countries. Most representative are citizens of Tajikistan, Kyrgyzstan, Azerbaijan, Moldova, Kazakhstan, Ukraine and Uzbekistan. Russian President Vladimir Putin said that in 2016 Russia took the second place in the world (after the US) for the number of migrants from other countries, mostly coming to work or permanent residence, while being citizens of the former USSR. According to official statistics of the Federal Migration Service of Russia today on a permanent basis in Russia live about 9.2 million migrants, for about 15% of them work legally .

Currently migration situation in Russian is constantly changing. Legislative and organizational conditions to assist migrants in obtaining the documents and start a legitimate work are created in Russia. According to Article 15.1 of the Federal Law July 25, 2002 N 115-FZ "On Legal status of foreign citizens in the Russian Federation", since January 1, 2015, all foreign citizens, which arrive to the Russian Federation in order to work, that requires a visa order and visa-free are obliged to confirm Russian proficiency, knowledge of Russian history and the fundamental principles of the legislation of the Russian Federation.

Conducting a comprehensive exam in Russian as a foreign language, the history of Russia and the fundamental principles of the legislation of the Russian Federation is carried out for the following categories of foreign citizens : foreign workers (for those applying for a work permit or a patent on the implementation of employment); for those wishing to get a temporary residence permit; for those wishing to obtain a residence permit.

Foreign citizen, successfully passed the comprehensive exam, receives a certificate of Russian proficiency, knowledge of history and fundamental principles of the legislation of the Russian Federation, the form of which is approved by the Ministry of Education and Science of Russian Federation.

Certificate is given by test organization to foreign citizens, who successfully passed the test. However, in practice there are legal disputes about the legal status of the certificate.

A public prosecutor filed a lawsuit in the Court of Orel to find a certificate of Russian proficiency, knowledge of history and fundamental principles of the legislation of the Russian Federation № 000100631107 24.09.2015 given to Adanov SH.I.U. invalid. We consider unreasonable the conclusion of Federal Migration Service of Russia in the Orel region, that Adan S.I. Ugli does not understand the Russian language and questions he was asked, as well as the conclusion of the prosecutor's office of the Railway District of Orel that Adan S.I. Ugli does not have spoken Russian skills and reading Russian skills. Determination of formation of communication skills and foreign citizens Russian proficiency, knowledge of history and fundamental principles of the legislation of the Russian Federation is beyond the competence of employees departments mentioned above, as specialists of these agencies do not know what level is required for foreigner applying for a patent.

The Court did not take into account the fact, that this conclusion was made by a person who is unable to determine the level of Russian proficiency of a foreign citizen, applied for a patent, whose duties and authority is not part of determination the degree of formation of communicative competence and compliance with the approved requirements to the level of Russian proficiency, knowledge of history and fundamental principles of the legislation of the Russian Federation in the framework of the Comprehensive exam.

Judicial practice is unequal, as an example, there was the appeal of Assistant Attorney of Orlovsky district Nechayeva I.I. for annulment of a certificate of Russian proficiency, knowledge of history and fundamental principles of the legislation of the Russian Federation from 17.06.2015 № 000100498942, that was given to the citizen of the Republic of Uzbekistan M.G. Nasibhonov. This claim was dismissed. The Court found the patent for bricklayer lawful and left the applicant's claim dismissed on the grounds of : firstly, the lack of knowledge or lack of knowledge of a foreign citizen of the Russian language is the subjective opinion of the prosecutor's office employee who took explanations from Nasibhonov M.G., who is not a competent person in this field; secondly, Nasibhonov M.G. passed comprehensive exam in the local center in accordance with the Order of the Russian Ministry of 29/8/2014 number 1156 and the local regulations of the authorized organization, which is confirmed by the submitted documents (matrices subtests), as well as audio recording interviews conducted by members of the Commission, so Nasibhonov M.G. showed the level of Russian proficiency, knowledge of history and fundamental principles of the legislation of the Russian Federation required for passing Comprehensive exam.

Thus, in judicial decisions it is not quite reasonably challenged the content of the official document - a certificate of Russian proficiency, knowledge of history and fundamental principles of the legislation of the Russian Federation, which has been obtained legitimately, on the basis of scientifically developed and legally established requirements.

Carrying out the corresponding legal procedure for examination by high quality experts to verify the knowledge migrant are indisputable evidence of their Russian proficiency, knowledge of history and fundamental principles of the legislation of the Russian Federation.

The absence of such litigation allows foreign citizens to come to Russia legally without fear, and to realize their labor and business rights.

We_EE_2_6

BREAKING MYTHS OF ENGINEERING FOR FRESHMEN STUDENTS IN INDIA THROUGH 1-DAY WORKSHOPS

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Abstract : *Engineering is one of the most widely chosen fields of higher education in India. While there are many different reasons for the above-mentioned fact, majority of them are alarming and needs immediate attention. Unlike engineering in developed countries such as U.S.A where engineering is rated as one of the toughest course to complete, engineering education in India is considered relatively easy to complete and is assumed to provide easy employment. Many other reasons add up to such myths which are imbibed inside high school students by friends and family resulting in majority of them opting engineering as their next course of study. This results in only a minimal ratio of students joining engineering with passion and interest and the others being left in the dark about the next four years of their education. The paper talks about a certain initiative taken by Footsteps, a social venture formed with an aim to help engineering students and faculty have a better and more fruitful engineering education experience through workshops and certification programs. The focus here is on a one day workshop "The E-Myths" which is delivered to freshmen engineering students. Through this one day workshop, freshmen are walked through the importance and necessity of engineering and engineers through a unique training methodology. Students are exposed to the methodology of looking at engineering as a fun-building and knowledge-gathering exercise which continues for 4 years. They will also learn the associated soft skills that are quintessential to continue their learning process and above all, life inside the institute.. The papers also list out the feedback collected from the participants which highlights the success of the program.*

Keywords : *Engineering Education, Myths,*

INTRODUCTION

One of the best known clichés has to be a modern-day parent determinedly parroting "What will my kid do?! Well, of course, engineering!" Not so surprisingly enough, these kids do go on to become engineers. Although one is often found arguing for the cause of freedom of the youth to pursue their stream of choice, it is definitely going to be a while to bring on this paradigm shift. Research has it that nearly half the students in India selecting engineering as a career are forced into it. These graduating students are then expected to become innovators of the future. However, a whopping 82% of the engineering student community completes the course to find that they actually lack the necessary employability skills.

We believe that the root cause of the aforementioned issue lies in the freshman year. The interest and dedication towards imbibing engineering has always been a major challenge. The attitude of teaching matters a great deal too! How can we possibly expect a student to implement Pascal's law without knowing what it was discovered for? An attempt is required to bridge this gap between myth and reality; theory and practice. The science of engineering should be taught and learnt practically.

OBJECTIVES

The program was designed taking into account the below objectives, which the students should be able to do at the end of the workshop. 1. Look at engineering with interest and passion; 2. Have increased confidence in seeing themselves through the career they have chosen; 3. Achieve increased creativity and collaborative outcomes; 4. Develop leadership skills; 5. See an improvement in teamwork, creativity and communication skills.

METHODS

The 1 day workshop is divided into 4 sessions starting with introducing the participants to engineering and its diverse domains. The session stresses on the importance for engineers in the community and the necessity to address the upcoming grand challenges of engineering. This is followed by an activity-based exercise to make the participants gauge the quality of their communication skills and ways to improve the same. The next session after lunch focuses on the practical application of few basic chemistry, mathematics and physics laws such as Pascal's law by showing movie videos. This is intended to make the participants appreciate engineering by linking it to real life applications. The final session is again an activity-oriented session where participants are given a problem statement, few basic materials and are asked to build a working prototype out of it. This session gives the participants a real time engineering experience as they create something using their knowledge, creativity to solve a problem.

RESULTS

The results of this initiative are showcased using the student feedback taken after the end of each workshop. The feedback form is designed to evaluate if the expected outcomes are met at the end of the workshop. The assessment of result shows a very high positive feedback with majority of the participants agreeing to have met the objectives of the workshop.

We_EE_2_7

LEADING ENGINEERING EDUCATION OF KERALA TO ACADEMIC AUTONOMY

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Abstract : *There is a need to create an ecosystem that will empower and enable the engineering colleges within the Kerala State to focus on quality education providing autonomy in academic activities. All engineering colleges in Kerala is presently under the university affiliating system. This paper presents the academic autonomy concept happening in engineering education of Kerala through APJ Abdul Kalam Technological University (KTU) and methods to implement these changes in the society.*
Keywords : *Engineering Education, Academic Autonomy, Affiliation, Clusters, Kerala*

INTRODUCTION - KERALA GENERAL EDUCATION - KEY INDICATORS

Kerala is a state in the south-west region of India, established on 1st November, 1956 combining various Malayalam-speaking regions. Spread over 38,863 sq.km, it shares borders with Karnataka, Tamil Nadu and the Lakshadweep Sea. Kerala became the first Indian state to accomplish 100% primary education through its literacy programme called 'Athulyam' in January 2016 [1]. The State had tracked a liberal higher education policy from its formation in 1956 to mid-eighties with regard to quantitative access to higher education. Kerala is in the top position with high literacy rate of 93.91% as against 74.04% at the national level [2]. A literacy rate above 90% is considered as complete literacy, as per the norms of National Literacy Mission [3]. On this basis, Kerala (90.86%) was declared a, 'Fully Literate State', on April 18th, 1991. Presently, 91.98% of women in the state are literate which is very much higher than the national rate (65.46%). The male literacy rate is 96.02%. Near total literacy, free and universal primary education, low school dropout rate, easy access to educational institutions and gender equality in access are well known achievements of Kerala in the field of education. These indices of Kerala are comparable with the indices of the developed countries.

Impact of Education of Kerala Economy

Kerala's education system has been one of its largest economic activities and Government expenditure on education as a ratio of state domestic product is one of the highest in the country. Kerala has always spent more than 40% of its developmental expenditure on education [4]. This is one of the main reasons behind the high educational capital of the state. Kerala spends much more per person in education than most other states in India. Without effective return in the huge investments made, Kerala's educational system is slowly becoming a drag on its economy [5]. Education system of Kerala played a definite and significant role in the past. But without updating to the modern education patterns and technologies, the question that is increasingly being posed is whether it can continue to play a major role in future.

Kerala Higher Education Scenario

The Technical Education system in the State includes courses in Engineering, Management, Computer Applications and

Architecture at diploma, degree, postgraduate and research levels. Engineering colleges, Polytechnics, Technical high schools and College of Fine Arts come under technical education system of Kerala. National Institute of Technology, Kozhikode having the Deemed University status offers graduate and post graduate courses. Cochin Science and Technology (CUSAT) is a government run autonomous University. Currently, there are four categories of Universities in Kerala viz. Central, State, Deemed and Institutions of National importance, a total of 20 Universities [6]. The status of colleges with all State Universities is in the affiliating mode. Till 2000, Engineering Education was confined to State run, Government aided or Government controlled institutions and the seats were so limited that the admissions were based strictly on merit among the aspirants. The rapid developments in the field of technology opened many opportunities for engineering graduates which could not be catered by the Government controlled institutions alone. After 2000, Government allowed private participation in technical education on self-financing basis. During the initial stages, institutions under Government outnumbered the private institutions as the Government policy did not favor private participation. The growing demand for technical education has led to an undue expansion at this level with the larger role assumed by private sector. The total intake during 2013-14 has grown up to nearly 100,000 in all programs put together [7].

KTU - LEADING ENGINEERING EDUCATION

In accordance with Chapter VIII of the Ordinance to establish APJ Abdul Kalam Technological University (KTU), Government of Kerala has made mandatory, the affiliation of all Engineering Colleges in the State with KTU from the academic year 2015-16. In view of this Kerala Technological University invited applications for affiliation of “Existing and New Technical Institutions” of the State which conducts Under Graduate and Post Graduate programmes in Engineering and Technology for the Academic Year 2015-16. The process was completed and the affiliation was given to colleges and their programs. 154 engineering colleges in Kerala are now affiliated to KTU [8].

CONCLUSION

Kerala has succeeded in becoming one of most literate, uplifted societies with high HDI. It is now time to transform Kerala into a self-sufficient, self-sustaining, quality higher education hub. Realization has dawned that it is possible only by promoting institutional autonomy. The focus of KTU is to foster quality education and through it in converting Kerala as a global destination for high quality technical education in future.

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We_EP_2_1

DEVELOPMENT OF GLOBAL TEAM-BASED SENIOR DESIGN CLASS PERFORMING INDUSTRY SPONSORED PROJECT

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Abstract : *A team-based senior capstone design class was developed to expose students to multi-national cooperative design process. Global industry sponsors propose challenging real-world engineering problems to student teams to develop mechanically functional prototypes. Student teams face and overcome several challenges such as cultural differences, time scheduling between different time-zone, multi-way communication among team members and sponsors, work-load distribution, and prototype parts shipping/assembly throughout the class. This paper reviews a case study of such program developed between Pennsylvania State University and Seoul National University.*

Keywords : *Senior Capstone Design, Global Team-Based Design, Industry Project*

INTRODUCTION

Modern-day design engineers face great challenges working in global environment. Accordingly, engineering students need to increase familiarity to such environment. Also, engineering education must provide key skills to students such as technical excellency, global communication skills and team-based engineering [1]. College of Engineering at Seoul National University (SNU) has years of experience on team-based senior-level design program. Furthermore, an experimental approach has been introduced to enhance the global design environment to the class. Global industries provide real-world engineering project to the students to augment the design experience. The US partner, Pennsylvania State University (PSU), jointly offered the class as a part of engineering undergraduate curriculum. Students from both university form global design teams to conduct industry project throughout a semester. Students teams must design and prototype a functional product at the final exhibition in the end of the semester.

CLASS ORGANIZATION

The lectures from each university initiate meetings at lease a few months before the semester starts. The class is typically offered in Fall semester to match the school calendar. During the series of meetings, instructors discuss the possible industry projects that each school has solicited. The emphasis is given to projects whose results are applicable to global product. Also, project tasks should be distributable to students. Instructors need to give a careful attention to holidays during scheduling since holidays from both country affects the class schedule.

The student team is formed during the beginning of the semester. Each university assigned students to each project according to the preference of students. A global team is formed simply by mixing two students groups from each university for works for the same project. Ice-breaking procedure among student team is highly recommended. It is helpful that during the class students deliver self-portraits including family information, favorite foods, specialty, hobbies, bio or any personal stuffs has cultural aspects.

Students and instructors needs access to professional communication equipment for weekly design meetings. Also, students efficiently use messenger apps to communicate frequently. Both methods are keys to enhance communication professionally and personally.

Students needs to figure out the available resources for designing and prototyping at each university. They distribute workload of project based on their design skills and access to prototyping equipment. Design and manufactured parts must be shipped to final exhibition site to demonstrate the functionality.

FINAL EXHIBITION

Student teams present the final prototype in final exhibition at PSU. If travel funds are secured, some students travel and join the US teammates to work on final presentation and prototype during the last week. Travel is not a must but face-to-face meeting has a great impact on students' cultural experience. Students should be prepared for the travel at the very early stage of the class to avoid conflicts with other classes.

CONCLUSION

The instructor need to carefully plan the schedule and monitor the conflicts among team members and progress of the projects. Students faces numerous special challenges during global design process. Students survey, however, indicates that they highly appreciate global design experience with students from other countries.

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We_EP_2_2

DEVELOPMENT OF A FRAMEWORK TO PLAN AND DEVELOP LEARNING ACTIVITIES

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Abstract : *There is constant generation of ideas and concepts regarding new activities, or modification of existing ones, to enhance learning in an academic environment. These ideas and concepts are usually developed according to the beliefs and frame of mind from the person or persons working on such ideas and concepts. This paper reports on the work performed on the creation of a framework that can be used as a standard format for the planning and development of learning activities. This planning tool is based on drawing a similarity between the proposed learning activity and the creation of a new small business, and therefore develop a framework with similarities to a standard proposal of a business plan. The developed framework has been titled "Engaged Learning Template" and it consists of three specific modules. The developed framework has been developed in preparation for a workshop where pedagogical approaches to introduce global sustainability awareness in engineering education.*

Keywords : *Framework, Learning Activity, Business Model*

INTRODUCTION

The proposed approach for planning and development of learning activities consists of a framework or template that can be used to identify and define engaged learning activities in a specific setting. The approach of the proposed framework is similar to the one utilized by the Business Model Generation [1] and applied to educational activities with the Learning through Service Program Model Blueprint [2, 3]. The framework that has been developed is entitled, Engaged Learning Template, and it is presented herein as version 1.0. It is designed to lead a person through the development and deployment of an engaged learning activity whether it is a course, a course module, a minor, a field trip, etc. The proposed modules in the framework are : a) strategy, b) logistics, and c) action. Each one of these modules has various factors in it, for a total of fifteen factors, six in the strategy module, five in the logistics module, and four in the action module. In our purpose, the goal was to incorporate sustainability in the engineering curriculum.

OBJECTIVES

This paper reports on the work performed on the creation and utilization of a framework that can be used as a standard format for the planning and development of learning activities. The proposed framework has been applied in a workshop for development of activities to introduce global sustainability in engineering education.

METHODS

The proposed approach is similar to the one utilized by the Business Model Generation [1] and applied to educational activities with the Learning through Service Program Model Blueprint [2, 3]. It is designed to lead a person through the development and deployment of an engaged learning activity whether it is a course, a course module, a minor, a field trip, etc. The proposed modules are a) strategy, b) logistics, and c) action. Each one of these modules has various factors in it, for a total of fifteen factors, six in the strategy module, five in the logistics module, and four in the action module.

RESULTS

Specifically, the proposed "Engaged Learning Template" consists of the following items (Figure) :

(1) Strategy, which relates to the intention of the proposed activity, and it is the description of the learning environment (S1), learning outcomes (S2), teaching strategies (S3), content (S4), learning assessment (S5) and target audience (S6) for a particular activity

(2) Logistics, which relates to the requirements of the proposed activity for sustainable deployment, and it is the partners (L1), relationships (L2), channels (L3), resources (L4), and associated value proposition (L5)

(3) Action, which relates to the deployment and deliverables associated with the specific proposed activity, and it is short term (A1) and long term (A2) activity deployment, deliverables (A3), and dissemination (A4).

CONCLUSION

The aim of this reported work is to present the development of a framework titled Engage Learning Template, which can be used to plan and develop learning activities. This approach has been utilized in an international workshop focusing on the development of didactic material to include global sustainability concepts in engineering education. The framework was well received, and it was helpful in the planning of learning activities during the workshop.

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We_EP_2_3

THE USE OF PEER-ASSESSED RETURNABLE DOCUMENTS TO IMPROVE LEARNING AS ACTIVE METHODOLOGY. THE CASE OF POWER ELECTRONICS

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Abstract : *Motivating students' interest is really important to achieve learning objectives satisfactorily by means of the called active methodologies. In the new European Higher Education Area it is necessary to involve more efficiently to the students and encourage their independent study and active participation. The called thought-provoking activities encourage students, by actively engaging them in the learning process.*
This new teaching tool, named returnable document, allows increasing student work outside the classroom, motivating the students while raising their awareness about the importance and impact of their work.
Keywords : *peer assessment, teaching/learning process, European Higher Education Area, active methodology, Power Electronics*

INTRODUCTION

In the new context of the EHEA (European Higher Education Area) [1], a new challenge arises : it is necessary to integrate learning and evaluation of contents, skills, as well as behaviours, which can be specific to several subjects at different level in the whole Bachelor Degree so that students develop these new educational competences and aptitudes, in the framework of the new teaching/learning process.

OBJECTIVES

With this objective in mind, to achieve this aim there is not a single answer. The problem must been tackled using multiple tools and strategies that, wisely combined, will provide the desired and targeted learning outcomes [2]. In this work a very simple and effective tool is described, named returnable document, in the framework of Power Electronics subject at Universidad de Malaga.
A returnable document consists of a set of exercises organized in topics. Despite its simplicity, the main value of the tool comes from its usage, which is organized around peer assessment, by students in this work. There are many studies focus on the benefits and advantages of the use of peer review in class. For example, student participation in peer-review process achieves an important enhancement and improvement in their learning of the basics of the subject and an outstanding achievement of the higher-level learning outcomes [3] and when students evaluate the work of their peers, they increase their self-assessment abilities [3].

METHODS

Once the subject finished, the students were asked to fill in a short survey with 15 questions and a free comment regarding to different aspects of the returnable document experience devoted to teaching and learning on specific topics of Power Electronics courses as well as other general competences in education engineering. For each question, students can choose one among five answers : Totally disagree; Disagree; Neutral; Agree; Totally agree. The values assigned to each answer are 0, 2.5, 5, 7.5, and 10, respectively.

RESULTS

More than 90 % of students consider adequate time given and effort required to resolve and assess the returnable documents. It can also be observed that the use of the returnable documents has been useful to prepare the exams to almost 80 % of the students, and that more than 90 % is satisfied with the experience.

Finally, it is important, from the point of view of students, to highlight that assessing and evaluating their classmates work represents a challenge for fresh students who have not been prepared for these tasks.

CONCLUSION

By using returnable documents teachers manage to strengthen the results of homework and the learning process in a flexible, motivating and entertaining way. In addition, compared to more traditional learning models, student participation is encouraged.

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We_EP_2_4

PEER REVIEWS OF TEACHING EFFECTIVENESS : CAN THEY BE USED TO STEER FACULTY TOWARDS NEW PEDAGOGIES?

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Abstract : *In most universities peer reviews of teaching play some role in the retention, tenure, and promotion process. However, most peer reviews lack rigor and consistency and as a result they usually carry little weight in the evaluation of teaching effectiveness of new faculty. To correct this problem, the paper proposes an instrument for peer reviews of teaching effectiveness, designed to serve as a tool for steering faculty towards new and effective pedagogies, while at the same time providing a meaningful way to assess and/or evaluate their teaching effectiveness. When combined with faculty development workshops on engineering pedagogy, this instrument has the potential to improve teaching effectiveness in a systematic and meaningful way.*

Keywords : *teaching effectiveness, peer reviews of teaching, engineering pedagogies, faculty development*

INTRODUCTION

In most universities peer reviews of teaching play some role in the retention, tenure, and promotion (RTP) process. A common problem with most of these reviews, however, is a lack of rigor, as well as a lack of consistency. There are usually several reasons for this :

(a) Faculty members who perform these reviews often do not wish to provide any meaningful feedback out of fear that they may hurt their colleagues' RTP prospects. As a result, most of the peer reviews included in faculty dossiers describe only the positive things observed in the classroom.

(b) Faculty members who perform these reviews do not have the proper pedagogical training to judge their colleague's teaching, so they often make judgments based on their own experience and preferences rather than on well-established principles of effective teaching.

(c) The first two problems are often compounded by the peer evaluation instruments themselves, which tend to include vague or simplistic prompts for the reviewer.

At the same time, engineering faculty around the world are called to teach students very complex skills (e.g. problem-solving, design, lifelong learning, self-assessment, change management, communication and collaboration), all essential in the 21st century workplace [1], yet most of the times, they have little or no training in pedagogy. To make things worse, most engineering faculty still rely on traditional, instructor-centered methods, despite extensive research, which shows that these methods are not effective in equipping students with the 21st century skills mentioned earlier [2].

OBJECTIVES

The objective of this paper is to propose an instrument for peer review of teaching, based on current research on effective engineering pedagogies [3]. The purpose of this instrument is to provide guidance to new faculty in a systematic and meaningful way, as they design and deliver their courses. In addition, this instrument can be used to assess and/or evaluate teaching effectiveness, aside from student evaluations.

METHODS

In the first part of the research two faculty surveys on teaching methods were conducted, one addressed to engineering faculty only, the other to all San Jose State University faculty. The purpose of these surveys was to establish a baseline of teaching methods used by University (on the one hand) and engineering faculty (on the other).

In the second part, a task force was formed for the purpose of designing an instrument for the peer review of teaching in the College of Engineering. The task force consisted of representatives from each program/department in the College. The members of this task force researched teaching methods that are proven to work well in engineering classrooms [3] and proposed an instrument for peer reviews of teaching effectiveness, using criteria based on this research.

In the third part, these peer reviews guide faculty development workshops, designed to help faculty address any weaknesses observed during these reviews. Thus the combination of the peer reviews and the faculty development workshops provides a fairly robust system for improving teaching effectiveness.

RESULTS

The results of the two surveys showed that engineering faculty for the most part, still rely heavily on traditional, instructor-centered methods in their classrooms. This presents a problem not only in terms of their own teaching effectiveness, but more importantly, in terms of their ability to mentor new faculty into adopting new engineering pedagogies. Furthermore, it presents a problem with evaluating teaching effectiveness for retention, tenure, and promotion purposes.

The use of the proposed instrument in a variety of courses in the past several years has shown promise in steering faculty towards more effective pedagogies, as they provide clear standards of expected behaviors in the classroom by the instructor and more importantly, by the students.

CONCLUSION

A new instrument for peer reviews of teaching effectiveness is being proposed, for the purpose of (a) guiding new faculty in their preparation of new courses, (b) informally assessing teaching and providing meaningful feedback to instructors, with a goal of steering them into the direction of effective engineering pedagogies, and (c) evaluating teaching effectiveness for retention, tenure, and promotion purposes. Any engineering program can easily adapt this approach.

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We_EP_2_5

RECOGNITION AND POSSIBILITY OF TEAM-BASED DISCUSSION FOR FLIPPED CLASSROOM IN ENGINEERING EDUCATION

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Abstract : *In this research, graduate engineering course was redesigned twice as individual-based flipped classroom and team-based flipped classroom, and evaluated based on observation, survey, and interview data collected. As a result, discussion as team-based activity is more effective in terms of interaction, and it prefer to individual activity.*
Keywords : *Flipped classroom, Discussion, Team-based activity, Engineering education*

INTRODUCTION

Flipped Classroom is a type of teaching-learning methods in which activities traditionally conducted in classrooms are done at home and conversely, activities usually done at home are conducted in classrooms [1]. In the flipped classroom, learners study with an online video lectures prior to class, and then apply or extend their understanding through active engagement in problem solving activities in class, either through discussions with peer learners or with the help of teaching assistants and instructors [2].

Increasing interaction between learners and learners is the key factor to manage a flipped classroom successfully, and team-based discussion is popularly used in Humanities and Social Science classes. However, discussion in engineering education, especially subjects based on mathematics content, is not general because of field's characteristics and lack of discussion experience. Therefore, individual activities are main activities in engineering classroom both lecture-based classroom and flipped classroom. It is difficult to increase interaction between learners and learners by individual activities for managing effectively flipped classroom, and it is needed to apply not only individual activities but also discussion as team-based activities.

OBJECTIVES

In this research, it was trying to verify whether team-based discussion could be managed effectively in engineering flipped classroom through managing the two types of flipped classroom : individual-based flipped classroom and team-based flipped classroom.

METHODS

The Nonlinear Systems Theory graduate course that was redesigned as flipped classrooms in 2013 fall semester at Seoul National University. Redesigning the course as flipped classroom made twice : before starting the course and after mid-term. The first redesigning flipped classroom focused on interaction between instructor and learners through individual activities, and the second one focused on interaction between learners and learners by adding to team-based discussion. During every class, observational data was collected by videotaping, and all twelve learners were surveyed at the time of mid-term and final examinations, and five learners were closely interviewed one-on-one at the end of the semester.

RESULTS

From reviewing classroom interaction as an indicator to manage flipped classroom smoothly by analyzing videotaping, the interaction in the first flipped classroom had decreased while many in the beginning, but the interaction in the second one had increased as opposed to the first one's case. In addition, the fact was proved through in-depth interviews.

The preference about instructor-focused problem solving as an individual activity (13 learners, multiple responses allowed) was higher than the one about discussion as a team-based activity (8 learners, multiple responses allowed) through the first survey conducted just before mid-term examination. However, the second survey's result after applying team-based flipped classroom was opposed to the first one; the preference about team-based activity (7 learners, singular response) is higher than the one about individual activity (3 learners, singular response), and the rest two learners chose the modified method which is combined team activity with individual one.

CONCLUSION

After implementing the two types of flipped classroom approach to Linear Systems Theory course, we compared individual-based flipped version and team-based flipped version based on observation and learners' responses. The results indicated that team-based activity is more effective than individual-based activity in engineering flipped classroom in spite of being unfamiliar with team-based activity both instructor and learners. In addition, discussion as a team-based activity enable the model to help novice learners observe and learn superior peers' approaches [3].

The research was limited somewhat by consideration of only one graduate course with a small size of less than 15 learners. Therefore, future study should move beyond the limitations to study of larger classes and undergraduate classes in diverse engineering fields.

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We_EP_2_6

Improvement of Major Field Capability, Teamwork, and Presentation Skill through a Capstone Class

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Abstract : *A capstone class has been designed for senior-level students to improve the skills for teamwork and communication along with the capability to make the combined use of the knowledge obtained from several major core courses. Students of different major study areas may form the same team, which needs inter-disciplinary cooperation. In this study, a practical experience related to a capstone class curriculum development is introduced. To improve teamwork and presentation skill in a capstone class, each team member is supposed to present his or her work assigned twice during the semester. The presentation should be done in English, and the presentation of each member is evaluated by a native speaker professor in ESL department. Student are supposed to take a pre-capstone class with the same topic and same member of the main capstone class. Each member is assigned with specific role, and has to cooperate for the successful completion of capstone project. Through intense capstone course, students can be helped to be equipped with many necessary capabilities to be successful engineer, and to increase their chance to get hired in industry.*

Keywords : *Maximum 7 Words, Times New Roman, Font Size 10, Italic*

INTRODUCTION

A capstone class is for students to make an intensive comprehensive semester project, which needs combined knowledge of several major core courses. Generally a capstone course is run with at least three or more credit hours because students need to study and make a combined use of several areas. Capstone courses may be run as a set of two courses, pre-capstone (or capstone 1) and capstone (or capstone 2) courses. With two set of capstone courses, students are supposed to participate a two-semester project spanning almost one year. Students may build up their capability in their major field along with team working and communication skill.

OBJECTIVES

The major goals with a capstone course in Handong University is as follows :

- Students obtains capability to connect and apply concepts and techniques of several major areas to make a real product that may be commercialized;
- Students may check and summarize their major study field knowledge through a challenging team project;
- Students may cultivate their personality through team working;
- Students can have a good chance to improve their communication skill among team members, and also increase their level of presentation in English; and
- Students may have a higher chance of having a job after graduation.

METHODS

In Handong Global University, students are supposed to finish all the design activity during pre-capstone course, named "Engineering Planning Project" course. Based on the design, students try to implement their projects during the following semester. Students with different major study areas may form a team that needs inter-disciplinary cooperation, in which students may learn how to make a combined use of different study areas. Students spend almost one year for these two courses, pre-capstone for design and capstone course for implementation. During the semester, each team is supposed to present their workings at least two times. Each team member should also present their progress in English. Student presentation in English is evaluated by a native speaker professor. The evaluation result will be used to improve the presentation in English. At the 14th week of the semester, in Handong, all the capstone teams should participate the event, Capstone Festival, in which all the teams' final results will be presented formally and evaluated by a committee of professors and industry experts. During Capstone Festival, all the students are invited to have a tour watching and taking a close look at final workings of all the capstone teams

RESULTS

Students taking capstone course are generally satisfied mainly because they can increase their capability with major study field. The following summarizes the results of carrying out capstone courses through one year for pre-capstone and capstone courses :

- Students can find their weakness with their capability in major study filed, and can have a good chance to strengthen their capability in their major areas;
- Students may have a chance to make a combined use of different study areas;
- Students can have a good chance to correct their potential problem in cooperating for their team; and
- Students may increase their presentation skill, and also improve the ability to present in English.

Some of capstone topics come from industry, which helps students to develop industry products under the advice and consultation of industry experts, and to increase their chance to get hired in job market.

CONCLUSION

The running and management of capstone course in Handong Global University could help students to check and improve their capability in their major study field. With two capstone courses spanning two semesters, students could build up their actual ability to implement some engineering products, and also their skills with cooperation training among team members, and presentation exercises especially in English. There are some problems to solve for managing capstone courses efficiently. Professors are given more load for consulting and guiding their capstone team students. There is also a strong need to find and develop good and challenging capstone topics, which is not easy. There is also a need to find some actual industry topics related to major study area, which can be advised from industry experts. Even with some difficulties for the successful running of capstone courses, student can be helped considerably for improving their capability with their major study area, team working, presentation in English, and high chance of getting hired in industry.

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We_EP_2_7

Sejong Co-Op program as a capstone design collaborated with a local industry company

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Sejong Co-Op program is a capstone design program of Hongik University, Korea, conducted by collaboration between students and local industry engineers. This program aims to increase capstone design ability of students, based on the needs in industry fields, and to help the development of local companies.

The process of the program is as follows ; 1) Local companies apply to the Sejong Co-Op program, and register their capstone design theme. 2) Management officer match those themes, students and professors of Hongik University. 3) Student matched to each theme is sent to the company, and able to get credits for gaining work experience. 4) All developing work is supervised by the professor matched to the theme. 5) Results of all works are reported at the end of the semester.

There are about 700 companies around Sejong city, and they are medium and small sized enterprises. Their main products are electrical parts, electronical parts, metalworking, parts for cars, and etc.. 15 themes were applied for the Sejong Co-Op program in 2015, and 10 themes among them were selected. Themes are about locking compartment for the truck equipped with wing-body, installing methods of photovoltaic panel onto a building, parts design for the mobile communication devices, developing a promotion materials like as homepage of a company and products catalogs, and etc..

Development of the locking device is the representative case of the Sejong Co-Op program in 2015. This team developed simpler and stronger locking device for the wing-body truck. They got a patent right of this, and confirmed a smooth motion and a stability of the device through an application to a wing-body truck.

At the end of the program, an enquete survey on the satisfaction of the program was conducted. All companies participated in the program expressed “satisfaction”. Also, many students expressed “satisfaction”. However, some students expressed “dissatisfaction” in point of inconvenience of approaching to working place because some companies placed in isolated place so that public transportation was not available.

Another aim of the Sejong Co-Op program is a job placement by connecting students and companies. However, the job placement results was “0”. Because companies participated in the program could not satisfy students from the points of salary and working environments, so that no students wanted to enter the matched companies. By this, it is thought that it needs to expand the geometric range of companies to the whole cities of Korea.

As a conclusion, Sejong Co-Op program in 2015 was very meaningful to both sides of students and companies. It is good for further development of the program to expand the geometric range.

We_EE_3*_2

STUDY ON THE ANALYSIS OF PROGRAM FOR UNDERGRADUATE RESEARCH STUDENTS IN THE ENGINEERING COLLEGE

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Abstract : *This study intends to analyze the undergraduate research students program currently operated in the engineering college for graduate students, and to propose a means of operating the system in a more positive direction by analyzing any problems thereof. Literature review and survey were conducted to achieve the objective of this study.*
Keywords : *Undergraduate research students, Engineering education, Survey research*

INTRODUCTION

The careers of graduates from the engineering college can be classified into employment, entrepreneurship, and entrance for the graduate school. Due to the continually decreasing youth employment rates, the employment rate for engineering graduates is also decreasing, whereas the enrolment rate in the graduate school is increasing [1]. Recently, universities have been operating various course and non-course activities in order to enhance the capacity of students. Such activities include the undergraduate research student program for students who intend to enter into graduate school. This undergraduate research student program has the advantages of allowing the students to experience own career during their undergraduate program, and the professors are able to obtain excellent researchers in advance [2]. However, since, in many cases, this program is operated according to the policy determined by individual professors, rather than as an official system established by the universities, the program includes extensively diverse methods and forms. In such case, this becomes the university version of a "small salary for passionate work," which is frequently becoming a problem in the society. The undergraduate research student system is currently operated in Stanford, Oxford, Harvard, Cambridge, and other universities in foreign countries. A research program that was institutionally established for undergraduate students in the US was conducted at MIT in 1969, and many similar programs were soon established [3].

Since there are many advantages of the undergraduate research student program, it would be necessary to benchmark an excellent overseas case, and to apprehend the good points of such system in Korea, to propose an improvement direction.

OBJECTIVES

The objectives of this study is to analyze the undergraduate research student program by apprehending the advantages and problems of the undergraduate research student program using an analysis of the experience of graduate students who were personally a part of the system, and to prepare a means of improving the system.

METHODS

In order to achieve the objective of this study, domestic and international literature related to the undergraduate research student system were reviewed, and 204 university students studying engineering were researched in order to analyze the current operation of the system, and the satisfaction and adaptation of the students in graduate school life.

RESULTS

Through this study, the current state of the undergraduate research student program, difficulties experienced by the students, the role of the students, and the method of instruction by the professors, and the current state of advanced placement subjects in graduate school were analyzed to examine the effect of such experience on graduate students.

The total proportion of students with experience in the undergraduate research student program was 41.1% out of the entire number of students. However, it was displayed that the experience in the undergraduate research student program did not provide a statistically significant effect on the standard of determining career, and self-efficiency in exploring career paths. Nonetheless, the experience of the program helped the students in adapting to graduate school life through their prior learning of procedures and related knowledge of research projects, and also increased the students' satisfaction in life.

Most of the students who participated in the undergraduate research student program were displayed to have voluntarily applied to participate. The participants responded that their understanding of the research process and their field of major increased, and also helped in their communication with the members of the research laboratory, and thus, they would recommend the system to any friend or student.

However, the students participating in the system displayed difficulty in time management by simultaneously attending to their undergraduate course and graduate school life, and displayed dissatisfaction of the lack of reward in return of their average 10 hour work a day.

CONCLUSION

Based on such study results, there is a need to prepare active support and operation guidelines established by the university, and there is also a need for added effort by the government, such as proposing guidelines for the payment of work that exceeds that of minimum wage, or connecting the system to a national scholarship system. Furthermore, the professor using the undergraduate research student program should approach the students for their education, as future researchers in the field, regardless of the importance of using the students for assistance in the professors' own research.

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We_EE_3*_3

RECRUITING AND DEVELOPING ACADEMIC LEADERS

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Abstract : *The overall success of any organization is greatly influenced by effective leadership. For effectiveness, leaders need to muster competencies, some of which are general and some specific. However, universities, particularly in developing countries have traditionally appointed academic leaders based on seniority in the academic rank regardless of whether or not the candidates have proven leadership competencies. Using 3600 assessment of the behavioural competencies of deans who were recruited and developed using leadership competency model and those who were recruited using the traditional approach of voting by colleagues over a period of three years, it was found that the former on average performed better than the latter. It was concluded that recruiting and developing leaders based on an academic competency model provides effective academic leadership.*

Keywords : *competence, competency model, academic leadership, academic sector*

INTRODUCTION

Academic leadership according [1] "is the act of building a community of scholars to set direction and achieve common purposes through the empowerment of faculty and staff". For effectiveness, leaders need to muster competencies, some of which are general and some specific to the academic sector. However, in many universities leadership position at the level of faculty deans is held by a faculty member who willingly gives up all teaching and research activities and become a full-time administrator. Traditionally, these deans are voted into their positions by colleagues in their schools/ colleges based on their seniority. Depending on campus policy, it may be for limited period of time. Most deans return to the faculty when their terms in office have expired. For them, leadership in the dean's position is complicated by the desire to bring accomplishment and excellence to the college or school [2] while keeping in mind that will to return to the faculty that they are shaping. For those deans who do not have to return to the faculty, and are normally recruited using a rigorous recruitment process, attention to leadership is more managerial/ professional in nature. Based on this background, this paper compares the behavioural performance of deans who were recruited using the traditional approach with those who were recruited using a rigorous process based on a leadership competency model.

OBJECTIVES

The primary purpose of the research was to determine whether leaders recruited and developed using an appropriate leadership competency model are more effective than the ones recruited using the traditional method of voting by colleagues based on seniority.

METHODS

Behavioural competencies of nine faculty deans at the university of Botswana, four who were recruited using the traditional approach of voting by colleagues in the faculty, and five who were recruited based on a leadership competency model were compared for a period of three years through the use of 3600 assessments. Data were collected from the annual performance reports of staff from the human resources after obtaining consent from the concerned deans on condition that they remain anonymous. The behavioural competencies included : development of core set of values; effective communication; reflection and analysis; facilitation and collaboration; creating a positive climate; problem solving and risk taking; and perseverance.

RESULTS

Compared to the period before the competency model was used to recruit academic leaders, it was found that there was significant improvement on behaviour competencies as the result of effective leadership that was recruited and developed using the leadership competency model. It was concluded that effective academic leadership at a university could be established using an appropriate competency model

CONCLUSION

Two approaches of recruiting academic leaders, particularly faculty deans were compared by assessing the behavioural competencies of leaders recruited using these approaches. It was concluded that effective academic leadership at a university could be established using an appropriate competency model.

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We_EE_3*_4

ENGINEERING EDUCATION AND GLOBAL COMPETENCIES

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Abstract : *The phenomenon of globalization continues to evolve. It has and continues to impact all aspects of world affairs and higher education is no exception. It is essential for the institutions of higher education to produce globally competent graduates with skills (global competencies) that allow them to work effectively in a globalized world. This is particularly important for engineering education. This paper discusses a process for the institutions to quantitatively assess their preparedness. A globalization index is proposed (an integrated form of several parameters) that can be used for comparing globalization preparedness with other institutions, establish trends and prepare projections.*
Keywords : *Global competencies, Globalization, Engineering Education*

INTRODUCTION

A recent report by the American Council on Education (ACE, 2011) suggests that the phenomenon of globalization has created a climate of change for higher education institutions. The report states that the evolution of the global environment presents both challenges and opportunities for the higher education institutions and an ongoing engagement between the institutions around the world is necessary for success. Engineering education is no exception and the institutions have a responsibility to play their role in creating knowledge and awareness about all aspects of globalization and in preparing their students with global competencies.

In a continuously evolving globalized world, the workforce (including engineers) often is called upon to work in multicultural teams, travel to different parts of the globe, communicate ideas clearly, and have leadership and management skills to execute the assigned tasks, possibly in unfamiliar regions of the world. Hunter et al. (2006) reported that according to an international panel of experts, global competence implies "having an open mind while actively seeking to understand cultural norms and expectations of others, leveraging this gained knowledge to interact, communicate, and work effectively outside one's environment".

The Commission on International Education (1998) stressed that America's future depends upon the ability of its academic institutions to produce globally competent graduates. Academic institutions have collective responsibility to play an impactful role in achieving this objective. Although, different institutions may have slightly different visions and approaches to addressing global competencies, some curriculum adjustments are necessary for this process. The academic institutions, therefore, must align their visions and resources for successful results.

OBJECTIVES

The objective of this research is to identify the characteristics that express the ability of the higher education institutions to prepare students with global competencies. These characteristics include :

- Adequately diverse and international population of students
- Robust study abroad programs

- Adequate faculty/student exchange programs with universities around the world
- Curriculum that reflects global awareness and internationalization/multicultural aspects
- Broad commitment to producing globally competent graduates

The universities with these characteristics are being referred to as "global universities" (U.S. News and World Report, 2015). The research reported in this paper identifies some of the relevant parameters that reflect these characteristics and presents an approach.

METHODS

The parameters that reflect the characteristics of a global university include percentage enrollment of international students, number of study abroad programs and enrollment, percent of budget allocation for international/study abroad programs, percentage of courses about international and/or global education, percentage of online courses, number of student/faculty exchange programs, number of degree program offered abroad, and emphasis on globalization in institutional mission, and strategic plans. This is not an exhaustive list of parameters that relate to globalization and there may be more. These parameters can be quantified and integrated to develop a "globalization index" for the institutions of higher education. The globalization index can be used to compare and assess the preparedness of universities to address globalization aspects. For a focus on engineering education, these parameters can be considered as they relate to engineering aspects.

RESULTS

Globalization index is a collective quantitative number and uses the parameters related to globalization. The parameters may be integrated using an equal or different weighting factors. The sum of all the weighting factors must add up to 1. The index can be calculated on an annual basis and can be used to compare as many institutions of higher education as needed. The index can also be used to establish trends for the past performance of institutions and for the future projections.

CONCLUSION

This paper stresses the need for the institutions of higher education to produce globally competent graduates with a focus on engineering education. Some of the institutions are already addressing the globalization aspects and are referred to global universities. A list of parameters that reflect the characteristics of a global university, is developed. These parameters can be quantified and integrated in a single quantitative number – globalization index. This index can be used to compare several institutions and also for establishing globalization trends/projections.

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We_EE_3*_5

A course research about potential development through special dance (II)

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Abstract : *The course of potential development through special dance, which is mainly for autism, Down syndrome, physical disabilities and other special groups, studies the theory and practice of body potential development. The research team is all the members of the Guangzhou Galaxy Dance Theatre (Guangzhou Galaxy art creation Co., Ltd.). The main course of research and development by JIA Donglin, Liang Jie, Yang Qijian three researchers completed. This study takes the member of Children's Palace Guangzhou Rainbow after the Rain integration Modern Dance Group as the research object.*

This course uses "four-in-one " dance teaching methodology, combining with the knowledge of Educational Drama, Dance Therapy and Psychology, to teach and develop the special populations. The teaching methods are systematic, according to their traits. To make the research system reach the acme of scientifically and perfection, we apply various methods like practice-as-research, reflection, collection and sorting of document and literature, field investigation of the special groups' living environment and interview. This research mainly uses the method of deep description to present the research result, it is a qualitative research paper.

Trained through this course, the special populations can develop their body language, which makes their future life much easier and more convenient. They can well express themselves and communicate with others with rich body language. Their emotional and psychological health will get a good and long-range development. This paper is a continuation of the research on the "A course research about potential development through special dance ".

Keywords : potential development through special dance, Four-in-one dance teaching methodology

We_ED_5*_1

THE POWER OF SELF-EVALUATION BASED CROSS-SPARRING IN DEVELOPING THE QUALITY OF ENGINEERING PROGRAMMES

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This paper describes how the quality of engineering education can be improved in practice by using a process starting with a self-evaluation followed by a cross-sparring with critical friends. With a focus on quality enhancement as much as quality assurance, the engagement in and attractiveness of the education is a key consideration of the development activities that are inspired by the process. The method has been developed in an ERASMUS+ project involving eight European universities.

Keywords : *Engineering programme development, improvement, self-evaluation, cross-sparring, paring, quality*

INTRODUCTION

In Higher Education today, institutions are constantly trying to balance the time spent and resource allocated to the areas of Quality Assurance (QA) and Quality Enhancement (QE). Often the quality assurance element dominates as this is what is most closely linked to the measures identified by institutions in ensuring a high level and consistency in tertiary learning provision. Quality enhancement is often identified in bespoke projects or left to the enthusiasm and energy of programme managers and individual teachers. In the project described in this paper the focus is in continuous improvement using self-evaluation as a tool to find the best possible cross-sparring partner for identifying effective development plans that will result in more dynamic and engaging engineering education.

OBJECTIVES

The objective of the approach is to identify an improvement plan and to share working practices in different programmes from different universities such that their adoption can be used to develop a more relevant and engaging engineering education provision.

METHODS

In the very beginning of the project all the most appreciated engineering education accreditation and evaluation formats were studied. These included for instance CDIO [1] and EUR-ACE [2]. Based on the different questionnaires and approaches to self-evaluation, a new set of questions focusing on the enablers of excellent education was set up. Questions concerning finance and management were left out as these were deemed outside the learning and teaching focus of the project. The result was a questionnaire of 28 questions. The definitions of the rubric and the scale for the evaluation have been presented earlier [3].

The self-evaluation results were stored in an online 'Market-Place' which pairs the participants according to their developmental priorities. After pairing, the institutions exchanged the self-evaluation reports, studied the background information of each other and finally each paid a site-visit to their partner institution. Many valuable development ideas and concrete suggestions were then identified and used to stimulate action plans and ideas for further activities [3] [4].

RESULTS

The idea of cross-sparring is seen as a productive way to initiate study programme development. The pairing of the partners had a great significance as it has the potential to bring generate productive and stimulating combinations of strengths and development areas in the paired institutions. In the optimal case, the cross-sparring shouldn't just be a "one hit" but lead to an ongoing cooperation in the future. Discussion is continuing on how the pairs should be matched - in the future it might be beneficial to give the participating units an opportunity to identify their preferences not only based on the evaluation criteria, but also based on the match of discipline. More experience is needed to create a working 'Market-Place' to fulfil the needs of different programmes.

CONCLUSION

As the project concludes, engineering programmes around the world are invited to use the self-evaluation created in the project - and then download their results to the 'Market-Place'. The more programmes that do so, the greater the selection of possible cross-sparring partners for participant institutions. Cross-sparring reports will be collected and further development conducted as further support for the activities is found. The ongoing evaluation of the process and development of the tools will be reported on in this paper.

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We_ED_5*_2

10 YEARS OF THE INTERNATIONAL FEDERATION OF ENGINEERING EDUCATION SOCIETIES

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Abstract : *The International Federation on Engineering Education Societies (IFEES), upon its 10th year of existence, is reflecting on its role, successes, challenges, and impact across global engineering education. In its mission to lead global engineering education into the 21st century, the IFEES strategic plan and several IFEES core areas of collaboration are reviewed : Capacity building with IIDEA, Administrative leadership with the Global Engineering Deans Council (GEDC), Student engagement with the Student Platform for Engineering Education Development (SPEED), industry relations with the IFEES "corporate board," and diversity and inclusion. Additionally, selected initiatives are presented to illustrate how the IFEES network can be leveraged to provide for success within our discipline. The paper discusses IFEES major accomplishments during its first 10 years, and shares the vision and milestones set for the next decade. The results of a survey conducted are utilized for a contextual realignment of IFEES strategies to aid the reflection of ongoing practices as well as guide the future directions.*

Keywords : *Engineering Education, Community of Scholars*

INTRODUCTION

The International Federation of Engineering Education Societies (IFEES) has worked towards a global consolidation of engineering education activities for 10 years.

After 10 years of organizational activities, conferences and summits, and strategic partnerships, IFEES has established itself as an important body within engineering education. The onset of IFEES, 10 years ago, coincides with, and is a response to the vigorous movement of internationalization of Higher Education, particularly in the technical areas, specially engineering. Areas like Physics and Mathematics have had an international existence for long ago time.

OBJECTIVES

The onset of IFEES, 10 years ago, coincides with, and is a response to the vigorous movement of internationalization of Higher Education, particularly in the technical areas, specially engineering. Areas like Physics and Mathematics have had an international existence for long ago time.

The necessary interaction of Engineering and the productive sector was the main reason to transform Engineering Education also in an area with strong international vision. The local Schools of Engineering, as well as the local Societies for Engineering Education had to adjust their actions and even their behavior in order to accommodate the needs for Internationalization of Education. However, it is important to mention that activities of Research and graduate studies became international much before the activities on Education at undergraduate kevel. The local Societies of Engineering Education played an important role in the development of Engineering Education at local level and the necessary communication among the institutions, even in treating similar local problems, were essential to the onset of an international community.

METHODS

IFEES has prided itself on striving for representation of the engineering education stakeholders : Academia, Students, Government, Industry, and Non-profit/NGO institutions. The strategic partnerships reviewed in this section are designed to act upon all stakeholder perspectives.

RESULTS

IFEES has prided itself on striving for representation of the engineering education stakeholders : Academia, Students, Government, Industry, and Non-profit/NGO institutions. The strategic partnerships reviewed in this section are designed to act upon all stakeholder perspectives.

- Student Initiatives - (BEST, SPEED)

The Student Platform for Engineering Education Development (SPEED) is a global non-profit student organization which works towards indulging students into engineering education (EE) discussions [1]. SPEED was founded by a group of engineering students in 2006 during ASEE annual colloquium at Rio De Janeiro, Brazil and was established as the student arm of IFEES. SPEED has been closely working with the IFEES leadership for all its initiatives till date.

- Corporate Partnerships

Since IFEES' inception, its relationship with corporate has been a constant subject of conversations, conferences and business meetings, recognizing that employers are essential stakeholders in any thought process about engineering education. Remarkably, industry involving discussions at IFEES can all be classified under two categories of subjects :

CONCLUSION

In reflecting on 10 years of IFEES the growth and outcomes illustrates the benefit and need of this organization within the engineering education community. In the next 10 years, it will be imperative for IFEES to (i) address the problem of poverty which is prevalent in developing countries (ii) provide closed collaboration between the north and south. The poverty level can be attributed to poor development of engineering infrastructure. Infrastructure development plays a vital role in the economic well-being of a nation. The level of development of a nation and standard of living in any country is a function of the state of her infrastructure while the state of infrastructure development is directly related to the engineering and technical skills present in a nation. The collaboration effort will focus on programmes that enable the transmission of skills from experts in the north to their counterpart in the south

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We_ED_5*_3

THE MULTI-CRITERIA DECISION ANALYSIS (MCDM) FOR ENGNIEERING EDUCATION : LITERATURE REVIEW AND RESEARCH ISSUES

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Abstract : *The Multi-Criteria Decision Analysis (MCDM) methodology had been widely applied and accepted in the business, industry and manufacturing sectors. However, there is a limitation of resources available on discussing the way of MCDM may be applied in in engineering education decision problems within University setting. The current economic crisis as well as the changes in the way Ministry of Higher Education providing funding to higher education institution had created a major shift in emphasis. Both public and private higher education institutions are facing increasing cost and declining revenue streams. The purpose of this paper is to review the literature which focuses in five majors engineering education decision problems. There are : resources allocation, performance measurement, budgeting, scheduling and evaluation. The paper carried out a review of article in international scientific journals and well known international conferences related to MCDM application published within 1996 and 2016 inclusive. Related articles will be review and analyzed for the types of decision problem were paid most attention to, MCDM approaches adopted and inadequacies of those approaches. Some improvements and possible future works are recommended based on those inadequacies The review result will create an interest to University management as it presents an effective way to academic process improvement, resources allocation and achieving greater satisfaction among students.*

Keywords : *Engineering Education, Multi-Criteria Decision Analysis, Decision Analysis*

INTRODUCTION

The Multi-Criteria Decision Analysis (MCDM) methodology had been widely used in making decisions in engineering settings. However, there is a limitation of resources available on discussing the way of MCDM may be applied in engineering education within University settings for quality improvement purposes.

OBJECTIVES

The purpose of this paper is to review the literature which focuses in five majors engineering education decision problems. There are : resources allocation, performance measurement, budgeting, scheduling and evaluation.

METHODS

The paper carried out a review of article in international scientific journals and well known international conferences related to MCDM application published within 1996 and 2016 inclusive. Meta-analyses and systematic reviews of the articles will then be carried out.

RESULTS

Related articles will be reviewed and analyzed for the types of decision problem were paid most attention to, the MCDM approaches adopted, and the inadequacies of those approaches. Some improvements and possible future works are recommended based on those inadequacies

CONCLUSION

The review result will create an interest to University management as it presents an effective way to academic process improvement, resources allocation and achieving greater satisfaction among students.

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We_ED_5*_4

THEORETICAL FOUNDATIONS OF VOCATIONAL AND TECHNICAL EDUCATION AND THE PART THEY PLAY IN THE PROCESS OF STATE BUILDING

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Abstract : *The theoretical foundations of Vocational and Technical Education are traced in various well-known studies. It would be helpful to scan those studies to gain a better understanding of what factors might be contributing to the development of Technical Education and the process of state building. The approach of classical behaviorist theory shows that it does not adequately address a full range of learning needs, which constructivist theory may address in a more comprehensive way. New studies have shown that Technical Education and the evolution toward higher technology in the workplace continue to advance.*

Federal support for Technical Education must be on the redoubling of efforts to increase the links between not only academic and occupational skills development, but also between businesses and education. UNESCO has held group discussions with TVET (Technical and Vocational Education and Training) with members from developing countries to better integrate TVET programs. As a matter of urgency, attention should be paid to Technical Education due to both its impact on society as a whole and its influence on the process of state building.

Keywords : *Technical Education, Development, State Building, Theory, Behaviorism, Constructivism.*

INTRODUCTION

This study has highlighted the theoretical foundations of Vocational and Technical Education by tracing various studies.

OBJECTIVES

My intention in scanning those studies was to gain a better understanding of what factors can contribute to the process of state building.

METHODS

Scanning and analyses of preliminary studies.

RESULTS

It has been shown that classical behaviorist theory does not address the many kinds of contemporary learning needs. On the other hand, constructivist theory addresses more comprehensively the fact that Vocational and Technical Education and the evolution of technology in the workplace continue to advance. It is clear that constructivist theory fundamentally and wholly answers my research question.

CONCLUSION

As a matter of urgency, attention should be paid to Technical Education due to both its impact on society as a whole and its influence on the process of state building.

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We_AE_2_2

A CASE STUDY ON PRACTICAL ENGINEERING EDUCATION THROUGH SOCIAL CONTRIBUTION ACTIVITIES OF ENGINEERING STUDENTS

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Abstract : *We will talk about the effects of social contribution activities conducted by YEHS (Young Engineers Honor Society) during last 10 years.*

Keywords : *Engineering Education for K-12, Young Engineers Honor Society, Junior Engineering Achievement, Engineering Exploration Seminar, National Academy of Engineering of Korea*

YEHS was founded by engineers from diverse universities to promote the exchange between the engineering students in various majors and to construct the long-term national scale network of engineers. YEHS selects the members through the recommendation of the President of each university and the Dean of engineering college. Currently, students and graduates of a variety of Universities are involved. There are more than 1000 members from 30 universities. YEHS is trying hard to be an organization that helps the engineers with endless potential raise the capability to grow into leaders who can lead the country in each field. In addition, YEHS aims to provide a platform that all the students from a wide range of majors and different universities can enhance mutual friendship and share the academic interchanges.

YEHS conducts two social contribution activities, Junior Engineering Achievement (JEA) and Engineering Exploration Seminar (EES).

JEA is a community service conducted by NAEK since 2004. The purpose of this service is to popularize the science and promote the scientific literacy of elementary school students. Since 2006, YEHS has been participating in this service so that members of YEHS and elementary students could share the thinking about science and technology. Moreover, because JEA is in the form of volunteer activity, it gives the opportunity for members to cultivate the social responsibility that future leaders should have.

We visit a small school that has a difficulty with the experiment because of the constraints of tools and materials for it. Then we provide lecture about scientific knowledge and experiments. This event is being conducted more than six times a year. For each event, there is a prior education for volunteers. JEA has been conducted 73 times during last 11 years, from 2006 to 2016.

EES is another volunteer program which is also conducted approximately six times a year. Through this event, YEHS members provide information about their own majors in the engineering area for the high school students who have college entrance examination ahead. This program introduces what is taught in engineering schools, the latest technologies and promising career choices. It has been well received by high school students and helps them choose the major in college. The volunteers act as role models of high school students and feel pride as YEHS members. EES has been conducted 47 times from 2008 to 2016.

These two activities indicate a possibility of making good educational cycle. Through these activities, well-educated YEHS members can deliver educational opportunities to students of K-12. If those who received this education become a YEHS member in the future, it will create a meaningful cycle of engineering education; the past beneficiaries become the providers for the next generation. It is predicted that when these activities are continued, this cycle will yield a huge educational chain that helps engineering education to be popularized.

JEA is a class where various Engineering Kits are used for educating 5~16 year-old students. Types of beneficiary is following, Figure 1.

For 11 years, 1668 volunteers have benefited 5,101 beneficiaries. This number is about 160% of the number of entire members in YEHS. The biggest achievement is that the benefit is well distributed all around the nation. Seeing the chart Figure 2, the class reaches out to the very end of the nation (Jeju Island). The fact volunteers actually have gone to the region where engineering education is needed have made it more special.

EES is one of the most popular events, where high school students can get a good quality of information about major-selection. For 11 years, there has been 6800 beneficiaries, including students within various types of school such as general high school, science high school, school of gifted children etc.

The biggest achievement is creating the positive cycle, in which many beneficiaries themselves become volunteers in the future, as a member of YEHS. This cycle will be getting more common as YEHS continues conducting these social contribution activities. A publication about engineering education, mainly based on the contents of EES, is launching revised 2015 version, continuing on the version 2009. It is contributing as well, in terms of engineering education in the society.

There are about 12,000 beneficiaries, which points out that about 2% of students who took the entrance examination have been affected by this education. Hereafter, we will produce the online version of JEA and EES contents and distribute them through the internet in order that much more students are benefited and it is expected to have huge impact on the society.

We_AE_2_3

SKP MOOC-MOOL : A NEW EDUCATIONAL SERVICE OF SCIENCE AND TECHNOLOGY

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Abstract : *MOOCs (massive open online courses), education model of the future, have been spreading quickly throughout the world in the last decade. In 2015, led by the Ministry of Education of Korea, the K-MOOC service was opened, and well-known Korean universities participated in the K-MOOC service. Now, a lot of people are taking the K-MOOC lectures, and showing a good response to the K-MOOC. But compared to the educational needs of those who want to learn the rapidly evolving science and technology, present MOOC services are still not enough. World-class research institutions should participate online science and technology lecture service, so that POSTECH, KAIST and Seoul National University jointly planned the SKP MOOC-MOOL(massive open online laboratory) service, and will soon start the service. The SKP MOOC will provide science and technology courses with diverse levels, which are made by top scholars. Anyone who takes customized online courses can get a course completion certificate after completion of an online course. Additionally, SKP will also provide MOOLs service. Firstly, people can learn experimental techniques related to MOOC through online courses, and do actual experiments in their own laboratories during vacation. Online-offline program of MOOL can provide effective learning opportunity. Moreover, SKP will provide a high quality education service in science and technology to students in developing countries via free MOOC-MOOL service. Finally, the SKP MOOC-MOOL, new education model of the future, can give effective learning, good experience of scientific theory and experiment to everyone.*

Keywords : *MOOC, MOOL, e-Learning, new education, science, technology*

INTRODUCTION

MOOCs (massive open online courses), education model of the future, have been spreading quickly throughout the world in the last decade. World leading universities such as MIT, Harvard, Stanford, and Georgia Tech are participating various MOOC services. In 2015, led by the Ministry of Education of Korea, the K-MOOC service started, and well-known Korean universities participated in the K-MOOC service. Now, a lot of people are taking the K-MOOC lectures, and showing a good response to the K-MOOC. But compared to the educational needs of those who want to learn the rapidly evolving science and technology, present MOOC services are still not enough. World-class research institutions should participate online science and technology lecture service, so that POSTECH, KAIST and Seoul National University jointly planned the SKP MOOC-MOOL(massive open online laboratory) service, and will soon start the service.

OBJECTIVES

SKP-MOOC provides science and technology courses with diverse levels, which are made by top scholars. Anyone who takes customized online courses can get quality education.

RESULTS

SKP-MOOC will provide science and technology courses, MOOLs service, education theme park service for students, and educational ODA(official development assistance) program. The SKP MOOC will provide science and technology courses with diverse levels, which are made by top scholars. And students, field workers and normal people take customized online courses and get a course completion certificate after completion of online course. SKP will also provide MOOLs service. Firstly, people can learn experimental techniques related to MOOC through online courses, and do actual experiments in their own laboratories during vacation. Online-offline program of MOOL can provide effective learning opportunity. Next, SKP will make and run education theme park. Education theme park will provide various experimental programs and students will get interested in science through these experimental program. Moreover, SKP will provide a high quality education service in science and technology to students in developing countries via free MOOC-MOOL service and building of science high school in developing countries.

CONCLUSION

The SKP MOOC-MOOL, new education model of the future, can give effective learning, good experience of scientific theory and experiment to everyone.

We_AE_2_4

Engineering proliferation activities for the youth of Korea

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Abstract : *The Junior engineering classes were started from 2004 by organization of national academy engineering of Korea with Hanyang university. Currently, 57 companies are participating as one of cooperated society responsibility activities. These activities are highly estimated as one of the best and representative activities to draw creativities from young students by connecting the basic science principles of textbooks to recent leading-edge technology and engineering, and their real products as the level of junior. Addition to these, mobile junior engineering schools are operating using specially designed trailers. The contents of these activities are based upon STEAM education concept which is the Korea's new science education system. These mobile junior school' trailer visit the elementary, middle and high school all over the country. The characteristics and concept of contents, and organization for these junior engineering proliferation activities will be discussed.*

Keyword : Junior engineering class & school, steam education

INTRODUCTION

Beginning of 2000, many of young generation is started to evade studying science fields since they feel that science studying is too difficult and tedious. Many CEO of company started to feel crisis to secure the industry competitiveness in future. Therefore, CEOs of industries discussed at national academy engineering of Korea meeting, and finally at the time the CEO of Samsung electronics Jongyong Yoon suggested to operate the junior engineering classes. And he donated the money for developing the contents. And national academy engineering of Korea asked to our center to develop the engineering education programs and its kits.

Just before to start the developing the contents of junior engineering class contents, LG chemical company donated a mobile chemistry trailer to our center as one of activities to promote student to chemistry fields. And after two years additionally LG electronics donate a couple of mobile electronic trailers for similar purpose. In 2014, the mobile junior engineering class which is especially oriented to vehicle technology and engineering were started. These mobile trailers are visiting more than 100 schools for all over the country. And the experiences to develop the technology and engineering oriented contents strongly dedicated to design the STEAM education system in 2010.

OBJECTIVES

The purpose of the junior engineering classes and the mobile junior engineering schools are both to promote the youth to technology and engineering fields, and through these activities we wants to cultivate the creative engineer based upon the convergence among science, technology and engineering as Korea's growth engine.

METHOD

Basically the contents of the junior engineering classes strong emphasize the connection of basic science which learn in school to technology and engineering according to the story-telling to give the creativity and the achievement with hands-on activities using well designed kits which are related to recent interested technology and products for just in time education. These junior engineering classes are controlled by headquarter of national academy engineering of Korea. And every volunteer of companies are training at the discovery center of science and technology of Hanyang University twice a year on. The mobile junior schools which are supported by industry independently, are equipped with stages for engineering dramas. These story of dramas are based upon the produced items. For example, the drama of junior engineering class which was supported by Hyundai MOBIS focus to motor technology and engineering.

RESULTS

The junior engineering class and schools were estimated by governments and teachers that one of most successful activities to promote student to technology and engineering fields and give creativities. Recently many of the youth prefer to study the technology and engineering fields. Moreover the experiences of developing its contents strongly dedicated to develop the STEAM education system which is the national science education.

COCLUSION

Through the junior engineering classes and the junior engineering school activities, the more youth are interested in technology and engineering fields. And these story-telling based contents and actual hands-on activities make the student creativity maxima.

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We_IE_3_1

Reinvigorating Manufacturing Strategy and Best Practice of Engineering Education Reform in China - A case study of Zhejiang University

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Abstract : *"Human-oriented" principle is the foundation of the "Made in China 2025" Plan. This study detailed analyzes the basic connotation on the strategy of reinvigorating manufacturing in China, and the current situation and key problems faced by Chinese Higher Engineering Education under the new international and domestic situation. The study regards four typical cases in Zhejiang University as the research objects, through the content analysis method to extract the four characteristic modes on "cross-disciplinary", "professional", "diversification" and "internationalization". Meanwhile, the study tries to put forward some systematic countermeasures and suggestions to deepen Higher Engineering Education reform in China, and to enhance the training quality of engineering and technical talent, laying the foundation for creating holistic engineering education paradigm.*

Keywords : *Made in China 2025; Engineering Education Reform; Countermeasures and suggestions*

We_IE_3_5

Korea University of Technology and Education's Industry Professional Practice: The Model and Outcome of the past Four Years

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Abstract : *Industry Professional Practice (IPP), a long-term on-site training model of Korea University of Technology and Education (KOREATECH), is a program in which students work long-term at a business related to their major, in order to learn about the actual work in their chosen field and earn credits. It began in 2012 as a long-term co-op Education model, an improved version of the short-term industry on-site training program. IPP has been invigorated over the last 4 years with a continuously increasing number of participating students every year. This improves the youth employment rate, and alleviates the hiring process of small- and medium-sized businesses suffering from labor shortages due to employment mismatch.*
Keywords : *Industry Professional Practice, major-related work experience, youth unemployment, improving the employment rate*

INTRODUCTION

The previous industry on-site training aimed to let students experience their chosen professional field and the corresponding work for 4 to 6 weeks. While this length of time allows the student to experience their actual field instead of just in theory, for businesses, 1 month is not enough to involve the students in authentic tasks related to their majors. Subsequently, students are mostly assigned simple duties, resulting in a low satisfaction level for both students and businesses. Additionally, the effectiveness becomes questionable, since it achieves very little of the program's original objective.

OBJECTIVES

KOREATECH, which values experiment and practice-oriented education focused on field techniques, has been operating a short-term on-site training course since 2010, which is mandatory for all students in order to strengthen their field education during their time in college. During this process, the school underwent an extensive improvement plan due to the short training period and its subsequent low effectiveness. As a result, a long-term co-op Education model, IPP was established. This model aims to increase the usefulness and advantages of industry on-site training by having students participate in fields related to their majors during a 4 to 6 months long training period. A summer school, a semester before participation in a practice, is run as major summer semester where major courses are offered in order to compensate the major classes lost due to participation in IPP program in regular semester. This major summer semester is a mini-semester of 7.5 week. And IPP participants are allowed to participate in the practice after taking the major courses here in advance.
This study examines the specific concepts, education management and procedure of IPP. The effectiveness is also evaluated now that the program has reached its 4 year mark.

METHODS

The progress of IPP can be determined by examining the data of the past 4 years on participating students, businesses and field practice training funds from businesses and college scholarships. Additionally, the employment rates and types of employers of graduates who took part in the IPP can be explored through the health insurance database, and comparisons can be made between students who were involved in IPP and those who were not.

RESULTS

Initial concerns and negative perceptions of the model due to the students' long-term absences from school courses and decline in academic performance were addressed with solutions such as opening major courses during the summer and winter terms. Thus IPP is currently perceived as an opportunity for students to earn wages and acquire field experience prior to employment. Subsequently IPP model has expanded throughout the school to include all students as participants since its inception in 2012, with an increase of 100 participants per year. Moreover, observing the employment rate of graduates who participated in IPP suggests that it has contributed to improving the youth employment rate. The employment rate of graduates who experienced IPP is 10.1% higher than of those who did not, at 89.5% and 79.4%, respectively. The employment distribution of small- and medium-sized businesses is 41.7% for non-participant graduates, compared to 46.1% of IPP participants. IPP has boosted the employment of small- to medium-sized businesses that were suffering from labor shortages due to employment mismatches. In the satisfaction survey for students who participated in the IPP program, it was revealed that the students received a 4.2 or above out of a full score of 5 for the last 4 years. However, the IPP partner companies got a score of 4.5 or above, which is higher than the score from the students.
Accordingly, in 2014, KOREATECH was ranked number 1 in terms of employment rates among 4 year-colleges.

CONCLUSION

IPP, a model for long-term industry on-site training, aims to provide on-site training experience for students in major related businesses. It is necessary to secure a full-time professor to be in charge of IPP in order to oversee students and courses before and after on-site training and to serve as the intermediary for handling the interests of both students and businesses. Upon analyzing the data of the past 4 years, the model's effectiveness could be observed among the three main parties involved: the students, businesses and the school. Not only were students able to learn the techniques of the work related to their majors, they also strengthened their employment abilities, which led to a higher employment rate than for non-IPP participants. For businesses, it is an opportunity to confirm a student's potential as a future employee, and to maintain stable employment by hiring IPP students. Finally, for the school, the students' strengthened employment abilities, received through on-site training and IPP improved the school's student employment rate. In addition, IPP helps mitigate mismatches between the school and industries by producing capable, talented individuals who have experience in their respective fields.

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We_IE_3_6

INTERNATIONAL CO-OP FOR ENGINEERING EDUCATION : OUR VISION AND EXPERIENCE

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Abstract : *The engineering school at Hanyang University-ERICA is keeping pace with these changes and pushing forward not just national but also international cooperation with Drexel University in Philadelphia, USA. The international co-op program for global talent training was constructed as the first in Korea based on international industrial-academic collaborative education. It is ultimately an innovative new engineering program pursuing internationalization and industrial-academic collaboration at the same time, with future potential to develop into a new model of industrial-academic collaboration through consultation with the Ministry of Education. The establishment of this creative and innovative program is expected to increase the employment rate among ERICA undergraduates through international internships and to raise ERICA's domestic/international status while reconfirming the status of advanced universities.*

Keywords : *International Co-op, Cooperative education, Engineering education, Globalization program*

INTRODUCTION

A recent common trend in innovations for university education around the world is training creative global talent. For this, it is necessary to balance theory and practice germane to industry by developing engineering curriculum reflecting demand at industry sites, and education in cooperation with industry must be reinforced to promote practical creative talent to cope with rapidly changing industry environments. The College of Engineering Sciences at Hanyang University-ERICA is keeping pace with these changes and pushing forward not just national but also international cooperation with Drexel University in Philadelphia, USA.

This is an international co-op program to train global talent that goes beyond existing concepts of Korean co-ops or internships. Korean undergraduates directly participate in a co-op course at a renowned American university to complete major curriculum and on-site practice at leading American companies. It surpasses existing internationalization and industrial-academic cooperation as international cooperation that develops infrastructure with Hanyang University's characteristic Korean industrial-academic cooperation success as Korea's first promotion of co-op courses in the same direction as an American university.

OBJECTIVES

Existing short-term (4-6 weeks) field practices operate as a system that takes about 1 month and can provide students an opportunity to experience an industrial site for a short period; however, from an industrial point of view, this level pertains to an on-the-job training (OJT) period, and it is difficult to actually enter the business. For this reason, there are many cases in which a short-term job is taken rather than work in the major field, and neither students nor businesses are satisfied with the existing field practice system; thus, the original purpose of field practice is not achieved [2]. According to surveys and industrial focus group interviews (FGI), most companies want a field practice period of at least 4 months [1], and in fact, a co-op period of 6 months to 1 year is successfully practiced at advanced universities operating for close to 100 years [3]-[5]. Therefore, a long-term field practice system of at least 6 months must be introduced to be effective [3].

A co-op course is an educational model that integrates academic study with work experience at an actual industrial site related to the major. Students who complete co-op courses (co-op students) alternate between periods of academic work and periods of building up suitable on-site experience in various fields such as work within the company and business [5]. Practical courses in cooperative education are called "co-op" courses, and they are a systematic method of directly getting work experience which are gaining educational confidence. The importance of co-op courses is recognized in that they help provide a soft landing for young people going from school to work and give new academic motivation.

Within the College of Engineering Sciences at Hanyang University's ERICA campus, 9 majors with excellent internationalized educational results are pivotal for the international co-op program to train global talent established and to move forward as international cooperation that develops infrastructure with Hanyang University's characteristic Korean industrial-academic collaboration results. The international co-op program is differentiated by being linked to internationalization and industrial-academic collaboration and is constructed based on Korea's first international industrial-academic collaborative education. Ultimately, it is a new long-term innovative engineering program that simultaneously pursues globalization and industrial-academic cooperation.

METHODS

Engineering majors from the College school of Engineering at Hanyang University-ERICA with excellent internationalized results are pivotal in the international co-op program. Through a 1-year co-op student exchange system (6 months for Drexel students) with cooperation between Hanyang University's ERICA campus and Drexel University, and students alternate between 6 months of major study at the American university and 6 months of practical study at an American company during their university courses. This type of international cooperative program is very difficult to carry out due to differences in international administrative systems, etc., but a group including Drexel President John Fry visited Hanyang University to sign an MOU between the two schools. This agreement was achieved though the preparation of communication channels with the Ministry of Education for program support with verification of Korean companies' continuous intention to be involved, along with 3 visits to Drexel University, program preparation sessions with a core preparation council, and about 20 meetings. The curriculum was designed such that through this agreement, students exchange places for 1 year, studying classes in their majors for one semester and doing co-op work at a participating company for one semester (about 5-6 months). Hanyang University students receive small salaries for working at American companies, while Drexel students receive small salaries for working at Korean companies.

RESULTS

Hanyang students chosen for the current program will attend major classes at Drexel University starting autumn of 2016 and then participate in the Drexel University co-op program, getting practice at a leading company in the US, and credits earned from those major classes and the co-op will be reflected in their grades for graduation. Likewise, outstanding engineering students from Drexel sent to Hanyang for 6 months starting in January, 2017, will undertake full-time field practice (6 months) at leading Korean companies. Through this program, students will be able to assess their own strengths and aptitudes through field practice in their major and thus will be able to clearly select their future careers. They will also be able to select the major courses they desire upon returning to the university after completing the co-op and study the subjects in more depth. Through these courses, they will gain more experience with cutting-edge technology and equipment used at actual industry sites, as well as experience problem-solving together with other engineers at industrial sites (learning by experience) to increase their competence in their majors. By increasing the students' competiveness in their majors, it will be easier for them to get jobs after graduation since they can immediately enter the workplace with no additional training. Companies will be able to securely acquire proven workers by continuing to employ participating students and will thus save on hiring and retraining costs.

CONCLUSION

The international co-op program for global talent training was constructed as the first in Korea based on international industrial-academic collaborative education. It is ultimately an innovative new engineering program pursuing internationalization and industrial-academic collaboration at the same time, with future potential to develop into a new model of industrial-academic collaboration through consultation with the Ministry of Education. The establishment of this creative and innovative program is expected to increase the employment rate among ERICA undergraduates through international internships and to raise ERICA's domestic/international status while reconfirming the status of advanced universities. Furthermore, it is expected that an international model for new engineering education can be proposed and domestic/international engineering education paradigms can be revolutionized through this program.

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We_EP_3*_1

INTERACTIVE MATERIALS FOR TEACHING AND LEARNING IN ENGINEERING MODULES

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Abstract : *This work is motivated by David Kolb's theory on experiential learning cycles. To fill the gaps between the teaching and learning in current approach, interactive materials are developed and applied to an engineering module. Developing tools are compared and the selection considerations are discussed. The new interactive materials have been used in the teaching and learning experiments. Data for our students' performance, student survey and teaching feedbacks are collected and analyzed. The results show students appreciate this new approach and their performance in this module are improved.*

Keywords : *interactive materials, engineering education, computable document format (CDF).*

INTRODUCTION AND MOTIVATIONS

Compared with static examples, interactive examples may be more suitable for illustrating the interaction of different parts in a system and how input parameters affect the system output dynamically. With such materials, explaining the correlation of elements becomes easier for lecturers. Students also can use the interactive function to clear their doubts, verify their ideas and practice. Such activities are important steps in students learning according to the experiential learning cycle theory by David Kolb [1][2]. In this theory, a learning cycle needs to go through four stages, namely, concrete experience, reflective observation, abstract conceptualization and active experimentation. To deepen their learning, student may need to go through a number of cycles in their study.

In our current teaching approach, introducing a new concept followed by a couple of static examples, which can be mapped to the first two stages, are usually taught first in the classroom teaching. Follow-up practice activities, such as lab experiments or tutorials mapped to the other two stages, are often arranged in several days later. Such a process seems sufficient and successful before. But the same process may not work for the students today due to the new learning environment and their learning styles. There are many eyes-catching things on internet and online social networks. Students today are easily distracted from their learning cycles if no follow-up practice materials are available at their convenient time. Consequently, their learning cycles are interrupted and their progress are affected. On the other hand, if interactive materials are available to students, they can complete the cycles with flexible arrangements. The argument is that the interactive materials, unlike the static materials in the current approach, can be developed with dynamic content which can accept adjustable parameters and inputs as well as show the corresponding results in real-time. Students can use them as a learning tool to try different setups, verify their ideas and practice at their convenient time.

OBJECTIVES

There are two objectives in for this project. The first one is to search for suitable tools and develop interactive materials for engineering modules. An ideal tool should be easy-to-use for both lecturers (to develop interactive materials) and users (to use interactive materials). It should be able to coherently synergy texts and the routines supporting interactive content. The other objective is to apply the interactive materials in the teaching and analyze how they can enhance the teaching and learning by helping students in their learning cycles.

METHODS

For the first objective, different tools are compared based on a set of requirements. It turns out that the Wolfram computable documents format (CDF) is a suitable tool. It is an electronic document format which allows authoring dynamically generated interactive content with Wolfram Mathematica [3].

The interactive materials are developed with CDF for this teaching experiment. They are applied as lecture notes in the classroom teaching and available to students. Lecturer promotes the usage of the interactive materials to students. To verify the effectiveness of the new approach, students quiz performance data, student survey data and teaching feedback are collected and analyzed. These data are compared with the data collected from another experiment without using the interactive materials.

RESULTS

We compare the student performance in a quiz for two semesters with the interactive materials applied in current semester and not available for the previous semester. It is observed that the students' performance in current semester are much better since higher percentages of students are in high marks range than previous semester. For example, the percentage of marks in the range of 14 to 16 out of 20 marks are 20% and 4% in current and previous semesters, respectively. The average marks for this quiz are 12.1 and 9.7 in current semester and previous semester, respectively.

Students' responses to the survey in current semester show that most of them are in favor of the interactive materials (66.7% vs. 33.3%) and will suggest to go on using it in teaching and learning (78.3% vs. 21.7%). Considering that they need to take efforts to learning about CDF before they can benefit from the interactive materials, we believe the survey results show students are keen on this new teaching and learning tool in this modules and think their learning are improved with this tool. This is coincident with above students' performance data and the teaching feedbacks from students on the interactive materials which shows students appreciated and benefited from the new interactive materials in their learning.

CONCLUSION

Although there are a few shortcomings, CDF is a promising for the development of interactive materials since it has good support for the integration of descriptive content and interactive functions. Based on the collected data, the interactive material developed seems to be an effective tool for teaching and learning enhancement for engineering modules. The results also show that the interactive materials are interesting to students and they appreciate the new approach.

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We_EP_3*_2

CHARACTERISTICS OF STUDENT CENTRED LEARNING FROM THE PERSPECTIVE OF ENGINEERING LECTURERS

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Abstract : *Student Centred Learning (SCL) approach is widely accepted in many areas of teaching and learning in higher education worldwide. The effectiveness of SCL approach has been proven by research in various disciplines including engineering education. However, many engineering lecturers are still reluctant to shift their teacher centered learning approach to the SCL approach because they perceived that effective teaching must have heavy involvement of teaching from the lecturers' side and that knowledge must be delivered or transmitted to the learners. Too often, they failed to see learning from the learners' perspective. Therefore, this research seeks to identify engineering lecturers' perspective of the characteristics of meaningful or effective learning. The characteristics are then compared to SCL characteristics as outlined by the How People Learning framework. The data was collected among engineering lecturers over a period of two years during the beginning of training workshops on SCL conducted in various universities throughout Malaysia. The data is analyzed qualitatively using thematic analysis. The results show that most of the positive characteristics mentioned by the engineering lecturers are those which are closely related to SCL. This shows that SCL is a relevant teaching and learning approach in engineering education because it is not only recommended by experts in engineering education but also concurred by engineering lecturers when they see learning from their perspective.*

Keywords : *Student centered learning, faculty development, training*

INTRODUCTION

The demand of high quality engineers today forces higher education institutes to reform engineering education [1]. One of the major shifts in engineering education today is moving from teacher centred learning to student centred learning (SCL) [2]. This is in line with the current educational paradigm or learning theory that knowledge is actively constructed by the learners, not passively received from the teachers (Felder, 2012). This educational philosophy coined as constructivism is not new but it is not easily accepted by engineering educators who are trained under different educational philosophy when they were students [4]. Therefore, it is important to find out what do engineering educators believe in effective or meaningful learning. Based on Bransford et al.'s [5] "How People Learn" framework, a learning environment that can foster effective learning has four aspects that focus on learners, knowledge, assessment and community. SCL promotes the learning environment mentioned earlier where the focus of learning is on the learners, that the learners know the learning goals, that the assessment are to improve the learning and that people learn from each other [5].

OBJECTIVES

Engineering educators still resort to teacher centred learning because this was the way that they were taught. To create paradigm shift or change in teaching conception cannot be easily done through training [4]. Therefore, we ask engineering educators to make reflection and to see learning from the perspective of learners. The aim is to identify the characteristics of both teacher centred and student centred learning among the engineering educators from the perspective of learners.

METHODS

The data was collected among engineering lecturers over a period of two years during the beginning of training workshops on SCL conducted in various universities throughout Malaysia. Each workshop participant was asked to write down their most meaningful formal learning experience, and their worst formal learning experience. These were then collected and discussed with all other participants in the workshop. The data is analyzed qualitatively using thematic analysis. Later, the themes are compared to the characteristics of SCL based on the How People Learn framework.

RESULTS

The result shows that the characteristics of the worst formal learning experience perceived by the engineering lecturers are:

1. One-way communication
2. Chalk and talk
3. Passive learning
4. Spoon feeding and preparing students for examination
5. Emphasis on memorization – rote learning
6. Teaching without informing the objectives
7. Examinations are not aligned to the teaching

While the characteristics of the most meaningful formal learning experience perceived by the engineering lecturers are :

1. Two-way communication
2. Hands-on learning and projects
3. Experiential learning
4. Use of real world & industrial examples
5. Group discussions
6. Peer learning / teaching
7. Feedback on learning tasks & assessment
8. Relate teaching with the previous knowledge
9. Use of visual aids and incorporate site visits

When the characteristics are mapped to the HPL framework, it can be seen that the characteristics of favourable learning experience perceived by the engineering lecturers are those that related to SCL.

CONCLUSION

It is concluded that SCL is teaching and learning approach that produce positive outcomes in engineering education. Engineering lecturers should reflect on their own formal learning experience to improve their teaching because what they perceive to be the effective learning process should be translated into their teaching methods. Therefore, the shift from teacher centred to SCL is the right way forward in engineering education as promoted [6].

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We_EP_3*_3

COMPUTER-BASED SIMULATION AS A STRATEGY FOR TEACHING QUANTUM TUNNELING CONSIDERING PARAMETRIC UNCERTAINTIES

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Abstract : *Computer simulation environments are most of the times useful for bridging the gap between theoretical concepts taught in the classroom and laboratory experiments. In this paper, a novel approach for teaching quantum tunneling is presented. A computer simulation environment was designed and tested in a subject of the career of electronic engineering. Students' performance has been assessed at different stages. Future upgrades for this environment are being developed.*

Keywords : *Strategy, Tunneling, Uncertainties*

INTRODUCTION

Lack of school facilities such as laboratories is one of the many hindrances that are likely to be encountered in developing countries. This is the case of our academic institution where a subject called Electronic Physics (EP) is offered to undergraduate electronic engineering students.

OBJECTIVES

In order to understand why the miniaturization of semiconductor devices has a limit, it is important to master some special topics covered in EP, among which is quantum tunneling. But, as mentioned above, the lack of laboratories prevents students from performing measurements that validate theoretical results. The goal of this research is to devise a computer-based teaching strategy that allows students to understand quantum tunneling when parametric uncertainties are taken into account.

METHODS

The first step to achieve the goal was to suggest to students using some free Java-based interactive science simulators, along with an online graphing calculator. But none of these tools can be successfully used to model semiconductor devices. This is so due to uncertainties that appear during the manufacturing process. Thus, the second step to achieve the goal was to design a computer simulation environment that allows students to modify the graph of the transmission coefficient of quantum tunneling, as a function of parameters such as the dimension of the barrier and the value of the potential energy. The assessment of this technique consists in pondering the scores of the midterm and final exams.

RESULTS

So far, it has been observed an improvement in students' performance in some of the activities of EP. This approach will soon be expanded to a next level. This will include the possibility of multidimensional barriers. Students are expected to perform robust design of semiconductor devices such as CMOS transistors.

CONCLUSION

It is clear that in the absence of laboratories, this strategy represents a great opportunity for students of a developing country to understand the need to take into account the uncertainties that arise from measurement processes. Besides, computers and software have changed the way engineering design is done.

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We_EP_3*_4

IMPLEMENTATION OF AN ENTREPRENEURIALLY MINDED LEARNING (EML) IN FRESHMAN ENGINEERING DISCOVERY COURSES AND ITS PRIMARY OUTCOMES

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Abstract : *It is recognized worldwide that first-year engineering education is critical for new entry-level engineering students to obtain a clear vision and direction for their future. The engineering discovery course developed at Marquette University – Opus College of Engineering offers freshman engineering students the opportunity to discover and explore their potential through various course contents/topics and activities integrated with entrepreneurially minded learning (EML). As a result, the students are able to develop their value as future engineers by gathering and assimilating information to discover opportunities or insights for further action. This is the first step that new engineering students take in fostering and establishing an engineering entrepreneurial mindset.*
Keywords : *Freshman engineering students, engineering entrepreneurial mindset, entrepreneurially minded learning, freshman engineering discovery course*

INTRODUCTION

Higher education should be a transformative experience for students. A few years of study and experience in college can lead to a lifetime of success. During school years, engineering students develop technical and professional skills. But beyond those skill sets, education and experience in engineering school can potentially transform a student's mindset. It was discovered that freshman engineering students frequently reexamine their values and motivations during their first year in college [1]. Thrown into unfamiliar situations with a new environment and expectations, undergraduate engineering programs become a crucible in which engineering students have an opportunity to think about the way they think; this is called metacognition [2]. An entrepreneurially minded learning (EML) is an emerging pedagogy that emphasizes discovery, opportunity identification, and value creation [3]. The EML builds upon other widely accepted pedagogical methods [4]. In order for new/freshman engineering students to consistently develop their engineering skills and entrepreneurial mindset, they need to be exposed to more opportunities to practice and explicitly express their creativity though various engineering works and related experiences.

OBJECTIVES

The main objective of the two-semester long freshman engineering discovery courses developed and currently running at Marquette University – Opus College of Engineering is to provide new engineering students a vision as world-class engineering students and successful engineers in the future, equipped with an engineering entrepreneurial mindset defined with the 3C's of Curiosity, Connection and Creating Value [3]. In order to meet the objective, this course adapted an entrepreneurially minded learning (EML) pedagogy, complementarily stacked alongside others (such as problem-based and project-based learning), to help new engineering students foster and establish an engineering entrepreneurial mindset through various course topics, contents and activities for two semesters.

METHODS

During the first semester, the students study and practice various engineering skills, such as introduction to engineering and engineers, engineering graphics fundamentals and computer-aided design (CAD), among others [1]. As the semester progresses, the students are asked to use/apply their intermediate/developing engineering graphics and CAD skills to create real objects (such as a stapler, hand-held calculator, hand dryer, among others). At the end of the first semester, all students participate in the graphics/CAD team project, in which all team members work together to create the assigned component, subassembly and complete models of real objects (such as machine tools, milling machines, buildings, among others). During the second semester, the students study and practice the course topics of (1) engineering problem solving, (2) engineering computing with MATLAB® and (3) engineering design process [1]. The engineering problem solving step or procedure is introduced to the students to solve a real-life problem, such as energy/heat efficiency of a building. The students practice the programming language MATLAB® to solve various engineering math problems/equations. While they study and practice engineering problem solving and engineering computing with MATLAB®, the students are introduced to the engineering design process, in which a (simple) traditional engineering design process is prepared for the students to explicitly use/follow for the course design challenge projects described in the author's previous work [1].

RESULTS

It has been shown that the student's performance and participation in the assigned course work (such as class assignments and project reports) and activities (such as presentation and poster exhibition) are very high. This obviously correlates to their interest and motivation for further action in establishing the engineering entrepreneurial mindset being extremely high as well.

CONCLUSION

This course is designed to create engineering students that are curious about the world around them, unafraid to challenge existing methods, able to identify unexpected opportunities for growth, and eager to seek out innovative solutions to challenging problems. This course provides new engineering students with a vision to become a future engineer with an entrepreneurial mindset.

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We_ML_3_1

A RESEARCH OF NEW-TECHNOLOGY LEARNING BEHAVIOR IN MULTIDISCIPLINARY LEARNING IN MAINLAND CHINA

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Abstract : *The purpose of this study is to explore about the influence of new-technology learning behaviors' significant cause on multidisciplinary learning students. On the basic of Fishbein & Ajzen's theory of plan behavior, a self-made questionnaire was developed and presented. To achieve the purpose, we implement the blended learning experimental teaching for the duration of one semester and survey on 363 students at the end of the multidisciplinary learning workshops. In this research, we applied structural equation modeling as statistical analysis method. The results showed that no remarkable mediation effect between the behavioral intention and actual learning behavior, and there were differences between the research model and measurement model, and the causal relationships between variables were not consistent.*

Keywords : *Multidisciplinary Learning, New-Technology Learning Behavior, Theory of Plan Behavior*

INTRODUCTION

The questionnaire targeted 363 university students from the mainland China for understanding student's learning behavior with new-technology. All of them with multiple specialized fields (i.e. information engineering, digital media, and art design) cooperated in the multidisciplinary learning workshops organized in Beijing and Hangzhou for creating digital publishing content APP.

OBJECTIVES

The purpose of this study is to investigate the new-technology learning behaviors of students. This research predicting multidisciplinary learning students' new technology learning behavior by revised theory of plan behavior (TPB) with technology acceptance model (TAM) and social cognitive views.

METHODS

In regard to questionnaire methods, the design of the questionnaire was based on the theory of plan behavior by Fishbein & Ajzen (2010). The questionnaire adopted the Technology Acceptance Model (TAM) and took into account social cognitive views. The terminologies of questionnaire were also localized to reconcile any cultural discrepancies between each place. The final version of the questionnaire underwent expert revision. The data collected were analyzed using such analysis methods as descriptive statistics, correlation analysis, and confirmatory factor analysis, as well as the structural equation modeling technique.

RESULTS

The study reached two results. First, there was no remarkable mediation effect between the behavioral intention and actual learning behavior displayed by the digital publishing students; these results were not fully consistent with theory, a probable cause for which was that the learning behaviors of the university students were influenced by self-evaluation or were limited by the curriculum arrangements made by the lecturers. Second, there were differences between the research model and measurement model, and the causal relationships between variables were not consistent; the researchers believe that the study was influenced by the software applications used by the teachers and students in Mainland China and the variation in the degree of autonomy.

CONCLUSION

The research conclusion that teachers in the mainland china should enhance the diversity of new technologies students come in touch with. Meanwhile, teachers should do their best to create a favorable learning experience about new technologies for students and enable them to conduct self-evaluation in a professional manner.

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We_ML_3_3

A matter of perception : The attitudes of students from different educational level and professional experience towards PBL method of learning

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Abstract : *This study report the perception of three groups of students having different level of education and professional experience toward Problem/Project based learning(PBL). The samples are 1st year Bachelor degree engineering students 2) master students in civil engineering and 3) master students with several years of professional experiences in civil engineering. The contents of the teaching were within the water recycling and urban drainage engineering with shared topics. Multi-model teaching techniques such as lecture, questions, pair discussion, jigsaw, brainstorming session, game based, Lego based training were used for facilitation of PBL processes. Questionnaire survey was conducted to observe how students perceive these teaching methods compared with traditional lecture based methods that are more widely applied. It was found that Group 1 students are eager and favor in the learning with this PBL style, while the 2nd group prefers lecture based teaching and feels that PBL pushes them out of their comfort zone requiring them to be active in class. The most positive perception could be observed in the last group of students. Students with work experience perceive the PBL methods a fun and fruitful learning experience. They are independently construct their own knowledge via different activities, and they found to be attentive and engaged throughout the learning hours.*

Keywords : *Problem-based learning, multi-model teaching methods*

INTRODUCTION

In PBL knowledge is built up by students through researching new contents, rather than the direct transfer of information from lecturers to students. PBL is relatively new for educational institutions in Thailand, where knowledge delivery method is traditionally frontal and one-directional. Currently, some of specific courses in the engineering program at Burapha University implements the PBL method. The focal aims of PBL courses is to transform the classroom from lecture based into a new learning environment, in which students are involved and engaged in the learning processes. Furthermore, it aims to increase the 21st century skills of the students through learning by this method.

OBJECTIVES

- To create the learning environment where lecture were replaced by a multi-model teaching methods (c.f., Table 2).
- To create a feedback system that would allow to evaluate the students perception and attitudes towards PBL
- To examine the perceptions of students towards PBL

METHODS

Table 1 and 2 show the class room setting and the teaching techniques used of bachelor and master degree students. Questionnaire was made online using www.surveymonkey.com to evaluate the student's perception toward the PBL and specifically for students at managing level for preference of employment toward PBL graduates. The author also observes the student's learning attitude.

Table 1 PBL class setting

Group	Number of students	Number of years in Bachelor degree (years)	Students work's experience (years)	Length of study	% of PBL	Respond ratio
1	19	0	0	15 weeks (45 h)	90%	15/19
2	3	4	0	15 weeks (45 h)	70%	2/3
3	16	4	3 - more than10	2 days (14 h)	90%	15/16

Table 2 Multi-model teaching techniques employed in the classes

Activities	Purposes	G1	G2	G3
Questioning	arouse student's curiosity/Challenge students	x	x	x
Jigsaw	critically think of the process train of water treatment	x	x	x
Map (Serious Game)	using game based technique to train students in water management	x	x	
Brainstorming	learn to do generate information rather than being receiver of information	x	x	x
Lego	visualize ideas into concepts	x	x	x
Flipped Class Room	online technical video for supplementing their learning	x	x	
Operating prototype	apply knowledge and utilize skills in conducting the project	x		
Report	write the report utilizing data from the prototype and not copying	x	x	
Presentation	assess students based on oral presentation and Q&A sessions	x	x	x

RESULTS

The survey shows that the 1st and 3rd group of students perceive PBL methods of teaching very well. However, the construction of knowledge take place in different level. The 3rd group was able to independently form the knowledge with only minimum input from facilitator, whereas much greater involvement were required by the 1st group of students. Conversely, the 2nd samples of students indicate the preference of lecture based over the PBL course. The main reasons were because they feel there is not much knowledge to be learnt as being a passive knowledge receiver for many years, and that they have to do a lot of self-directed learning on the project. PBL also pushed them out of their comfort zone having to present in front of an audience in English. In addition to that, students at managing position in the company was surveyed if they would prefer PBL trained graduate for employability. It was also found that the majority of manger would prefer PBL graduates than the traditional one.

CONCLUSION

PBL was well perceived by freshly students and students with work experience, while students passing through passive learning methods prefer the lecture based. Managers who experienced PBL learning methods indicate the preference of PBL trained graduates for employment.

We_ML_3_4

ROLE OF GLOBAL COLLABORATIONS IN TRANSFORMING ENGINEERING EDUCATION : CASE STUDY OF "INDO UNIVERSAL COLLABORATION FOR ENGINEERING EDUCATION (IUCEE)"

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Abstract : *Indo Universal Collaboration for Engineering Education has established itself as a prime mover for improving quality of engineering education in more than 100 engineering colleges in India. The major factor contributing to this is an ecosystem built with the help of global experts from around the world. This includes face-to-face workshops, webinars, courses in a blended format, international conferences, a peer-reviewed journal, as well as networking opportunities. This paper describes these programs and presents preliminary insights regarding their impact in transforming engineering education in India.*

Keywords : *Collaborations, International, India, Engineering Education*

INTRODUCTION

The Indo Universal Collaboration for Engineering Education (IUCEE), with headquarters at Massachusetts Lowell, USA, was conceptualized by over 150 leaders of engineering education and businesses from USA and India in 2007. This short paper analyzes the lessons learnt by IUCEE in the process of creating an ecosystem for transforming engineering education at several engineering colleges all over India, during the past 9 years.

OBJECTIVES

The objective of the work of IUCEE is to assist the faculty in engineering colleges all over India become more effective teachers, with the help of a collaborations through existing international networks for engineering education.

METHODS AND RESULTS

The ecosystem is built and nurtured by offering various programs for faculty development with emphasis on improved teaching and learning processes as well as curriculum development :

- Face-to-Face Workshops by experts from around the world to discuss global best practices in teaching and research in their field with Indian faculty. During the past seven years, almost 200 workshops have been conducted.
- Virtual Webinars to enable engineering education experts to conduct live webinars and mini-courses on-line to faculty and students all over India. More than 500 one-hour webinars on teaching, research and general education topics have been conducted online by international and Indian experts since 2011. Recordings from these webinars are available for sharing.
- International Networking fostered with international community of engineering educators and leaders through IFEES (International Federation of Engineering Education Societies), GEDC (Global Engineering Deans Council) and ASEE (American Society for Engineering Education). IUCEE members attended annual conferences organized by GEDC, IFEES and ASEE. Faculty

from over 100 engineering colleges in India are now connected with over 200 international faculty members from over 50 international institutions, resulting in a wide variety of research and teaching collaborations.

- Annual IUCEE Conferences co-organized by IUCEE under the banner of International Conference on Transformations in Engineering Education (ICTIEE) in India since 2014. Most recently, more than 1000 participants including 40 participants from around the world attended ICTIEE 2016, where around 200 papers were presented.
- Peer-Reviewed Journal, the Journal for Engineering Education Transformations (JEET) started in 2014, in collaboration with Rajarambapu Institute of Technology. This journal is a vehicle for sharing best practices in engineering education by Indian and global engineering educators.
- Certification under the name of IUCEE International Certification for Engineering Educators Program (IIEECP) offered by IUCEE with assistance of IGIP (International Society for Engineering Education), Austria and support from Microsoft. The first three pilots have been successful and efforts are underway to scale up the program for broader impact.
- Student Programs are being led by students from several colleges associated with IUCEE, who have aligned themselves with SPEED (Student Platform for Engineering Education Development). The leaders of these efforts have spread the SPEED programs at workshops conducted for students all over India.

Initial evaluation of the outcomes looks promising. A critical issue is the financial sustainability of the programs as well as the ability of the leadership of the colleges to leverage these programs to promote sustainable transformations in their institutions.

CONCLUSION

IUCEE has fostered global collaborations for improving quality of engineering education in several engineering colleges in India. An ecosystem has been built with the help of global experts from around the world. IFEES has played an important role in this process. Although there is significant evidence of transformations in several colleges which can be attributed to IUCEE, a rigorous assessment of the impact and sustainability of the ecosystem is needed. After a couple of years of funding from well-wishers, an IUCEE College Consortium of 70 members is trying to financially sustain and promote institutionalization of transformations in engineering education.

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We_ML_3_5

BEST PRACTICE IN CATALYZING CONTINUOUS REFORM IN ENGINEERING EDUCATION

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Abstract : *As we all know, engineering education has to keep up with changes in today's world. Therefore, all stakeholders (academic leaders, industry partners, students, NGOs, society in general) need to be proactive in understanding what are the economic/society needs and constantly adapt strategies to better develop the engineering professional that will contribute to the development of new ideas as well as solve local, regional and global problems. In other words, how to form the "locally pertinent, globally competent" engineer. Engineering schools need to also assess and evaluate continuously to make decisions to improve. But given the conservative history and nature of higher education, innovation/reform does not come easy. The system has existed virtually unchanged for centuries. So, how can engineering schools engage in a reflection, adapt, change path? How can faculty, deans, department chairs promote innovation, continuous formative and outcomes assessment to make informed decisions to better achieve its mission in society? How can all stakeholders work together in this process? This paper proposes answers to these questions and discuss a unique model, followed by an international team of experts in mentoring engineering institutions around the world, to understand the why, how, who, and what of engineering education innovation. It shares concrete examples of the process being followed as well as the outcomes of innovation. These examples can help other institutions catalyze similar roadmaps for better serving their constituents.*

Keywords : *engineering education, innovation, mentoring, best practices, engineering competencies*

INTRODUCTION

Many higher education institutions, especially engineering schools, are either revisiting their mission and strategies or are thinking about doing so. This may be the result of one or multiple factors that have to do with both internal (e.g., resources constraints, enrollment, retention) and external pressures (e.g., industry needs, government regulations, accreditation). Many of these reforms include continuous assessment of outcomes for quality improvement. Going about reforming a system that has been in place for hundreds of years does not come easy. Again, the highly conservative higher education culture permeates across all sectors making the process more difficult. Issues and questions like these surface : Why change when we are excellent? We have done it like this and it works, why change? Why do we have to listen to what industry says? I have been teaching like this, the same way I was taught. Nobody is making me change. Facing these pressures academic leaders find themselves in a crossroad with no other path to take but that of facing reform head on, reflect on current state, understand what society needs and analyze alternate pathways to finally make decisions to innovate to better serve stakeholders [1].

OBJECTIVES

For the last few years a group of engineering (and associated disciplines) professors and industry experts who have dared to change themselves, the way they teach, deans who championed major transformations in their colleges, to Silicon Valley entrepreneurs and industry leaders who have nurtured and expanded academic partnerships have come together to assist engineering (and associated disciplines leaders) in their transformation processes. These individuals have dedicated their lives to improve higher education, especially, engineering education, many are world recognized educators with prestigious awards and recognitions. They have transformed themselves, their institutions and higher education – and are making themselves available to help others through similar transformations. The paper describes the mentoring approach being used with institutions as well as examples of the outcomes that have resulted from the guiding process.

METHODS

Executive coaching/mentoring brings best practices and guidelines in helping leaders excel at what they do [2]. The coach/mentor group follows a process that is designed as unique, one-on-one individualized to benefit the leader and his/her organization. It works with goals jointly defined by both the leader and the organization, and use methods and feedback data to develop the leader's capacity for current and future leadership. The coaching is guided by a coaching partnership to achieve maximum impact and the highest level of learning, not only of the leaders but also of the academic/staff community they want to include. At a high level perspective, the method used follows a simple pattern : 1) assess the institution/college/program needs, 2) together with leaders, help develop their innovation/reform plans to address those needs, and 3) accompany/mentor the academic leaders through the implementation phases, through : high value meetings/brainstorming sessions, focused seminars and workshops, individual and group consulting/mentoring and efficacious and agile follow-through via email and conference calls. Once the institution leaders communicate an understanding of their needs, a group of experts is assembled and an initial agenda for meetings, brainstorming sessions, seminars and workshops in the areas of interest is put together. The agenda is amply discussed based on desired outcomes, time and resources constraints and other issues. High emphasis is placed on learning effectiveness, outcomes assessment, industry/employer partnerships and faculty development. The first visit occurs under a congenial, open atmosphere, both sides, mentors and mentored, open to change the flow, scope and content of topics. Homework is requested of all participants to further scope their understanding their knowledge as well as make them aware of important issues pertaining to engineering education in the 21st century. Tasks are also assigned to the institution with frequent follow up via email, phone/skype conference calls. The mentoring process also includes motivating institutional leaders to write up their experiences and publish/present a paper in a national, regional or global conference.

RESULTS

The paper will include a description of the mentoring process for innovation of five (5) institutions or alliances of institutions with which the group of mentors have worked. A brief description of each institution's motivation and challenges, innovation areas and plans, and the reform general outcomes will be included.

CONCLUSION

Engaging an academic reform is not a simple task and involves many stakeholders. Being accompanied by a group of experienced professionals in the innovation /reform of engineering education has proven successful for a group of institutions worldwide. The process and examples described in this paper may be of assistance to other institutions wanting to walk a similar path.

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We_ML_3_6

Sustained Adoption of Educational Innovations and Development of Potential Adopters

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Organizations that fund STEM educational development are increasingly emphasizing expectations for propagation of educational innovations. For example, the current solicitation for the NSF Improving Undergraduate STEM Education (IUSE) program states "transferability and propagation are critical aspects for IUSE-supported efforts and should be addressed throughout a project's lifetime…." The Alfred P. Sloan Foundation, in reference to STEM Higher Education, states "[s]uccessful proposals are expected to be…concerned with the dissemination and portability of results to other institutions." The compelling reason for this shift is that most educational innovations are not being widely adopted, although convincing evidence for their efficacy with respect to student learning has accumulated over the past twenty years. As the need for this shift is increasing being recognized, educational developers comment, "We know that conference presentations, journal papers, and websites do not lead to sustained adoption; we just do not know what else to do." Educational developer funding agencies comment similarly, "We know that conference presentations, journal papers, and websites do not lead to sustained adoption; however, we are not sure about what to look for in proposals that are likely to propagate."

One area in which educational development processes could improve is cultivating potential adopters of educational innovations under development. Too often the focus of educational development activities is creation and implementation of an education innovation for the specific context, program, and institution where the educational developers are located. Further, developers emphasize implementing the educational innovation in their classrooms, not the products and resources that academic staff and faculty members at other institutions could use. As a result, the education innovation may be implemented in a classroom and shown to support student learning, but there may be no other academic staff or faculty members who are interested in adopting the innovation as implemented in this specific setting. The situation is similar to startup companies, where Steve Blank points out, "More startups fail from a lack of customers [analogous to potential adopters of educational innovations] than from a failure of product development." However, if educational innovators begin to think about potential adopters of their innovations, they are uncertain about who would be interested and how to identify those people that might be interested. Again, the parallel to startups is clear, as Steve Blank has articulated, "We have processes to manage product development. What are processes to manage customer development?" Therefore, progress in the area of identifying and cultivating potential adopters is likely to improve sustained adoption of educational innovations.

The paper will present approaches to identifying and developing potential adopters of educational innovations. Approaches include : (a) listening to potential adopters outside the contexts with which educational developers are familiar, (b) working with earlyvangelists to provide feedback early and throughout the educational development process, (c) developing minimal viable products to engage potential adopters in helping educational developers focus on the resources and materials, and (d) working with alpha and beta testers. Establishing processes for identifying and cultivating potential adopters will lead to broad, sustained adoption of evidence-based educational innovations.

We_CI_2_1

Impact of Engineering Students' Learning Experiences on their Learning Outcomes through International Summer Programs

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Abstract : *To develop 21st century engineers, multiple platforms have been adopted to expose students to diverse learning experiences and to develop global competences such as leadership skills, intercultural communication skills, teamwork skills and so on [1]. In the past decades, International Summer Programs (ISPs) have emerged as an effective platform to provide students with short-term, flexible and dynamic international learning experiences. This research investigates engineering students' learning outcomes and learning experiences. We try to explore the link between students' learning experiences and their learning outcomes. Our findings suggest that learning activities such as site visits to local companies and group projects have demonstrated specific impacts on improving engineering students' learning outcomes. Our results can be used to inform the design of future international learning programs to incorporate effective and meaningful learning experiences.*

Keywords : *International learning experiences; Learning outcomes*

INTRODUCTION

Engineers of the 21st century were expected to have diverse experiences and global competencies to compete in a global market [2]. Against this context, many engineering schools incorporated international elements to their courses as a way to provide international learning experiences for students. As a result, international learning experiences have been emphasized as pathways for high-impact experiential learning in global context. For the past decade, leading Chinese universities have been organizing International Summer Programs (ISPs) at the graduate level as a way to expose students to innovative teaching, cutting-edge research topics and diverse learning experiences. Through international learning experiences, students develop strong analytical skills, leadership, practical ingenuity, cultural awareness and communication skills [3]. In terms of understanding students' learning experiences, several researchers have tried to explore students' learning outcomes through international experiences. Nonetheless, there remains a need for exploring the link between students' learning experiences and their learning outcomes through empirical studies.

OBJECTIVES

Built upon our prior work on developing a valid instrument to measure engineering students' learning outcome, this research seeks to understand the link between students' learning experiences and their learning outcomes through an empirical research on engineering students that have participated on these ISPs. A theoretical framework that features Knowledge, Skills and Attributes (KSA) was used to explore students' learning outcomes. The exploration of students' learning outcomes permits an overall understanding about the effectiveness of international learning programs in preparing engineering students as global competitive professionals. Possible strategies were proposed to improve engineering students' learning outcomes through international learning experiences.

METHODS

Based on survey results, we will interview 20 engineering students in all from five ISPs from a leading Chinese university to explore the impact of international learning experience and their learning outcomes. Results from six interviews were included here. Based on a priori first-level codes (Knowledge, Skills and Attitudes), open-coding was used to identify the next-level codes. A codebook was built based upon analyses of those transcripts. Preliminary findings are described below.

RESULTS

Based on qualitative data, we explored engineering students' learning experience and outcomes through ISPs in the dimensions of Knowledge, Skills and Attitudes. Our findings suggest that varied learning activities, such as site visits to local companies and group projects, have demonstrated specific impacts on improving engineering students' learning outcomes in these three dimensions.

KNOWLEDGE DIMENSION

In the dimension of Knowledge, students described that lectures on the cutting-edge engineering technology and site visits to factories, companies, museums, and laboratories have exposed them to latest information on engineering, which encouraged students' career and academic interests.

"We worked in a company, and people in this company showed us the latest innovations in their field. It was very interesting. When we visited their factory workshops and laboratories, we learned about their core technology, processes of design and production, and saw how people from other companies communicate them. All of those processes were open to us.

In many ISPs, students from different majors worked together to finish a project. Through this mixed grouping, some engineering students learned more about interdisciplinary knowledge :

"…Our group members were from different countries and majors, and each team was composed of students from design, mechanical engineering, software, and human factors. So it's a very different experience for me. Because through lectures and group discussion, I can learn lots of professional knowledge of other majors, such as design and software programming. It helps me broaden the knowledge."

Moreover, some of the group work have impacted their thinking :

"…My major is mechanical engineering, so I'm used to the engineering thinking, which is more pragmatic and make us use the fastest way to realize intended functions. But design thinking includes more consideration, such as aesthetic measure and user experience. In this interdisciplinary team, I learned more about the design thinking."

Skill Dimension

In the dimension of Skills, most students mentioned about the improvement in their communication skills, teamwork skills and foreign-language skills through negotiations when they worked together to finish a complex engineering project.

"…my communication skills were improved. We needed to design a product together, so we had lots of communications and presentations during the process. Sometimes we would have conflicts, then they needed to be solved. I think these processes have trained us."

In order to realize desired outcomes, students learned how to make their voices heard in group discussion and how to solve conflict in the process of project implementation.

"Maybe because of cultural differences, some foreign students in our group are a little self-centered, and have strong views. Sometimes they may neglect your opinions, so you need to spend more time and energy to communicate actively with them. You have to say it repeatedly, or even speak to him one-on-one, to convey your ideas. In the end, we are of the same group. For me, this is an improvement of my communication skills."

Project-based-learning is an effective way for engineering students to improve their engineering skills, especially in regard to problem solving [4]. Through designing a real product and solving complex engineering problems, students learned how to be an engineer with problem solving skills, design skills and programming skills.

"We needed to complete a project a project together, that is, designing a product. This means we went through the whole process [of a project] including forming an idea, market research, product design and realization, which were the same as the actual process for creating a new product in the company. Those processes trained us a lot. They taught me how to turn my idea into reality, how to choose materials, and how to design. I think my abilities to solve real-life problems was indeed improved."

Attitude Dimension

International summer programs provide a chance for engineering students to get in contact with people from different majors and cultures. In the dimension of Attitudes, students learned more about another countries' economy, cultures, history, education, food, etc. Students could develop more respect for other cultures and broaden their horizon through visiting museum and host families.

"I think the main benefit for me is it broadened my horizons. You can experience the local culture of the foreign countries. Foreigners' habits and ways of thinking are quite different from us. Though you may not agree with them sometimes, but I think people can be more tolerant through this experience."

Cross-cultural learning experiences help students enhance their global competencies effectively [5]. Students who were exposed to diversity developed their awareness of diversity of countries, and learned to look at things in a new way and open their minds to new ideas.

"…It's certainly very eye-opening. You can experience different cultures. For example, foreigners are more independent, and they emphasize on individuals, not like Chinese, who prefer to do things together. So we tried to accept their cultures and use their concepts to get along with them. We exchanged our ideas, and we found that our perspectives and ways of thinking were quite different."

CONCLUSION

This work-in-progress reports students' learning experiences and their possible impact on students' learning outcomes through international learning experiences. The incorporation of international learning experiences and activities is deemed as helpful in preparing students' cultural awareness, communication skills and so on [3]. Through diversified learning activities, students can develop their interdisciplinary knowledge, teamwork skills and an awareness of the diversity of different countries. These findings are expected to provide feedback to universities and engineering colleges to promote the design of future international learning programs and to incorporate effective and meaningful learning experiences into the curriculum design.

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We_CI_2_2

CDIO in Singapore Polytechnic : Enhancing Innovation in Engineering Education

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Abstract : *This paper describes and analyses a 10-year educational development process of redesigning the engineering programmes at Singapore Polytechnic(SP) using the CDIO framework. CDIO (Conceive-Design-Implement-Operate) is a worldwide initiative for reforming engineering programmes towards a multidisciplinary, hands-on curriculum that emphasizes real world applications. Adopted by 120 educational institutions worldwide initiative aims to equip students with deep technical knowledge and engineering skills required by industry. These include personal and professional skills and attributes; interpersonal skills of teamwork and communication; and engineering design and product building skills. Singapore Polytechnic (SP) joined the CDIO collaboration and adapted the framework for its 15 full-time engineering programmes in 2004. In this paper, the authors will share the milestones in Singapore Polytechnic's journey of engineering education curricula reform and the outcomes of the reform on its programmes and graduates. They will revisit the objectives of the educational development, the changes that were introduced, and the review the outcomes. Critical success factors for sustainable educational development will be shared.*

Keywords : *CDIO, engineering education development, critical success factors*

INTRODUCTION

CDIO is a worldwide initiative that was conceived by Massachusetts Institute of Technology (MIT) in Cambridge Massachusetts in the late 1990 in collaboration with 3 Swedish universities : Chalmers Technology, Linkoping University and the Royal Institute of Technology (Crawley, et al. 2007). The initiative was funded by the Wallenberg Foundation. The initiative was a response to industries', governments' and academia concern about the greater emphasis on the teaching of theory in engineering. As such, engineering graduates lacked essential practical engineering skills and attributes necessary for real world practice. As Crawley et al (2007) summarized :

...we identified an underlying critical need – to educate students who are able to Conceive-Design-Implement-Operate complex, value added engineering products, processes and systems in a modern, team-based environment. It is from this emphasis on the product, process, or system lifecycle that the initiative derives its name-CDIO. (p.1)

In 2002-2003, SP's management realized the need to produce graduates who are more Creative, Innovative and Entrepreneurial (CIE) and embarked on its journey to transform its engineering programs. Being the first Asian higher educational institution to join the CDIO initiative in 2004, the team of engineering faculty had to customize the CDIO educational model which was conceived in a western university context to the Asian and polytechnic context of Singapore. From 2006 onwards, there were active experimentation, innovation and adoption of the CDIO range of competencies and best practices by 15 engineering programs. This was the start of a 10-year educational development process which involved changes in the design of curricular, pedagogic approaches and learning spaces.

OBJECTIVES

Curriculum reform and innovation are essential to better prepare our students for the changing economic and social needs of a country. It is also a reflection of the responsibility of educators to incorporate new evidence based research and understanding about human learning into their practices. Very often, curricula reforms are perceived as transient and to be discarded and replaced by the next initiative. Overtime, faculty become weary and fatigue by the numerous changes they are expected to implement in their teaching. The need for a sustainable and enduring educational development process is necessary.

Educational development needs to be viewed as a long-term strategic process involving meaningful enhancements and continuous faculty and stakeholder engagement for it to be sustainable and enduring. Key to the process is strong institutional support from leaders and resource personnel to establish appropriate cultural and structural contexts as well as support for capability building (Malmqvist, et al., 2010)

The aim of this study is to examine the experiences and outcomes from a long-term education development process. In particular, this paper aims to identify the critical success factors for achieving a sustained programme development and to propose improvements in education development practices.

METHODS

Education development is shaped by numerous factors. It is influenced by the needs and vision of the nation, institution as a whole and the school the faculty belongs to and involves cultural, structural and capability factors.. For this paper, we have adopted a qualitative research approach. This approach involves the study of the implementation of a case of an education reform to identify the critical success factors. Data of the implementation was gathered from multiple sources and individual and group interviews conducted to map out the process and outcomes of the case. Additional information like a 3 year programme evaluation which included students' and faculty perception and learning, and feedback from external reviewers were also considered.

RESULTS

Guided by a set of customized skillset for the modern engineer and 12 CDIO best practices, 15 engineering programmes from the Schools of Electrical and Electronic Engineering, Mechanical and Aeronautical Engineering, Chemical and Life Sciences and Architecture and the Built Environment were revised and restructured. The 12 CDIO best practices address :

- Programme philosophy (Standard 1)
- Curriculum outcomes and design (Standards 2, 3 & 4)
- Design-implement experiences and workspaces (Standards 5 & 6)
- Teaching and learning approaches (Standards 7 & 8)
- Faculty development (Standards 9 & 10)
- Assessment and Programme evaluation (Standards 11 & 12)

Some of the revisions made include the integration of the CDIO skills of personal and professional skills and attributes; interpersonal skills of teamwork and communication; and product and process design and build skills into the programmes. In all programmes, an Introduction to Engineering module was introduced to provide students with opportunities to develop the basic conceive, design, implement and operate skills and link and integrate knowledge across the courses to stimulate interest in, and strengthen students' motivation for, the field of engineering. Existing assessment schemes were also reviewed and revised accordingly. Teaching of the revised programmes began in April 2008 with the first year modules. After 8 years of implementation, the CDIO has taken root in Singapore Polytechnic.

A longitudinal study of faculty and student feedback on the initial version of CDIO implementation was positive. Throughout the 8 years of implementation, the original framework has been enhanced to include the adoption of design thinking methodology to promote a user-centred approach to conceiving and designing solutions; an emphasis on attributes like sustainability, appropriate technology and a global mindset; integration of principles of self-determination theory (Deci & Ryan, 2000) in learning activities; and adoption of EduTech for teaching and learning.

The results of the CDIO implementation have been positive. The CDIO framework provided a systematic approach to curriculum development and also provided faculty with a common language and vision for engineering education. This systematic and systemic approach adopted by the Diploma of Chemical Engineering to revise their curricula recognized by the Institute of Chemical Engineers. In 2012 and 2015, SP was awarded the Excellence in Education and Training in Chemical Engineering by IChemE Singapore for adopting the CDIO framework to deliver the best educational experience to students. SP was identified in a 2012 study by the Royal Academy of Engineering (UK) and MIT on "Achieving excellence in engineering education : the ingredients of successful change" as one of 20 institutions worldwide with programmes of educational change in engineering that is highly regarded (Graham, 2012).

More engaging, real world learning opportunities based on the conceive-design-implement-operate model were introduced into the curriculum. As a consequence of its practical, real-world approach, these activities better engaged students in their learning and equipped them with deeper engineering skills and habits of mind. Furthermore, the design thinking methodology strengthened their abilities to generate innovative concepts and products. Overall, they were better able to work on real world engineering projects and generate innovative products.

CONCLUSION

Curriculum reform is multifaceted. There are many factors that influence its implementation and hence sustainability. Unpinning the success of the CDIO implementation in SP is the structural, cultural and management support provided by the CDIO framework and the institution. The CDIO standards and best practices provided a systematic approach to the development of a coherent interconnected curriculum based on stakeholders and employers feedback. The framework also provided faculty with a clear purpose and strategy for curriculum development. It was important that the framework was not prescriptive but customizable to the institution's context. Early gathering of student and faculty feedback provided faculty with information on the progress and impact of the changes. This gave faculty a sense of ownership of the changes and motivation to continue. Strong management support and carefully considered enhancements gave faculty the confidence that the framework was not transient but was the foundation on which other meaning educational developments can be incorporated. This allowed faculty to see that educational developments are on-going and require constant monitoring and experimentation to ensure its success, continuity and relevance. Finally, strong faculty competence development programmes and learning opportunities aimed at providing lecturers with the necessary skills to design curricula and teach effectively need to be considered. Continuous sharing of good practices among faculty and with faculty from other institutions reinforced the purpose and importance of the innovative curriculum changes.

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We_CI_2_3

Relationship Between Student Capstone Design Project and the Entrepreneurial Mindset

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Abstract : *For many engineering curricula, student teams are formed to complete a capstone design project. Besides technical knowledge, capstone projects can foster team building skills, leadership skills, problem-solving skills, opportunity recognition, project planning and budgeting, innovation, tolerance for uncertainty/ambiguity, and risk management among other attributes of the entrepreneurial mindset. A study was previously performed to gauge student awareness/extent of these attributes during their capstone project. This paper provides an expanded analysis of student perceptions of the entrepreneurial activity and the recognition of the entrepreneurial mindset associated with capstone design projects. In other words, this study seeks to determine if students associate their capstone design learning experience with the entrepreneurial mindset. The current study involves surveys of students from capstone projects from an expanded group of institutions in the Kern Entrepreneurial Education Network (KEEN). Because colleges of engineering within KEEN have a particular focus on instilling the entrepreneurial mindset, their students serve as a resource that enable us to identify any possible relationship between senior design projects and the recognition of the entrepreneurial mindset. Analyses of the survey results are presented, and a statistical analysis was performed to validate the research findings compared with previous results. Of particular note is the students' recognition of terminology and actual behavior.*

We_CI_2_4

An example of an integrated project in an engineering PBL curriculum : Shower water recycling

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Abstract : *Faculty of Engineering, Burapha University, Thailand, is offering a new bachelor program in Civil and Infrastructure Engineering, Embedded System Engineering, and Environmental Engineering. We employ Problem/Project based learning (PBL) in the program aiming to enhance the 21st century skills of students. The major portion of the learning is conducted through the integrated semester projects starting from the 1st semester. Students from the three majors work in team, utilize their expertise, interests and contents in contributing to the success of the project. This paper describes an example of a suitable integrated project for these three majors – "The shower water recycling system". The key question of the project is "Would you shower with other people's shower water?" as a starting point of investigation. Students construct their knowledge throughout the project investigation where the final outcome was a operating prototype. Students have perceived that the project enhanced their critical thinking, application of knowledge, project management, social skill and team work.*

Keywords : *Problem/project based learning, 21st century skills, shower water recycling*

INTRODUCTION

The newly founded Burapha Engineering English Program (B.Eng.) consists of three majors –Civil/Infrastructure, Embedded System and Environmental Engineering and applies a Problem/Project Based Learning (PBL) model conducted in English. Students divide their time between lectures and project work right from the 1st semester. Working in groups of 4-5 students from the various majors, students learn to form their project questions and apply the knowledge gained from various subjects to produce a report and/or a prototype for assessment. It is anticipated that through the PBL model, students will gain the skills needed in the 21st century, including collaboration, discussion, critical thinking, creativity and team work. The PBL model will also enhance student's English language development which is another focal point of this program. Both 21st century and English language skills require heightened attention in Thailand, where students have been shown to lack behind in these respects.

OBJECTIVES

To equip students with the necessary skills for that process, the selection of the first project topic is crucial. It needs to layout the fundamental understanding of the PBL processes, and stimulates the students' learning in a motivating environment. Further, the project must be beneficial to students from all disciplines since each group has students with mixed majors collaborating on a project.

THE PROJECT METHODS

Before the start of the semester the PBL was conceived by members of the faculty of engineering. Faculty members from all three majors were invited to a workshop in which a shower water recycling project was conceptualized. Students are to develop a new concept of recycling shower water for reuse in order to save water. The goal of the project is to build a fully functioning shower water recycling unit whereby they are also introduced to actual engineering work. Within this scope, 5 groups of 4 students from mixed majors explored different project questions, thus, they are allowed to share information but still maintain competition among the groups.

Project tools such as stakeholder mapping, stakeholder analysis, and formulation of project questions and hypotheses, mind map, milestone, and action plan are given along the project span of 4 months. A multi-model approaches on ideation such as Jigsaw, Lego-based brainstorming as well as coaching, peer reflection of student's progress, and guidance were given. A project proposal was presented by the groups in the middle of the semester to ensure students have a concept ready to conduct in the second phases. Evaluation of the project is based on the running prototype, oral presentation, open-discussion and Q&A session. Surveys were conducted to get students' feedback over the course of the PBL semester.

RESULTS

The shower water recycling projects delivers an integrated and comprehensive learning experience for students in these three majors. It involved learning the basic water treatment for environmental engineering students. To control the quality of water and optimal low energy consumption, a light-adsorption sensor and water level sensors were developed by Embedded System Engineering students, whereas Civil Engineering designed and constructed the concept so that the system could be ready in place in a short time. Based on student's feedback and lecturers' observation, it was found that student's development in term of 21st century skills have significantly improved. A survey has been conducted and a student says the PBL project allow students to

- Think critically : the project begins from questioning, followed by planning solutions, analyze of data and find out solution.
- Collaborate in team : because doing project needs each individual input and a ranges of expertise, that students need to work in team to be success.
- Do practical work. By working on a project, students learn to apply the knowledge learned in the classroom practically. They learn how to fix the problem. And lastly,
- Experience how to work with different kinds of people with the leadership and supporting skills. Students learn how to allocate the tasks and time to reach the goal.

Last but not least, a good PBL project should be enjoyable and bring out all the student's capacity, where students apply 3D drawings, manage bills of quantity (BOQs), construct and operate the prototypes. They learn to create technical reports and present to the faculty. It was also a challenge for them to take a shower with their classmate's treated water.

CONCLUSION

It is important to find the right project for students in the PBL curriculum. PBL projects for engineering students must be challenging and realistic. Students should explore and construct their own knowledge within the relevant field. In this paper, a shower water recycling project is introduced. The project showed to well perceived by students and successfully enhance skills of engineering students in application of knowledge where 21th century skills and English language are crucial.

We_CI_2_6

Problems of creating a system of professional accreditation in the Republic of Kazakhstan on the example of engineering education programs

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Since 2011 in Kazakhstan the system of accreditation is transferred to public sector. That is the state certification is gradually replaced public accreditation. Since 2017 the state certification will be completely replaced with accreditation. However, those formal requirements which have been put in a basis of the Order of the Minister of Education and Science of the Republic of Kazakhstan don't allow to create adequate system of accreditation in engineering education which considerably slows down development of this institute. A problem of accreditation system of Kazakhstan according to authors even not that it is formal, and that basic criterion of entry into the national register don't proceed from understanding of quality of education. There is no criterion which spoke well for a quality assurance. In this article authors try to open an essence of accreditation and understanding of this process from government bodies on the example of engineering education.

We_AE_3_1

IS THE CONVENTIONAL WISDOM ABOUT MOOCS CORRECT? LESSONS LEARNED FROM TEACHING A MOOC ON THE MATHEMATICAL FOUNDATIONS OF ROBOTICS

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Abstract : *Conventional wisdom suggests that massively open online courses (MOOCs) are most appealing when organized into easy-to-digest compartmentalized modules, accompanied by exercises that provide instant feedback, and that make effective use of multimedia instructional material. Subjective feedback and anecdotal evidence obtained from teaching a MOOC on the mathematical foundations of robotics seem to suggest otherwise : a considerable proportion of students appreciate, and in many cases prefer, the old-fashioned pedagogical approach of uninterrupted lectures on blackboard, limited use of multimedia, and an emphasis on following the logical flow of the content.*

INTRODUCTION

By and large, the majority of massively open online courses (MOOC) available on sites such as EdX and Coursera share the underlying objective of making university-level courses available to the general public. One underlying consequence has been that, in an attempt to attract as wide an audience as possible, the course content is quite often watered-down from what is normally offered to the instructor's university students. In some cases this watering down is intentional, while in other cases it is an unintended consequence of the inherent structure of MOOCs. Conventional advice in preparing such a MOOC often recommends that lectures be partitioned into shorter, easier-to-digest sequences, and that the accompanying contents--exercises, homework assignments, supplemental materials--be modularized accordingly.

This paper reports on the opposite experience, in which a subject that commands broad popular interest and appeal--robotics--is offered as a MOOC, but unlike other existing MOOCs on robotics that emphasize the technological breadth of the field and the latest trends, is focused on the analytical and theoretical foundations of robotics. The content is made considerably more mathematical, and largely inaccessible to those without at least a sophomore-level mathematics and physics background. Conventional advice to modularize the lessons into compact segments is ignored; standard 90-minute university-style lectures are instead given, together with challenging homework assignments identical to those given in the original non-MOOC version of the course. The results of the course, offered through EdX, provides a partial answer to the question of whether such courses can have broad appeal as a MOOC, and whether the conventional wisdom on how to organize and structure a science or engineering MOOC course is universally valid.

OBJECTIVES

To assess whether a science or engineering MOOC course on a topic of broad popular appeal, but emphasizing mathematical and theoretical foundations instead of technological breadth, and structured into

90-minute university-style lectures accompanied by assignments with a relatively high degree of difficulty, have a global audience; we wish to measure both the extent and enthusiasm of the audience as well as the overall mastery and retention of the course material.

METHODS

The methods employed for the purposes of this paper are decidedly unscientific; we only offer subjective, at times anecdotal evidence of our findings and conclusions, based mostly on the written and quantitative feedback obtained as part of the post-course evaluations submitted by the course participants.

RESULTS

Contrary to expectations, initial enrollment for the course exceeded 11,000 students. This is not a large number when compared to other similar courses in science and engineering, but given that the course description begins by stating that "This course is not an introductory, "get-a-taste-of-X" course whose primary objective is to entice you to consider science or engineering as a major or career. You won't be seeing any videos of the latest trends and technologies in robotics. There are other courses that serve this function much better. Rather, this course is about learning the analytical and computational tools that will enable you to analyze, program, and design such robots...," the numbers considerably exceeded our expectations. The level of preparation of the students varied widely, from those with only high school level training in mathematics and physics to professionals and practitioners interested in continuing education. The percentage of students completing and earning the EdX course completion certificate was close to the statistical average (approximately 10%).

The subjective feedback also offered a number of surprises. A large number of respondents stated that although they found the long lectures---the usual lectures given at the university were simply videotaped for the course---challenging at first, after a few lectures they actually preferred this format; many mentioned that they felt they were physically present in the classroom and appreciated this virtual immersive experience. Exclusive use of the blackboard (no powerpoint slides were used for any part of the lectures), and the continuous uninterrupted flow of the lectures, together with a review of the contents of the past lecture at the beginning of each lecture, were also features of the course that received highly positive feedback. Perhaps the most surprising feedback was that although many confessed to having a less-than-satisfactory understanding of the subject matter upon completion of the course, several students found the experience of focusing intently throughout the entire duration of the lecture a highly rewarding one. Other subjective feedback and quantitative indicators provided surprising feedback that went against the conventional wisdom about MOOC courses.

CONCLUSION

Our experience with the course, although based mostly on subjective feedback and anecdotal evidence, seems to suggest that, contrary to the general perception that a successful MOOC course must be compartmentalized into small, self-contained modules, with regular feedback and assessment provided in the form of quickly answered questions and exercises, there is a sizable audience that appreciates the old-fashioned pedagogy of uninterrupted lectures, without using media aids, even for technology-oriented courses like robotics.

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We_AE_3_2

Technology & engineering education fortified New Revolutionary Science Education in Korea : STEAM Education for K-12

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Abstract : *Korean government officially declared to reform the science education system according to the multidisciplinary convergence concept (so called STEAM education) at end of 2010. And immediately, "Korean Ministry of Education, Science & Technology" has started to develop its contents and to carry out the workshops for teachers to introduce this new science education system from beginning of 2011. The purpose of this revolution of science education system in Korea is to nurture the capable people who can predict the future science, technology & engineering, having good abilities to cope with rapid social system changes with global sense, emotional intelligence & good human character. Especially, this Korea's new science education system strongly emphasize the connectivity of basic science principles to recent technology & engineering, and multidisciplinary convergence among them including arts & liberal arts.*

Keyword : *STEAM, Multidisciplinary convergence, arts and liberal arts*

INTRODUCTION

In beginning 2010, Korea Foundation for the Advancement of Science and Creativity requested to develop the new science education program for creativity and good character to our center. We reported so called STEAM education with its particulars and examples on august of 2010.

Previous Korean science educations mostly focus to the just well understanding of basic science principles on chemistry, physics, biology & earth science. Lack of examples for how to the basic science described in textbook of K-12 could be applied to recent high technology & real life science are no more attracting the student's interesting and curiosities in science. Especially current science textbook had the limitation to give diverse thinking. That is, it is practically impossible to draw creative thinking with current science textbook. Therefore we thought to develop the new revolutionary creative science education system having the connectivity of basic science principles to high technology, engineering, even arts including liberal & fine arts with good human character for creativity maxima.

In 2011, the Korean ministry of education, science & technology (MEST) has started to develop its contents and to carry out the workshops for teachers to introduce this new science education system. And we have developed the examples of diversity fields among science, technology, engineering, arts and mathematics according to the already suggested STEAM education concept through from 2012 to 2013.

OBJECTIVES

The objectives of our designed this science education system is to nurture the capable people who can predict the future science, technology & engineering having good abilities to cope with rapid social system changes with social and global sense, and good human character.

METHOD

The STEAM education contents have developed according to the following basic concept.

1.Systematic interdisciplinary liaison based upon the story-telling among science, technology, engineering, arts and mathematics should be emphasized for creative thinking.

2.It should be the just in time education (or learning).

3.It should be the systematic education to nurture the integrative thinking, the interdisciplinary communication skill, and abilities to see among science, technology, engineering including arts and liberal arts in holistic sight.

4.Education about the diversities of applications of basic science to technology, engineering and arts should be introduced for creative thinking.

5.It should be the education to nurture the global leader who could contribute to the global society through science, technology and engineering.

6.It should be adopted the science education to nurture the abilities to predict the future science, technology and engineering society, and trend for future national growth engine and the exploration of future job.

7.It should be the education to nurture the scientist, technician and engineer having good human nature.

8.For attaining the successful goal of STEAM education, the creative hands-on activities, teaching techniques including exploiting the teaching auxiliary experimental apparatus according to the recent science, technology and engineering trends for effective education.

RESULT

Now most elementary, middle and high schools are starting the STEAM education.

DISCUSSION

The government have pushed and have invested huge amount of funds to develop the contents to teachers. However, most teachers have still suffered from lack of real contents according to the STEAM education concept, and teaching methodology and knowledge about technology and engineering fields. To attain the successful goal, the policy of government should be changed to select and concentration strategy to develop the STEAM education contents effectively.

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We_AE_3_3

EXPERIENTIAL DOCUMENT FRAMEWORK : A NEW PARADIGM FOR CURRICULUM DEVELOPMENT IN ENGINEERING AND SCIENCES

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Abstract : *We have developed an experiential document framework which allows traditional lecture notes and laboratory manuals to be converted into digital live format where students can change parameters on the fly and can communicate with laboratory experiments in an active mode. The teaching modules are available in mobile platform for ease of use and the content development requires minimal programming knowledge.*
Keywords : *Experiential Education, Mobile Platform*

INTRODUCTION

Typically, the curriculum in engineering and related technical disciplines depends on complex content components such as equations, models and simulations, and real-time experimental data acquisition and application. The inherent complexities of developing e-learning content in engineering and physical sciences hindered the timely adoption customized modern digital resource techniques for experiential learning in engineering. Moreover, current text books and laboratory manuals used for live experiments are all "static" and the users (i.e., students) have no active role to play in terms of extracting outcomes based on their choice of parameters derived from their own queries and questions. On the other hand, this generation of students are digitally native and have significant expectations in terms of blending digital modern technologies with the classroom curriculum delivery [1]. Our proposed experiential document framework meets this much needed gap and empowers students with an active learning environment.

OBJECTIVES

The objectives of this present work are two folds : (a) convert the traditional lecture materials (be it in power point or other modes) and laboratory manuals to live documents; (b) creation of interactive content on a mobile platform with capability to operate on both Android and iOS through user friendly interface.

METHODS

We have partnered with Quanser Inc., who have developed the "qdex" platform that allows the seamless delivery of dynamic, rich, content through mobile devices such as tablets and smart phones with a thoroughly native look and feel making derived content more in line with expectations of contemporary students and ultimately making dynamic learning more accessible to students – anywhere, any time. The development architecture for the experiential document framework is presented in Fig. 1.

RESULTS

We have chosen two different courses in the current Mechanical Engineering curriculum taught at the Lassonde School of Engineering. One of the courses is the general foundational course in engineering taken by all first year students, with a typical student population around 300. The other one is a laboratory course on Measurements, offered to second year students with a typical enrollment around 80. We have deployed the "qdex" platform for these two courses, snap shot of the platform is shown in Fig 2.

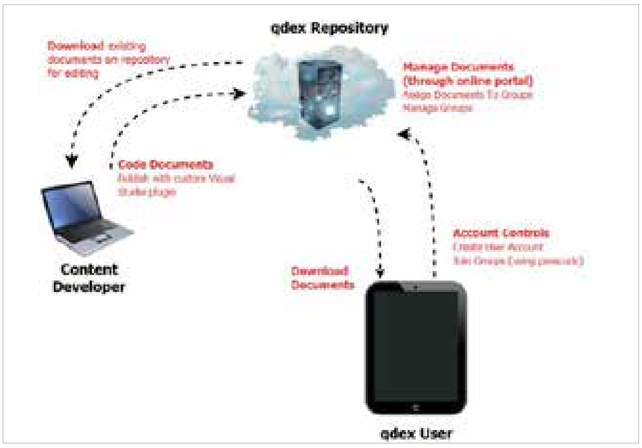

Figure 1 : Development process used for the experiential document framework

Figure 2 : Interactive simulations and enhanced documents in qdex

CONCLUSION

We have successfully developed an experiential document framework which allows converting traditional "static" curriculum material into "live" interactive document. This platform ensures an optimal balance of progressive experiential pedagogy and sound development and deployment processes utilizing state of the art digital content development technology specifically designed to address the shortcomings of conventional eLearning systems for engineering content.

ACKNOWLEDGEMENT

The content development work by K. Shaw, H. Khachikyan, and T. Sigaeva are acknowledged here. Technical support from Peter Martin and Abbey Desjarlais, Quanser Inc. are also acknowledged here. The authors also acknowledged the funding received from York University through the Academic Innovation Fund program.

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We_AE_3_4

A STUDY OF USAGE OF E-LEARNING AMONG STUDENTS IN ENGINEERING COLLEGES

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Abstract : *Information and communication technologies (ICT) have become common place entities in all aspects of life. Over the past twenty years, the use of ICT has fundamentally changed the practices and procedures of nearly all forms of endeavor within business and governance. Technology has found its way into every aspect of our culture today. Within education, Information and communication technologies such as e-learning have begun to have a presence but the impact has not been as extensive as in other fields. Education is a very socially oriented activity and quality education has traditionally been associated with strong teachers having high degrees of personal contact with learners. An attempt has been made in this study to assess the learner's expectations for introducing e-learning methods and implementing ICT in engineering colleges.*

Keywords : *e-learning, Instructional strategy, ICT, Web Based Learning*

INTRODUCTION

The use of ICT in education and e-learning lends itself to more student-centered learning settings and often this creates some tensions for some teachers and students. But with the world moving rapidly into digital media and information, the role of ICT in education is becoming more and more important and this importance will continue to grow and develop in the 21st century (Ron Oliver, 2002). Technological advances are significantly changing and shaping our world. Undergraduate students, who are the focus of this study, perceive technology's persistence in their lives. Engineering and business students use more technology especially for spread sheet and graphics editing and males are more likely to spend extreme amounts of time online. 70% of students said that Information Technology helps them to do research (Judith Borreson, 2007). The way we learn and teach has transformed a lot due to the advancement in educational technology and changing audience profile. The approach towards learning has transformed a lot as a student learns and imbibes knowledge in various easy means in their day to day life when compared to the class room education. Web based Training and it's newer and more general synonymous term e-learning are two of todays buzz words in the Academic and Business worlds. Decision makers associate with them new ways of learning that are most cost efficient than traditional learning strategies and which allow students to better control the process of learning because they can decide when, where and how fast to learn. There is a very little research done in this area to find out the usefulness of e-learning process and implementation of the innovative teaching methods using ICT. An attempt has been made in this study to find out the existing gaps in the field of research especially among engineering college students.

OBJECTIVES

The primary objectives of this study are listed as given below :

- To find out the need for e learning in engineering and polytechnic college students
- To study the effectiveness of e-learning process compared to traditional class-room teaching.
- To manage and study the effect of the online resources to engineering college students for learning

METHODS

Seven hundred engineering college students and seven hundred polytechnic college students in Tamilnadu, India were selected. Gender, age, level of schooling and type of schooling are the independent variables. The knowledge and skill of the student towards the usage of ICT and e-learning are the dependent variables. The study was conducted through descriptive survey research method. Ex-post-facto research design was used to carry out the present study. Rating Scale was used to collect the data from the students. The rating scale is used to identify the level of awareness of the students towards the usage of ICT and e-learning . The rating scale was divided into Part A, Part B and Part C. Items in Part A is used to identify the demography of the students. It is of concern on student's gender, age, type of disability, level of schooling, type of schooling and the monthly income of the parents. An item in Part B is used to find the extent of the usage of e-learning and ICT Tools. Part C is used to find the skill of the students. The respondents gave the answer of research questions by responding to all the questionnaire items in term of weight of scale.

RESULTS

The collected data was analyzed by descriptive statistical approach in order to get the answer to the research questions. The data that collected from Part B and Part C rating scale are presented in the form of mean score and standard deviation. The research finding shows that students acceptance towards e-learning and ICT usage in learning process is at a moderate level. The student's level can be improved by providing laptop and other ICT devices to the students in their respective Colleges. The detailed analyses have been discussed and remedial suggestions were listed in this study.

CONCLUSION

The findings revealed that more students were in favor of the e-learning procedure and web based learning environment as compared to conventional methods and other learning preferences on the respective scales. Only few students are coming forward to use the e-learning techniques and ICT devices. The awareness level of the female students should be improved. The conclusions of this study are that e-learning teaching methods are not different with traditional teaching methods with respect to their learning achievement especially for the fresher in the college. Also, e-learning teaching strategy is superior to traditional teaching methods with respect to learning motivation of the students.

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We_AE_3_5

OUT-OF-SCHOOL STEM EDUCATION AND PROJECT-BASED LEARNING WITH EMPHASIS IN ELECTRICAL ENGINEERING AND COMPUTER SCIENCE FOR PERUVIAN HIGH SCHOOL STUDENTS

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Abstract : *Peruvian high school students perform poorly in reading, math, and science. The objective of this work is to contribute to improve STEM education in out-of- school settings according to students' interest and necessities. After many years of research and practice, we have developed a high school curriculum, kits, and software for teaching and learning the foundations of electrical engineering and computer science. Among these, a computer program for learning digital design is used freely in many schools and universities around the world.*

Keywords : *high school engineering education, project-based learning*

INTRODUCTION

The Peruvian education system is ranked in the last positions world-wide [1]. The country's ability to innovate is low and its weak competitiveness relies mainly on its current macroeconomic situation [2]. As we have taught in many Peruvian universities and high schools, both public and private, ranging from very low-performance to high-performance ones, we have found many failures in the Peruvian education system. We have reviewed and analyzed standards and policies from top-performers countries in education, and literature about curriculum design, instructional methods, inquiry-based learning, and project-based learning. Although most Peruvians dislike cooperation, we think Peru's well-being can be reached by working in teams and we currently are seizing on-line resources from top-ranked universities and world-class companies.

OBJECTIVES

The purpose of this project is to provide a high school curriculum, materials, and tools for teaching and learning the foundations of electronic design and computer programming. The aim is to engage more Peruvian students in science, technology, engineering, and math education from early years in high school.

METHODS

We tried different approaches every time we had opportunities for developing extracurricular workshops in schools. Many times students worked in real-world projects by applying engineering design and scientific inquiry through project-based learning and inquiry-based learning. We used and also developed software tools to help students in their understanding and design tasks.

RESULTS

Based on our teaching and learning experience, we have developed a comprehensive curriculum for teaching science, technology, engineering, and math with emphasis in electrical engineering and computer science. This curriculum promotes intensive, creative, and critical thinking by applying both inquiry-based learning and project-based learning in out-of-school settings. Students will learn how to use programming and design tools, and how to analyze and design a variety of logic circuits, amplifiers, electronic interfaces, sensors, computing algorithms and programs. They will learn how to apply scientific research, engineering design, project management standards, real-time systems design methodology, and entrepreneurship to solve important local problems. The topics include control systems, telecommunications, digital signal processing, machine learning, and artificial intelligence with their connections to math, physics, chemistry, and biology. All topics build over historical, social, environmental, and economical contexts. To support teaching, we have developed interactive multi-views, easy-to-use programs to teach and learn math, electronics, physics, computer programming, and automation systems. For instance, a program serves to teach math and physics by using both interactive tutorials and microcontrollers to capture real-world data and find patterns and mathematical models; other program is useful to design and simulate digital circuits using schematic diagrams, flowcharts, standard TTL integrated circuits, FPGAs, environments and instruments. Another tool helps students in translating Spanish descriptions of simple circuits and instructions in VHDL for a FPGA hardware implementation or C code for a microcontroller; and another program can be used to analyze and design single-input, single-output control systems by specifying the Laplace transform of linear time-invariant continuous-time functions.

CONCLUSION

We can support Peruvian education in out-of-school activities by developing custom tools and specialized curriculums, tailored to individual and collective needs. Currently, we are looking for opportunities to work in long-term projects to test these approaches. Meanwhile, we are updating our website to share our findings, tools and reports with the community.

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We_AE_3_6

AN EXPLORATORY STUDY OF INFUSING 3D PRINTING IN MECHANISM DESIGN LEARNING

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Abstract : *The purpose of this exploratory study was to develop a mechanism design instruction model which infuse the 3D printing technique within students' engineering design project. An action research was conducted with 36 participants in Taiwan' high school. Base on the results, this preliminary study supported the positive effective on infusing new digital manufacturing technique high school technology class.*

Keywords : *3D printing, High school technology education, Engineering design, Mechanism*

OBJECTIVES

Recently, the 3D printing technique was quickly developed, more and more teachers able to infuse the 3D printing technique into their curriculum [1]. This study sought to infuse the 3D printing tools into a mechanism design instruction model, thus to improve the "modeling precision" and "design problem-solving" within high school students' engineering design project.

DEVEPLOMENT OF INSTRUCTIONAL MODEL

The basis of this instruction model was derived from engineering design-based learning approach that intentionally integrates conceptual knowledge of science and mathematics with the content and the processes of mechanism design. A dimensional plane mechanism toy design project was designed to help students understanding the application of mechanism parts. The research team developed three instruction units to help students construct the prior knowledge; as well as introduce the application of 3D printing technique. The framework of overall instruction modules was showed in Figure 1. Each instruction unit integrated one or two mechanism concepts and related STEM knowledge. When teaching these units, the teacher first used virtual computer simulation models as well as hands-on models to explain the application of mechanism. Furthermore, inquiry experiments and design thinking challenge questions were used to help students solving engineering problems.

METHODS

A total of 36 high school students aged between 16 and 17 years old participated in the study. The three instruction units were implemented during the first 6 weeks, the students were then asked to complete a mechanism toy project during the remaining 8 weeks. Wood was the main material of the toy, and the students were encouraged to apply 3D printing to design and making mechanism parts for their products. The instruments included formative (the design portfolio) and summative (the mechanism toy and oral presentation) assessment. All instruments were assessed by two participating teachers using the five-point rubrics designed by research team. The rubric of formative assessment included : (1) Design idea and mechanism analysis, and (2) problem-solving processes; while the summative assessment rubric included : (1) mechanism function and design complexity, and (2) modeling precision and 3D printing application.

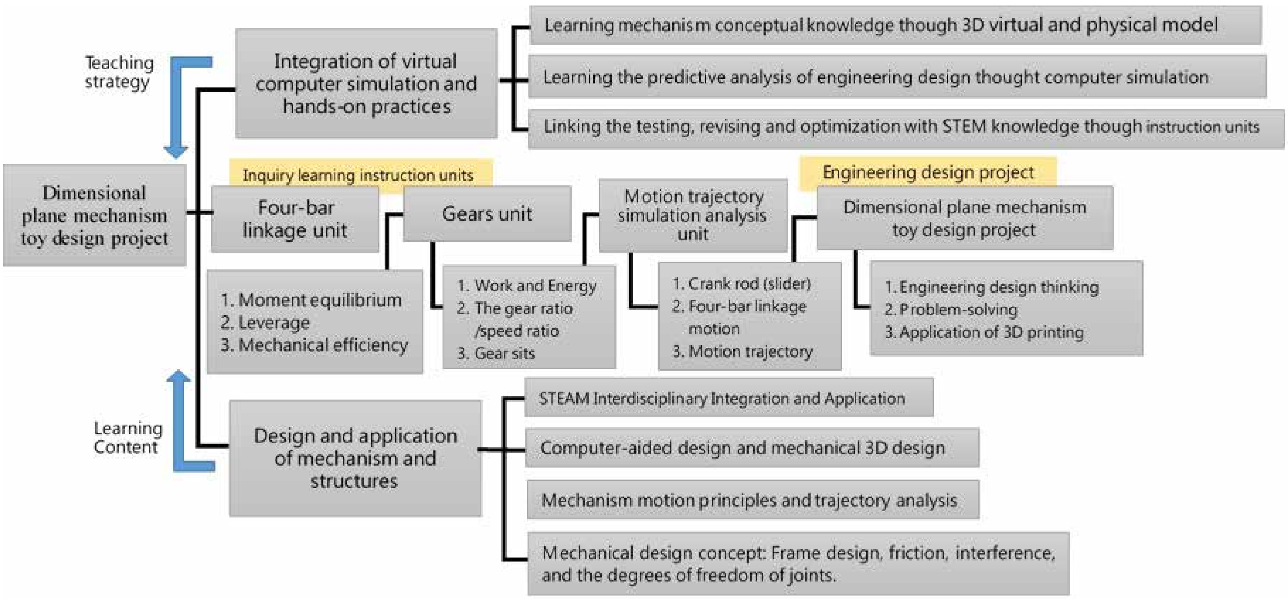

Figure 1. The framework of instruction modules

RESULTS

Based on the analysis results, the average score of design project was 4.25 and the scores of each categories were shown as Table 2. We found that most students could create good ideas about their mechanical toy, and presented well modeling precision and 3D printing application. However, the performance of "mechanism function and design complexity" was lower than other scores. From the students' oral presentation, the researchers noticed most students spent a lot of time on revising the size and position of mechanism part, thus unable to complete more complex design.

Table 2. The results of students' mechanism toy and design portfolio

Instruments	Subcategory	Mean	SD	Skewness	Kurtosis
Formative assessment (Design portfolio)	Design idea and mechanism analysis	4.42	0.84	-0.94	-0.90
	Problem-solving processes	4.22	0.90	-0.47	-1.63
Summative assessment (Mechanism toy & oral presentation)	Mechanism function and design complexity	4.08	0.73	-0.13	-1.06
	Modeling precision and 3D printing application	4.28	0.85	-1.18	1.07
Average score		4.25	0.75	-0.71	-0.85

CONCLUSION

Base on the findings, this study supported the positive effect of infusing 3D printing as a support tool to help students in practice engineering design project, thus to improve the modeling precision of their final product. However, some further research about their design thinking, especially the predictive analysis ability of 3D modeling, will be needed in the future.

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P_EP_01

ENGINEERING EDUCATION PROGRAM ACCOMPANIED WITH SCIENTIFIC PRESENTATIONS BY STUDENTS FROM FRESHMEN TO JUNIOR IN INTERNATIONAL MEETINGS ON FOREFRONT TECHNOLOGIES

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ABSTRACT

The students before starting their graduation studies have been participating in the collaborative forefront R&D projects which have been conducted by the private companies and the university. Such practical activities conducted in the industries intrinsically contain the educational elements for the university students. And the students are able to obtain the proper skills, abilities, attitudes, and knowledge of engineering techniques on the processes. This education program was taken over as one of the research themes in the novel educational reform activity called "Smart Dormitory" project. There, the students from the freshmen to junior can make their teams together and study the forefront scientific researches about the topics they freely choose. In the process of researches, the students have been assigned the scientific presentations about the results of their on-going investigations in the international meetings, which have been held in the domestic areas or even overseas. The authors report the results of the environmental purification project driven for years by the undergraduate students in Department of Electrical and Electronic Engineering. The students are well motivated to the presentations when they were given the opportunities in their early stage of university life. This engineering education activity is characterized as one of the leadership programs for the scientific engineering leaders in the internationalized practical industries.

Keywords : *Forefront Technology, International Meeting, Engineering Education, Presentation, Research, leadership*

P_EP_02

RULES OF ENGAGEMENT: SMALL SET OF GUIDELINES TO DEVELOP A SUCCESSFUL ENGINEERING LABORATORY COURSE AND INCREASE INTEREST OF UNDERGRADUATE STUDENTS

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ABSTRACT

One of the many situations encountered by professors teaching courses revolves around the resistance of students to engaging in any type of interaction while in a class. Current engineering courses follow strict curricula that were specified many years ago by a department's committee, but the teaching style of every professor is different. Much of the apathy of the students to participate is due to the indifference of the students towards the topic being covered. This has to be addressed by the professor early in the semester in order to assist the students in developing an interest in the course. The main objective of this presentation is to propose a set of guidelines that have been tested in a small scale throughout several semesters in the past three years as part of a Solid Mechanics and Materials Laboratory course in the Department of Mechanical Engineering. These strategies have shown a growing impact in achieving better performance on behalf of the students regarding material retention and a much better flow of the laboratory sections after the theory has been learned. The use of pre-laboratory assignments as homework to be turned in the day of the laboratory session enables the students to look into the material covered during lecture before the professor explains the theory. This has improved the level of engagement from the students since they have read engineering applications before linking the theory. The second step in this approach is delivering the lecture and discussing the applications of what the students found regarding the pre-laboratory assignments as part of their discovery phase. After lecture, the students conduct the experiments specified by the professor with guidance from the teacher's assistants. The changes suggested expose undergraduate engineering students to situations where they need to work out the details of how to present information as part of their weekly reports after the laboratory sessions. This idea tries to address the concept of "a person can do the science, but: can this person talk about the science and provide a good report that explains it?" The last step before submitting a report deals with post-laboratory assistance. This is crucial since the students bring up questions or issues from analyzing the data obtained from the experiments and there might be a need to bridge a small gap of knowledge from the theory. These guidelines focus on providing the students with a modified version of a "real-world" experience before graduation, while developing skills that will help them further their careers.

Keywords : *engineering, practices, motivation, performance, quality, classroom, laboratories*

P_EP_03

On Judicial Support for Engineering Activities: A New Managerial Project

S. Barabanova, V. Ivanov, M. Suntsova

According to the Federal Law "On Education in the Russian Federation", one of the principles of national education policy is the humanistic nature of education, as well as the primacy of human life and health, responsibility, legal culture, rational nature management, environmental friendliness, etc.

Because of the step-up of technology-induced issues and the increase in the amounts of incidents and disasters caused by human factors, particularly in engineering activities, it seems to be advisable to develop new approaches to arranging the activities of non-science departments at higher engineering educational institutions.

Within the Research University, the following steps are proposed to solve the problems of educating modern engineers also having the necessary background in the legal fundamentals of their future vocational activities:

- Establishing a new Department of Judicial Support for Engineering, or transforming the existing Department of Legal Studies into an interdisciplinary department involving lecturers and instructors with years of experience in higher engineering educational institutions or companies that monitor or supervise the safe working practices in industries, or perform other oversight functions over the activities of economic entities;
- Developing an interdisciplinary master degree program at the intersection of engineering sciences and jurisprudence to educate engineers with good command of legal regulations applicable to engineering, which ensure technosphere and industrial safety, compliance with workplace safety rules, the industrial implementation of innovations, intellectual property protection, compliance, etc.;
- Involving the department members in working with customers on contractual basis on the development of regulatory documents for industrial enterprises;
- Integrating the department members into project teams,
- Organizing further training courses for the management and personnel of industrial enterprises and corporations regarding administrative, employment and economic legislation;

- Extending jurisprudence-based modules and topical units within the bachelor/master degree programs, with the consideration of the students' specializations;
- Holding academic conferences regarding the matters of judicial support for engineering, and attending engineering education conferences;
- Preparing by engineering students their interdisciplinary final theses or projects on requests from enterprises, involving the department members.

We can study some interesting results obtained in a variety of higher educational institutions and scientific centers. For instance, subsurface use or mining relations are very specific and have many special aspects, making up a broad range: These are subsurface resource studies, prospecting, mineral resource survey, granting the use of plots, extraction and processing of mineral resources, and protection of subsoil resources and continental shelves within a country. Understandably, the matters of the legal regulation of such relations cannot be studied in isolation from understanding the features and characteristics of technical processes and procedures. And conversely, engineering students cannot be trained in exploration, production and processing of mineral resources without studying the related regulations, standards, and other legal instructions. This is why the Gubkin Russian State University of Oil and Gas established the Department for Mineral Law in 1998 and the Institute of Mining and Energy Law in 2014.

Another graphic example is opening a training program for lawyers at the National Research Nuclear University MEPhI (Moscow Engineering Physics Institute). Legal regulation of atomic energy use, i.e. nuclear law, is studied and developed at this university within the framework of the close cooperation of students, teachers, and scientists from various areas, such as engineering and physics, technics, management, and law.

We would also like to draw a special attention to the practice of teaching the jurisprudence basics in the English language to students majoring in the Process Chemistry of Natural Energy Carriers and Carbon Materials at Kazan National Research Technological University. In fact, students get into another educational reality "loaded" with doubled, or even tripled amounts of information, i.e. information set by standards, Anglo-Saxon legal system details, and the special aspects of legal regulation of the relevant professional area in the developed countries.

It is obvious that, in all the above cases, we cannot mechanically sum up information and professionals; we need some new interdisciplinary approaches to complex phenomena. However, the methods of pedagogical process just become enriched with interdisciplinary approaches and with the contributions of other sciences to its development.

P_EP_04

PROBLEMATIC PEDAGOGY AS A TOOL FOR THE ENVIRONMENTAL EDUCATION FOR ENGINEERING

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ABSTRACT

Address the needs facing engineering education in the XXI century is essential to make part of it all that it entails to environmental education as one of the challenges is scheduled in "Agenda 21" (Rio de Janeiro 1992). The main role of the engineer is to meet the community service and the environment so it is necessary to link engineering education to the environmental education objectives: Awareness, Knowledge, Attitudes, Skills and Participation. One of the dynamic teaching methods to the development for new "green" ideas in engineering students is the "problematic pedagogy", in that a lot of the community issues are presented for the students who proposes possible solutions and argues with their acquired knowledge; this not only foster in them an environmental culture but also the ability to argue and investigate. For the development of this chair are available 6 themed as central themes: water, air, soil, energy, weather and the community. In the first sessions will be presented to the student several problematics related to the topics, so students investigate possible solutions given through engineering without forgetting the purposes of environmental education.

Keywords : *Environmental Education, Problematic Pedagogy, Engineering Education.*

P_EP_05

GO GREEN: TEACHING SUSTAINABILITY THROUGH INTENSIVE INTERNATIONAL EXPERIENCES

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ABSTRACT

GO GREEN stands for Green Organizations: Global Responsibility for Environmental and Economic Necessity, and is an intensive, experiential course that teaches engineering and other students important concepts related to sustainability through international experiences. Offered by IUPUI, the GO GREEN course has for more than 10 years provided a framework for students to learn about the triple bottom line of people, planet, and profitability, and does so by providing information relevant to a variety of engineering disciplines, student backgrounds, and levels of preparedness.

The principal features of the GO GREEN course include pre-departure readings and orientation; an intensive, immersive week of site visits to various industries, organizations, and communities in Germany; and post-trip reflections and assignments. High impact educational practices, such as study abroad, undergraduate research, and service learning, are all incorporated in the course. This poster presents an overview of GO GREEN, outlines the course objectives, explains the nature of learning activities, and summarizes evaluation data from course participants. Implications for teaching, learning, and assessment are included, as are suggestions for adaptation or replication of GO GREEN in other contexts.

Keywords : *Internationalization, Education, Curriculum, Sustainability.*

P_EP_06

STRATEGIES FOR SUCCESSFUL IMPLEMENTATION OF APPROPRIATE TECHNOLOGY IN CAMBODIA: A DAVINCHI ENGINEERING CAPSTONE DESIGN PROJECT EXPERIENCE

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ABSTRACT

Capstone engineering design project transferring appropriate technology in a foreign country is difficult to implement because of language barrier, cultural misunderstanding, and underestimation of the complexity of problems in the communities. A local-user-centered system is the most important factor for successful adoption of appropriate technology. However, because of the local uniqueness, different implementation strategies are needed for each community in need. The purpose of the study is to delineate the strategies we used for successful implementation of appropriate technology in suburban Cambodian community. The DAVINCHI(Dongguk, Academy, Value, Identity, Neutrality, Creativity, Internationality, Program) capstone design project was proceeded during spring semester of 2016 as a program provide by Innovation Center for Engineering Education at Dongguk University. Two weeks of fieldwork was conducted in a suburban community near Phnom Penh, Cambodia in August 2016. Seven students with different engineering majors working in a team designed a solution to meet the needs of the locals and executed the field engineering. Majors included material engineering, chemical engineering, computer engineering, electric engineering, information communication engineering. The team analyzed their fieldwork activities and identified factors related to adoption of the provided appropriate technology. The design was developed to provide water safety using a solar powered UV water purifier system applicable to water pipes since many locals in the community suffer from chronic diarrhea and dysentery. During field work, we found that our prepared design could not provide significant water safety since pipe water was not the source of infection. Most locals used ice box to store food materials and the icebox was the main contaminant. By communicating extensively with engineers and students in Phnom Penh University and the community members, we modified our design to develop built-in solar powered UV sterilizer system for iceboxes. The implementation of the technology was successful and the users were eager to adopt the technology themselves, since the technology was sensible, feasible even for non-engineers, and can be done at low cost. Our capstone engineering project experience in Cambodia shows that building a strong multifaceted team including designers of different engineering majors, engineers and students from the partner communities, and community members can result in successful implementation of the appropriate technology.

Key words: Appropriate technology, Capstone design, Implementation, Cambodia, Multifaceted team, Communication

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P_AE_01

ADDITIVE MANUFACTURING IN THE FABRICATION OF INSERTS FOR INJECTION MOLDING OF PLASTIC CLIPS

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ABSTRACT

The use of Additive Manufacturing (AM) to produce inserts for injection molding of plastic clips has been studied and it is reported here. This particular application has the potential to drastically reduce the costs and times for both, short run prototyping and rapid quoting. Currently, prototype injection molding can take thousands of dollars and several weeks to develop and manufacture, therefore the use of AM is a viable option and initial results are provided in this report. The use of AM (3DP) as well as other molding techniques (e.g., silicon based) for mold creation has been reported in the literature, with the goals being for either one-shot situation – in the case of 3D prints, or unique parts – usually for other molding approach. Models of mold inserts for the injection molding of test parts with geometric features corresponding to plastic clips were designed and analyzed utilizing CAE tools. Calculations for cooling and mold compression was performed in order to properly design the mold inserts, and to expect as much quality duration from them as possible. The computer models of the inserts were used to fabricate 3DP parts, with the fabrication process done in a high-end polyjet printer. The printed inserts were mounted in the steel molds in a commercial injection molding machine, the setup of the machine was performed first, and then testing of the inserts was done.

Measurements were taken on the molded parts in order to validate calculations, and to check on important feature dimensions on the final product. Each pair of inserts was tested until failure, or when it was considered that the resulting injection molded part did not have the required tolerances for acceptable quality. The 3D printed mold inserts were fabricated with the available type of material with high thermal properties – some pairs of inserts were fabricated without cooling channels. Two different plastic (i.e., nylon and polypropylene) were utilized for the actual injection molding process. Acceptable parts were obtained during testing of the various mold insert pairs. The testing performed did result in quality parts for the two materials being injected. Of interest was the effect of the cooling channels, based on number of quality parts obtained from tests, which do not help in the process, but further analysis and testing is needed. Additionally, the testing did show the importance of properly setting up the injection molding machine, adjusting for the use of 3D printed inserts.

Results indicate that 3D printed insert molds for short runs and rapid quoting are feasible. However, more design and testing needs to be performed in order to generate some guidelines that provide proper information to the practicing engineers. The recommended work should be in three areas: 3D printing (material), engineering (strength and thermal analysis), and process (setup parameters). This feasibility study was the initial step towards the establishment of those needed guidelines.

Keywords : *Additive manufacturing, injection molding, short runs.*

P_AE_02

An Analysis of Elementary and Secondary School Administrators' Perceptions of Engineering Education for K-12

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ABSTRACT

Administrators' understanding and support played a key role in engineering education. Therefore, this study was developed to investigate 365 elementary and secondary school administrators' perceptions of engineering education. This study were examined current perception of engineering education, implementation of curriculum, perceived needs in engineering education. As a result, the findings of this study showed that most school administrators perceived the importance of engineering education and the needs with an average repose of agree to strongly agree. School administrators stated that students can experience creative design process and problem solving process through engineering education. Unfortunately, most school administrators thought that the current curriculums are not interested to students for engineering field. They perceived that including engineering in the curriculum will show positive effects on elementary and secondary education and students' engineering career choices. They also perceived educating engineering in K-12 class is feasible. Most school administrators perceived that the best school year in beginning engineering education is elementary 4 ~ 6 grade and the best way to reinforce it in K-12 is to include it at various related subjects. They perceived that the technology subject is the best to include engineering education. Most school administrators propose that teachers' professional developments and education materials for engineering education are strongly required. Lastly, they also emphasize that the significance of design equipment and various field trip programs for supporting engineering education in K-12. We expect that this work will be a fundamental basis of engineering education research in K-12.

Keywords : *School Administrators, Perception, Engineering Education, K-12*

P_AE_03

Research of Developing hands-on course with 6E model in Makerspace

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ABSTRACT

Learning by doing and maker have been discussed and concerned by lots of research in recent years. Lots of schools have begun to build many kinds of the environment of makerspace, and related teaching activities have been developed. This study focused on the course of Living Technology in senior high school and adopted STEM(science, technology, engineering, and mathematics) instructional design by using 6E(engage, explore, explain, engineer, enrich, and evaluate) model in the environment of makerspace. The students were required to create toys with Taiwanese features during the course and participated in the Maker Faire Bay Area 2016 where students requested to explain their ideas, production methods, application of technology and market their products. After the activity, the STEM Learning Attitude Scale (a 5-point Likert scale included 3 dimensions: Interest, Perceived Competence, and Value) was used to measure the participants' learning reaction.

Sixteen senior high school students participated in this research, and they have already taken the training of STEM courses. The experimental process lasted 18 weeks with 4 lessons a week, and the teaching contents include STEM knowledge, 3D printing, carpentry, creative thinking, packaging and marketing courses. Each group included 4-5 participants and was required to complete weekly tasks. In 6E model, the teacher mainly play the role of guidance. The students need to realize the toys with Taiwanese features and search for their knowledge. The group members would be discussing, deciding the theme, and proposing to the teacher. Afterwards, the product design would be conducted, and the teacher would discuss and revise the problem; finally, the work would be verified and then published.

The results showed that (a) all students finished their products and presented in the Maker Faire Bay Area 2016; (b) the average score of STEM Learning Attitude Scale is 3.76 (Interest:3.66, Perceived Competence:3.73, Value:3.90). It shows that students performed good attitude after finishing these activities; (c) students following the 6E procedures would be helpful regarding the practical ability.

Keywords : *STEM instructional design; 6E Model; Makerspace*

P_AE_04

Developing and Disseminating Female-Friendly Engineering Experiments for Middle and High School Students: The Case of the WISET Seoul Regional Center

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ABSTRACT

With a goal to develop and disseminate engineering experiments suited for female middle and high school students, The WISET Seoul Regional Center held engineering student competitions for developing female-friendly engineering experiments in 2012 - 2014.

The competition was implemented in three stages: Stage 1 for submitting experiment plans, Stage 2 for submitting experiment manuals for teachers & students, and Stage 3 for implementing experiments. The judges for the submissions included college engineering professors, high school science teachers, and female middle and high school students. The judges focused the evaluation on the following three criteria: a) arouses interest in engineering, b) presents engineering principles clearly, and c) has high potential for dissemination.

For three years, forty-two female-friendly engineering experiments in nine engineering fields were developed. Leading experiments included 'An Automobile Operating on Sound', 'LED Shake Light using ATmega 128', and 'Titanium Rainbow Bookmark'.

The developed experiments have been disseminated to the science club activities at the middle and high schools in Seoul through 'WISET Seoul Mobile Laboratory' program since then, which allowed female middle and high school students to participate in hands-on engineering experiments. The experiments were well received and were instrumental to generate interest in engineering and to promote the diversity of engineering majors. The program is also beneficial to engineering students who participated in the competition. They obtained an enhanced understanding of their major, and the need for engineering education for K-12 and the gender diversity.

Keywords : *Female-Friendly Engineering Experiments, Middle and High School Students*

P_AE_05

EFFECTS OF STEM PROJECT-BASED LEARNING ACTIVITY IN DEVELOPING STUDENTS' ATTITUDES TOWARD ENGINEERING AND COGNITIVE STRUCTURE OF ENGINEERING DESIGN

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ABSTRACT

Most engineering educators concern about the issue of lacking talented persons when it is mentioned to the field of civil and construction engineering properties. This study focused on developing two STEM project-based learning activities for senior high students, one is applying the engineering design process and the other one is applying the problem solving process, and the 3D technique also integrated in these activities for improving students' modelling during the engineering design process in order to develop students attitudes toward engineering and engineering design thinking. In order to achieve the research purpose, this study employed the nonequivalent pretest-posttest designs of quasi-experimental design in exploring the effects of the STEM project-based learning activity in students' attitudes toward engineering and engineering design thinking. Data were analyzed using descriptive statistics, analysis of covariance, and flowmap analysis. Results revealed that students have better learning interests in the engineering design group; meanwhile, students also have more complete cognitive structure of engineering design in the engineering design process group. According to the results, this study suggest that the future study should put more emphasis on developing students' cognitive structure of engineering design process, especially on the steps of modeling, feasibility analysis, and communication.

Keywords : *STEM, Project-based Learning, Attitudes toward Engineering, Cognitive Structure, Engineering Design*

P_AE_06

The STEM Learning Attitude Scale: Development and Validation

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ABSTRACT

With the development of industry and technology in recent years, the demands of STEM (science, technology, engineering, and mathematics) talents increased rapidly. The importance of encouraging and preparing the students to invest in this field has been highlighted. Many countries tried and are still seeking to improve quality of the STEM education, researchers and governments had made efforts to increase the interest in STEM areas, and lots of curriculums were developed and implemented in schools. Therefore, this research aims to development a STEM Learning Attitude Scale and tested the validity. The STEM Learning Attitude Scale includes three dimensions which are Interesting (6 items), Perceived Competence (7 items) and Value (6 items). All items referred to relative research papers and teacher's teaching experiment. Validation was based on the experience within an expert group and thorough analysis of pilot test. Nine experts from industry, government and academy domains were invited to join the experts group. A three rounds Delphi method was used to obtain the most reliable opinion consensus of a group of experts to improve content validity. There were 309 participants (age 15~17 years old; 130 females, 179 males) from 4 senior schools attend the pilot test. Factor analysis supported the 3 dimensions. Cronbach alpha for the entire questionnaire was 0.956; for each dimension, alpha ranged from 0.896 to 0.908. In conclusion, the STEM Learning Attitude Scale is a fairly reliable and reasonably valid questionnaire and could be used to determine students' attitude of STEM curriculums, and teachers will know how to arrange and adjust their teaching activities.

Keywords : *STEM, STEM attitude, scale*

P_AE_07

THE MEDIATION EFFECT OF SELF-REGULATED LEARNING STRATEGY BETWEEN PROBLEM-SOLVING EFFICACY, TASK VALUE AND LEARNING OUTCOME IN CAPSTONE DESIGN COURSE

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ABSTRACT

This study aimed to identify the mediation effect of self-regulated learning strategy in the structural relationship between problem-solving efficacy, task value and learning outcome in engineering capstone design course. The study employed structural equation modeling in order to examine the causal relationships among the variables and mediation effect of self-regulated learning strategy.

The research questions are:

- Does the theoretical model that explains learning outcome in engineering capstone design indicate a reasonable model fit?
- What are the effects of the factors (problem-solving efficacy, task value) on self-regulated learning strategy in engineering capstone design course?
- What are the effects of the factors (problem-solving efficacy, task value, self-regulated learning strategy) on learning outcome in engineering capstone design course?
- Does self-regulated learning strategy mediate between problem-solving efficacy, task value and learning outcome?

The data from 363 engineering college students who enrolled in capstone design courses during fall semester 2014 were analyzed. The major findings of this research are as follows:

First, regarding the structural model fit, the results indicated that the model, problem-solving efficacy, task value, self-regulated learning strategy, learning outcome provided a reasonable fit to the data $\chi 2= 93.77$ ($p <.001$), TLI= .97, CFI = .98, RMSEA = .06(90% confidence level, .05~.08). The results show that the theoretical model consisting of four factors were reasonable.

Second, the direct effects of the variables related with self-regulated learning strategy in engineering capstone design course are significant.

Third, the direct effects of the variables related with learning outcome in engineering capstone design course are partially significant. Among those three factors, only self-regulated learning strategy has direct effect on learning outcome.

Fourth, self-regulated learning strategy has an indirect effect mediating problem-solving efficacy, task value and learning outcome.

Findings indicate that it is necessary to facilitate the problem-solving efficacy, task value and develop self-regulated learning strategy in order to improve learning outcome in engineering capstone design course.

Keywords : *capstone design, problem solving efficacy, task value, self-regulated learning*

P_AE_08

IMPORTANCE OF ADDRESSING GAPS IN KNOWLEDGE DURING EARLY STAGES OF PREPARATION IN STEM FIELDS

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ABSTRACT

The lack of motivation to excel in STEM fields can be linked to the lack of preparation in these fields at the basic education levels. Incoming freshmen at universities begin their careers in the field they are mostly inspired by. The primary reason for selecting a major is fueled by the passion to create solutions and discover alternatives to issues within their communities. After the first semester in college, some students in STEM tracks tend to change fields, withdrawing from anything related to science or engineering. This is mostly driven by the low performance achieved in introductory core courses. The noticeable pattern shows that students that drop out of engineering and math fields received inflated grades in STEM courses. This leads to having a false sense of understanding of the materials covered, since they seemingly excelled in most evaluations. Then in college, since the courses require more profound comprehension, these students notice that there exists gaps that need to be filled. The main objective of this presentation is to discuss the ability of educators to identify interest from the students towards potential career paths, as well as to address the root cause of potential deviation from pursuing a degree in a STEM field.

Keywords : *higher education, STEM, guidance, success, fundamentals*

P_AE_09

Effects and learning support of a new distance education system for overseas educational institutions of technical education: A case study of Physics Education

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ABSTRACT

The main purpose of this study is the construction of a new distance education system between Tokyo Salesian Polytechnic and overseas educational institutions for technical education. For this study an intensive course has been created and applied at the University Technology MARA (KTJ) in Malaysia.

In order to collect basic data for the new distance education system, the program has been started in 2012. By 2013 we finished the making of the lecture-contents for the new system. Besides the need of a Mirror type server will be necessary minor improvements on the system itself for the stable movement of MP4-files. For the reason of a fast development of the system, a pre-test appliance of the same system for the Mongol Kosen (MK) in Mongolia, Salesian Polytechnic could start the deliverylectures in the academic year of 2014. This new system included the using of Mirror type server joined with web conference system. In order to reach a successful result, the full appliance of this education system between Salesian Polytechnic and Mongol Kosen is programmed to start in the academic year of 2016. In addition, the Science school has started since 2015, by using web conference system between Salesian Polytechnic and Mongol Kosen.

Keywords : *Distance education system, Mirror type server, Web conference system, Salesian Polytechnic Tokyo, Mongol Kosen*

P_AE_10

GEARUP – STARS: Using Summer Engineering Programs to Promote STEM to Underrepresented Minorities

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ABSTRACT

There is a lack of interest for students in the United States pursuing STEM fields, particularly engineering. According to the National Science Board [1], only about 8.6% of high school students end up going into STEM fields, and worldwide, only 4% of the total engineering graduates go into engineering compared to 34% for China and 17% for Europe. This is a serious issue that will probably only get worse over time [2]. At the same time, according to the National Academy of Engineering in the Educating the Engineer of 2020 report [3], the engineering job market has been increasing steadily for the past ten years.

According to Abaid et al. [4], getting more students to enter STEM fields is instrumental to society's well-being and technological competitiveness and their findings conclude that summer workshops where students learn about engineering outside the school environment has been largely successful in increasing their interest in STEM fields. Outreach programs to schools are one of the methods often used to effective promote engineering and STEM, especially elementary school students, Johnson et al. [5].

To address the issue of the GEARUP – STARS research project funded by the U.S. Department of Education addresses 1) the lack of interest by underrepresented students to pursue STEM education and 2) the ability for high school STEM teachers to teach engineering as suggested in NGSS (Next Generation Science Standards). This is accomplished using a summer outreach engineering program where 60 middle school level underrepresented minority students and 15 middle school STEM teachers from selected school in the United States participated in a week-long summer program and professional development to develop classroom materials related to their summer workshop experience meeting the needs of NGSS. The students and teachers spend a week preforming real engineering research investigation in collaboration with university engineering research faculty to study the interaction of urban and natural areas and their effect on water quality in the Bear River Water Shed in Utah.

A survey administered at the beginning and end of the workshop gauge the students' interest in STEM fields. Follow up is conducted during the school year to determine the effectiveness of the program. Teachers attend a professional development workshop to develop materials related to NGSS. After the professional development researchers gathering data on the implications of that professional development workshop and teachers' ability to teach engineering in their classroom. The professional development workshop for the teachers enables them gain knowledge and skills that they can use later in their classes. At the time of the WEEF conference, survey results from 60 students and results of the professional development for 15 teachers will be discussed.

Keywords : *Summer Outreach Engineering Program, STEM Professional Development, Next Generation Science Standards,*

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P_CI_01

DEVELOPING AN ENGINEERING DESIGN COURSE USING 3D PRINTING TECHNOLOGY FOR HIGH SCHOOL STUDENTS

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ABSTRACT

The Ministry of Education in Taiwan is currently rebuilding the national education curriculum framework for K-16 students. The science and technology curriculum will introduce new technology and cultivate the engineering talents of students as the main objective. According to the framework, we developed a STEM (Science, Technology, Engineering, Mathematics)-oriented course that includes lessons and hands-on activities of building 3D CO2 dragsters for high school students in Taiwan. The course was reviewed by five high school teachers in the field of science and technology. The lesson plans and activities of the course were revised based on the teachers' suggestions and were implemented for 182 high school students. The course is an eight-hour course over four weeks (two hours per week). In the first week, 123Design was introduced to students. They learned how to draw 3D geometrical objects and used basic editing tools to build digital CO2 dragster models. In the second week, students were introduced to STEM knowledge related to CO2 dragsters, including the concepts of aerodynamics, Newton's laws of motion, car assembling, and 3D printing technology. Students applied the STEM knowledge to build their own digital 3D CO2 dragster models. In the third week, students were divided into 36 groups and used Flow Design—a virtual wind tunnel software application for testing design ideas. Group members discussed with each other and then selected the best CO2 dragster design to revise according to the visualized airflow around the 3D digital models. Thirty-six final designs of CO2 dragsters were printed using MakerBot Replicator 5th Generation 3D printers. In the final week, racing activities were held using the PITSCO impulse G3 race system, and students showed a high level of enthusiasm during these activities. Students were asked to complete a learning evaluation sheet and the Science and Technology Attitude Scale. The detailed analysis of the attitude scale scores and the learning evaluation sheets, as well as the pros and cons of the 3D CO2 dragster course are discussed.

Keywords : *3D Printing, Engineering Design, Curriculum*

P_CI_02

BECOMING AN ENGINEER AND A TEACHER FOR VOCATIONAL SCHOOLS IN AN INNOVATIVE ENGINEERING STUDY PROGRAM

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ABSTRACT

The so called "dual system" in vocational education in Germany includes education at schools and companies at the same time. In general, that dual system is well established and accepted. Many other countries have adopted this structure without major modifications. Besides the successful vocational education, there is an increasing demand for more teachers for technical subjects at vocational schools in Germany. To aid in finding solutions for this situation, many efforts are being made by local and statewide governments and stakeholders. One example is the newly added program at our University of Applied Sciences. The existing engineering program was restructured and expanded with education classes and internships. The combination of an engineering program with education classes offers the participants two ways for their future profession: to become an engineer or a teacher. The students complete their bachelor program as an engineer but since they attended education classes as well, the students can continue with a master's program either in engineering or in education. So the students gain two options for their professional life. The principal idea of the new program is that engineering students become interested in the teaching profession although they might never have thought of it before. Even if they decide after their bachelor's degree to follow the engineering profession, their additional educational background provides them with useful knowledge and skills for their professional life, e.g. when coaching apprentices. This poster will explain the program and also the conditions under which this combination of engineering und education can be implemented and accepted by all participating institutions. The program started in 2014, the results are preliminary.

Keywords : *curriculum, teacher education, vocational education*

P_CI_03

INFORMAL EDUCATION: PROJECT BASED LEARNING IN MAKER SESSIONS

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ABSTRACT

As technology becomes more pervasive, new opportunities have been created to leverage technology in more different environments. This research explores the potential of Internet of things devices such as Raspberry Pi, iBeacons, and Arduino microcontrollers in improving classroom communication and interaction. A series of prototypes will be given to instructors and students, and the prototypes will test in the classroom.

Keywords : *IOT, Internet, of, things, open, education, classroom*

P_CI_04

THE PROBLEMS OF PROVIDING ASSISTANCE TO MIGRANTS WHO COME TO RUSSIA WHEN THEY PASS THE EXAM FOR OBTAINING PERMISSION FOR TEMPORARY RESIDENCE, WORK, PATENT AND RESIDENCE PERMIT

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ABSTRACT

Together with the international community Russia is building a common future including implementing effective assistance to visiting foreign nationals. There is a need to ensure that annual migration flows at the level of 300 thousand people in Russia. As a highly developed country, Russia suffers a shortage of specialists including people with engineering education. Migrants are one of the sources for manpower replenishment. Migration processes in Russia develop rather intensively so in 2015 the territorial bodies of the FMS of Russia registered 8,7 million foreign nationals. Currently there are 298 courses of Russian language for foreign citizens in Russia, 99 of them work on a Pro Bono basis. By the decree of the President of the Russian Federation on the 7th of May 2012 № 602 "On ensuring ethnic harmony" was provided for the introduction of mandatory exams in Russian language, history of Russia and basics of Russian legislation for migrant workers, except for highly qualified specialists.

According to the article 15.1 of the Federal law from 25.07.2002 № 115-FZ "On legal status of foreign citizens in the Russian Federation" certificate of foreign citizens in the Russian language, knowledge of Russian history and fundamentals of legislation of the Russian Federation, the Federal law from 20.04.2014 № 74-FZ, a foreign citizen when applying for the permit for temporary residence, residence permit, work permit or patent, will be obliged to confirm the Russian language proficiency, knowledge of history of Russia and fundamentals of legislation of the Russian Federation, in particular the certificate of proficiency in Russian, knowledge of Russian history and fundamentals of legislation of the Russian Federation. The Russian Federation consists of republics, territories, regions, Federal cities, Autonomous oblasts, and Autonomous areas are equal subjects of the Russian Federation.

There are different requirements for the exam which is a significant problem of providing a real assistance to migrants for obtaining a temporary residence permit, work permit or patent, or a residence permit provided for by two Federal laws governing Federal and regional systems for the comprehensive exam.

The first is the Federal system the comprehensive exam in the Federal law of 20.04.2014 № 74-FZ "On amendments to the Federal law "On legal status of foreign citizens in the Russian Federation".

The second is regional the examination procedure by the Federal law of 24.11.2014 No. 357-FZ "On amendments to the Federal law "On legal status of foreign citizens in the Russian Federation" and certain legislative acts of the Russian Federation".

These procedures are not uniform, so we cannot establish a single education space for foreign nationals wishing to live and work in Russia.

Attention is paid in the article to a number of contradictions that creates enforcement problems in these laws.

First, the Federal system comprehensive exam (FS) provides for unity of methodological requirements, the amount of knowledge of foreign citizens and united organizational and methodical conditions for all local centres of testing and in the regional procedure of exam requirements for level of proficiency in russian language as a foreign language, the amount of knowledge on the history of Russia and basics of Russian legislation for foreign citizens vary depending on the subject of the Russian Federation.

For example, we identified a number of significant violations of the minimum level of knowledge of foreign citizens placed in accordance with the order of the Ministry of education and science of the 29th of August 2014 № 1156. In particular, in the framework of a regional arrangement established in Moscow and the Moscow region does not comply with the provisions of paragraph 2 of annex № 2 of the Ministry of education of Russia. Conducting subtests "Speaking" and "Writing" are not set.

Second, under Federal rules the development and regular updating of test materials and educational documents are conducted under the supervision of the expert community and the Ministry of education and science of Russia and development and update of test materials are not regulated in the regions.

Third, the Federal rules established a single form and procedure of examination which ensures certainty and uniformity of conditions of the exam while the regional form and conduction of examination in different subjects of the Russian Federation are different.

We identified general shortcomings in the regions. There are no road maps for the organization and administration of the exam, there are no selection criteria educational organizations involved in the exam, no exam papers or an insufficient number of them, there are no regulatory-methodical documents as well as the accounting system of the examination results.

Fourthly, a central registration of certificates and persons who passed the exam is set up at the Federal level and at the regional there is no such thing.

Fifthly, there is the rapid exchange of information with regional divisions of the FMS of Russia according to Federal acts and after the exams in the regions, Federal migration service of Russia has no information about the authenticity of documents on the exam that generates the circulation of counterfeit certificates.

However, these problems require the development of a comprehensive unified methodology for conducting the foreign nationals' exam on both the federal and the regional procedures. RUDN University is one of the five Russian core facilities with accreditation to hold testing for foreign citizens and to issue the certificates. In University the experience of this test in all regions of the country is generalized and a new method of conducting a comprehensive examination for foreign nationals is developed. This technique ensures: the unity of requirements to the level of knowledge and transparency in the examination procedure, the use of electronic testing and assessment materials, electronic interaction between the testing centers and government bodies, the organization of preliminary preparation of candidates through the Internet.

In general, great methodological and informational assistance in preparing for the exam has been made for foreign nationals. Therefore, RUDN had published bilingual vocabularies of historical, legal and cultural terms for foreign citizens who pass Federal system comprehensive exam. Furthermore, published works on Russian history and the basics of the Russian Federation law, in particular, translated into Romanian, Tajik, Uzbek (Cyrillic and Latin), Vietnamese, Turkish, Chinese, Korean, Kyrgyz languages).

This Presentation is devoted to features of innovative techniques, the basic prospects of its implementation and the potential benefits of its use for attracting qualified personnel in Russia.

Keywords : *migrants, Russia, comprehensive exam, test materials, rapid exchange of information*

P_ED_01

ENGINEERING EDUCATION VS EDUCATION OF ENGINEERING. AN ANALYSIS OF THE CURRENT RESEARCH TRENDS IN THE UNITED STATES

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ABSTRACT

The current education system is not producing enough engineers to meet market demand for several reasons, including misalignment of curriculum with companies' demands, high dropout levels in the Engineering programs, students' motivational aspects, and lack of adequate technological tools that improve the teaching and learning processes. This poses a great challenge for engineering education. Some of the current questions are: how to improve the quality of teaching engineering? What are the differences between engineering education and the education in other fields? What tools can be developed to improve the teaching and learning process?

Given these concerns, there is a growing number of masters and PhD theses focusing on technologies, learning analytics, models and theories related to Engineering Education. These come from programs offered by colleges of education, or by departments of engineering education within colleges of engineering, or by programs in traditional engineering departments in colleges of engineering. This results in a wide spectrum of topics and perspectives that vary from education of engineering to engineering education.

This paper looks at the evolution of engineering education research in the United States by processing and analyzing dissertations documents and theses related to Engineering Education, using information retrieval techniques classifying the topics and the researcher profiles, to determine the current research approaches and trends in this field. Results include information extracted by processing thousands of documents from several years of publication, as well as comparisons between the focuses of the research according to the origin and context of the research and finally some trends about how is going to be configured the Engineering Education in the following years.

Keywords : *Dissertations, engineering education, information retrieval, theses, United States*

P_ED_02

FOOD LAB: A LEARNING EXPERIENCE FOR THE DEVELOPMENT OF PROFESSIONAL SKILLS IN ENGINEERING STUDENTS USING GAME MECHANICS AND EDUCATIONAL INNOVATION

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ABSTRACT

In these days of globalization the commitment and effort of universities has been to design new pedagogical processes and training, enabling engineers to meet the demands of their environments so that new professionals are in the ability to innovate and encourage significant changes in solving global social problems. Furthermore, all universities are responsible for development and implementation of new learning approaches other than traditional, to enhance critical thinking in their students, this helps to increase the processes of abstraction and forces assessment scenarios for processes "teaching and learning".

Therefore, bring in the food into engineering education increases the level of appropriation of knowledge. Using scenarios healthy and creative food have become an educational space that allows learning an extensive range of content developing skills for teamwork, creative thinking and assertive communication, which are part of the transversal skills programs the Faculty of Engineering. Incorporate game mechanics, during the learning process the student may apply the underlying concepts of professional skills and these are measures through validation scenarios and how they significantly impact student learning, that will challenge student´s skills and put knowledge to the test. The purpose of this paper is the measurement of the impact of these four skills and determine how successful the experience of applying a methodology using the kitchen as a laboratory.

Keywords : *Engineering Education, Educational Innovation, Innovation, Learning, Food, Teaching*

P_ED_03

TRIBRIDS POWER AND FISHERIES STATION

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ABSTRACT

The problem of poverty and provision of energy are receiving considerable attention in Indonesia. These problems surge almost region of Indonesia including the area of Small Islands and or outlying and coastal areas (PPKT). In the supply sector of energy, there are 8533 coastal villages that do not provided the electrical energy. It is happened because the small islands separate from the main island so it is difficult to reach by the national network (the national grid). Then, from the sector of economy, society coastal areas and small islands belong to poor society. Based on Data poverty in Indonesia, the number of poor society is 34.96 million citizens (15.42 percent) and the majority (63.47 percent) of the poor in Indonesia is located in the coastal and rural areas. Contrary from above problems, the potential of Indonesian fisheries can be exploited by 5.12 million tons per year and the potential of marine energy can be harnessed by 49,000 MW. To address it, the researcher creates renewable energy power station that is combined with fish cultivation named Tribrids Power & Fisheries Station. The station is constructed of three sources of energy (Tribrids). They are sea energy that consists of current and wave energy, wind energy and sunlight energy. All of them is combined in a single station, so we will get bigger energy than we use one energy. This station can also be used for aquaculture throught the concept of Blue Economy that is environmentally friendly. The first phase of research collects literature review of the potential and the condition of ocean that exist in Indonesia. From the literature review and mathematic calculation, the Daerrieus turbine is used for converting ocean current energy, Pelamis for converting the ocean wave energy, the combination of Daerrius and Savonius turbines for converting the wind energy and Solar Cell for capturing the sunlight. From the discussion, one station can produce power of 123.978 kWatts and can produce 90 kg of fish. Throught the explanation, The Tribrids Power & Fisheries Station is expected to be solution of energy provision and poverty in the area of PPKT.

Keywords : *Daerrius Turbine, Fisheries Cultivation, Pelamis Wave Converter, Renewable Energy, Savonius Turbine, Solar Cell, Tribrids*

P_ED_04

DEVELOPMENT OF A HUMAN-MACHINE INTERACTING MOBILE TRASH COLLECTING ROBOT FOR A VOLUNTARY INDUCED ECO-FRIENDLY ENVIRONMENT

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ABSTRACT

One of the most common waste problems in many urban areas is garbage on the street. In many cases, garbage that is not properly thrown away is located near trash can and they are mostly spread out, which makes the street dirty and stinky. It would be beneficial if something induces the pedestrians to throw their garbage in the trash can properly, thereby achieving more clean street environment voluntarily. In this paper, we present a robot called DDOBAGI, which is a human-machine interacting mobile trash collecting robot for a voluntary induced eco-friendly environment. The aim of the development of this robot is to induce the pedestrians to throw their garbage in a trash can voluntarily, where the can is installed inside the robot. This robot interacts with people by talking and giving reactions through speakers, LCD monitors. Also the robot was developed in a way that people feel more comfortable and friendly as far as the appearance is concerned. Two places, one within the university and the other located outside of the university, were chosen for the experiment. To compare the result, we first used a conventional trash can. We intentionally placed some garbage on the street nearby trash can, and checked the time interval before and after the garbage were collected. Replacing trash can with the robot, same experiment was conducted. We also conducted a simple survey to those who showed an interest to the robot or picked up the garbage. The result showed that people tend to throw garbage in the trash can properly, rather than leaving them on the street, when the proposed robot was installed in the experiment area. According to the survey, more than 83 percent among 67 people responded that they felt good impression about the robot, and showed positive response when asking if this robot actually takes action on the urban area. By doing this research, we observe that the engineering inspired robot shows a possibility to solve the social issue.

Keywords : *garbage, trash can, mobile robot, pedestrian, human-machine interaction, social issue*

P_ED_05

GLOBAL ENGINEERING DEANS COUNCIL (GEDC) SUMMIT IN ETHIOPIA: STRENGTHENING THE COLLABORATION AND PARTNERSHIP BETWEEN US AND AFRICAN ENGINEERING PROGRAMS

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ABSTRACT

The Global Engineering Deans Council (GEDC) in collaboration with the African Engineering Deans Council (AEDC) organized and completed a very successful two day summit in Addis Ababa Ethiopia in September 17-18 2015. The summit was well attended an attracted around 100 participants, with 18 from the USA, around 30 from Ethiopia (the host country), and around 50 from the rest of Africa, Canada, Latin America, Europe, Asia and the Middle East. We conducted all the sessions (10 presentations, 8 panel discussions, and 2 hands-on workshops) in one plenary hall without parallel breakout sessions to assure that all the conference attendees received the maximum participation.

We were able to take 18 participants from 13 different US universities through the support of the National Science Foundation (NSF). The GEDC in collaboration with the International Federation of Engineering Education Societies (IFEES) and its corporate sponsors, such as GE-Africa, M-Tutor and the private donations of several individuals was able to raise enough funds to sponsor around 28 African Engineering Deans to attend the summit in Addis. The US participants included one VP of Research, 6 Engineering Deans, 2 Assistant Deans, 2 department chairs, 4 faculty members, and 3 graduate students. Nine of the participants from the US (50%) presented their work, participated in the panel discussions, or conducted hands-on workshops. The three graduate students from the US also had a very fruitful meeting and discussion with 23 engineering students from Ethiopian universities and two graduate students from Nigeria. There were also presentations by the corporate sponsors such as GE-Africa and M-Tutor from India. Finally, the Founder of Terra Global Energy Solutions, a small business based in the Silicon Valley presented his $20 Million USD wind farm project in Ethiopia and gave a glimpse of what is possible in the future when government, industry, and academia partner to work together on the same project.

This summit gave all the participating universities from the US high visibility and access to 100 of the top Engineering Deans on the Continent of Africa. It has laid the foundation for a very strong partnership and long term collaboration between the US universities and with the top engineering programs in Africa. We want to thank NSF, GEDC, AEDC, IFEES, the private and corporate sponsors and the all Ethiopian Universities for their support and collaboration.

Keywords : *African Engineering Deans Council, African Engineering Education Association*

P_ED_06

GENERATIONAL DIVERSITY AT THE WORKPLACE: HOW TO LEAD AND MANAGE

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ABSTRACT

In today's world businesses employees now come from many different age generations, cultures and environments. Now more than ever businesses need to focus on diversity in the workplace. By properly managing generational diversity businesses can expect many benefits including higher job satisfaction and work performance by their employees and also a greater customer base and public perception.

What separates the generations from one another are the skill sets and how one generation views the other generation. For example, the Baby Boomers are viewed by younger as workaholics, always in the office 24/7 while the Generation Y is all about technology and the internet.

The managers have to be careful about generational stereotypes and instead they must recognize the differences and manage their employees to work in harmony capitalizing on the strengths each generation. Different strategies for: facilitating mentoring between different aged employees to encourage more cross-generational interaction, offering different working options like telecommuting and working offsite, creating various recognition programs, and accommodating personal employee needs need to be adjusted for the generations a manger has at the workplace.

This poster defines the generations in the US workplace in terms of their lifestyle and workplace rules preferences. It also provides managers with the advice on how to lead a multi-generational team.

Keywords : *Multi-generational workforce, Baby Boomers, Millennials, Diversity*

P_ED_07

A STUDY ON EDUCATION OF FLUID DYNAMICS USING E-SCIENCE BASED SIMULATION SOFTWARE AND CONTENTS

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ABSTRACT

Mostly, education of fluid dynamics has been based on theories in textbooks. Because the physical phenomena around us but invisible, such as the wind, is described in complicated equations of fluid dynamics, students have a difficulty when they face fluid dynamics at the first time. Moreover, the equations are a system of nonlinear partial differential equations (PDEs), it is difficult to understand and solve the PDEs for students and even professors. Thus, in fluid dynamics education, most textbooks deal with simple flows around cylinders or flat plates through simplified equations inevitably. To students who may imagine that flow around aircraft, ships, or cars, those simple flow cases are not interested in, eventually, they lose their interest in fluid dynamics. EDISON_CFD, which is computational fluid dynamics tool based on e-Science, helps students simulate flow around complex geometries through the internet. Since flow around aircraft, ships, and cars can be simulated and visualized, students can easily take an interest in fluid dynamics. Several universities including Seoul National University started to develop flow solvers and contents, and Korea Institute of Science and Technology Information (KISTI) has provided web service and computing resources. In the beginning, EDISON_CFD was used by a few universities but more and more universities utilize it. In the early stage of the project, there were problems which were not expected at development phase. The server broke down because too many users accessed to the portal and executed hundreds of simulation at a time, but the system has been stabilized by feedbacks from users. For four years, 8,040 users in 74 universities have used EDISON_CFD, and it has been utilized widely, from simple assignments to term projects. This change of education induces students to have an interest in and delve in flow phenomena around us for themselves. This study shows that education of fluid dynamics based on EDISON_CFD helps students understand fluid dynamics and develop an interest in it. After the success of EDISON_CFD, EDISON system has extended to Nano Physics, Computational Chemistry, Computational Structural Dynamics, and Computer Aided Design fields not only Computational Fluid Dynamics.

Keywords : *EDISON_CFD, computational fluid dynamics, e-Science*

P_IT_01

UNMANNED AERIAL VEHICLES NETWORKING PROTOCOLS

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ABSTRACT

Unmanned Aerial vehicles (UAV), more commonly known as drones, are widely used by military and civilian applications. They can be used for remote sensing, transportation, scientific research, armed attacks, search, and rescue. They can be used in applications where human presence is dangerous. Drones could be equipped with cameras, sensors, communications equipment, and weapons. UAVs can be piloted by a human from land or can be autonomous. In the future, autonomous UAVs will work collaboratively with other aircrafts. UAVs can communicate wirelessly, forming a MANET. Thus the constraints and advantages of MANETs are transferable to networks of UAV. This paper presents some networking protocols for UAV networks, their advantages, disadvantages, applications, possible improvements, and an approach model of a simulation using agents.

Keywords : *Communication, Networking, Unmanned Aerial Vehicles*

P_IT_02

ENGINEERING ARTIFICIAL INTELLIGENCE IN A SENSOR-BASED CONSUMER APP FOR PAIN PREDICTION IN POSTSURGICAL KNEE REPLACEMENT

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ABSTRACT

Pain is the top cause of Emergency Room visits as well as a major symptom of other chronic conditions. Although there have been ways to detect and measure pain intensity, until now, there has not been a way for consumers to non-invasively measure and manage their pain. The reasons for being able to non-invasively predict and measure pain are; that sometime patient experiencing pain cannot expressed their pain, or that pain management when predicted, can help preempt pain care and avoid prolonged care. In this research, we sought to use artificial intelligence(AI) to engineer a consumer mobile health app to guide, predict, measure and manage the pain that people go through after a total knee replacement. In this novel research, we designed a machine learning back end with training for pain biomarkers and other knee replacement patient experiences. We then engineered an interface for patients to be able to interact with a user interface of the app that sends real time feedback to health providers. We go through an agile engineering model that enables our design and technology to be implemented globally. Especially in developing countries and places with minimal health providers and centers. Current findings show that; 1. There are a lot of pain biomarkers that can be captured with a smart phone. 2. Pain is a very subjective feeling which has cultural and personal pushbacks when we try to compare pain prediction versus subjective experience. 3. It is feasible to predict pain for postsurgical care. The current phase is pilot testing this engineering app on real patients to see how accurate and useful the app actually is.

Keywords : *Artificial Intelligence, Mobile Apps, Total Knee Replacement, Pain measurement, Engineering, Interface Design, UX research,*

P_IT_03

VISUALIZATION SKILLS IN A GRAPHICS AND A SOLID MODELING COURSES

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ABSTRACT

Visualization has received significant attention from practitioners and researchers in fields such as education, psychology, and engineering. Visualization skills have been often linked to mental capabilities that indicate likeliness or aptitude to perform certain tasks or professions. Similarly, there are numerous reports on exercises that focus on developing visualization skills, both, for development of imagination and creativity, as well as development of competences directly related to technical fields such as engineering graphics and design.

In this field of graphics and design, there has been reports about the development, and improvement/expansion, of tests such as the Purdue Spatial Visualization Test - Rotations PSVT:R, the Cutting Plane test, or the Shepard-Metzler Rotation (S-M) Test. There are as well reports on several techniques being utilized in the classrooms in order to develop such visualization skills. Just as there are reports on the applicability and usefulness of those various techniques.

This report deals with evaluation of possible improvement of visualization skills on a group of students that have taken either a hybrid (i.e., 2D graphics and 3D solid modeling) course, or a 3D solid modeling course. Both courses are semester courses, the theoretical courses are similar, and all students have indicated interest in technical curricula. The evaluation performed looks into the possible improvement of visualization skills based on PSVT:R test. The test was administered as pre- and as post-, during lecture time and there was has been a high level of participation. Results indicate differences between the two subgroups, with limited statistical significance.

Keywords : *Visualization, graphics, STEM.*

P_IT_04

ELCIR – ENGINEERING LEARNING COMMUNITY INTRODUCTION TO RESEARCH: GLOBAL OPPORTUNTIES TO LOW-INCOME FIRST GENERATION STUDENTS

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ABSTRACT

The National Academy of Engineering states that a core need for engineers is to be able to work with a diverse, multinational, and multidisciplinary workforce. One way to prepare students for this challenging global environment is to encourage students to participate in study abroad programs. While there is consent among international educators in the need to do more to prepare students to succeed in the global economy, there is still a large portion of students who will not or cannot take advantage of these high impact educational opportunities. Some of the barriers for students to study abroad includes cost, lack of knowledge of the system, curriculum and culture. This is especially true for low-income first generation students, many whom are also ethnic minority students.

To increase the number of students studying abroad, more specifically low-income, first generation students, the college of engineering of a large land-grant university from the South of the United States partnered with the Office for Higher Education of one of the States in Mexico and launched in 2015, the Engineering Learning Community Introduction to Research for Regents' Scholars (first generation students who received a $20,000 dollars to attend this land-grant university). For the first year of the program, 17 low-income, minority and first generation students were selected and participated in the program. On the second year, 28 students were selected. The program was conceived with three goals: (1) to expose raising sophomore students to research, (2) to immerse students in a global research setting to maximize retention in engineering, and (3) to start to develop students' global competencies. The program started with a 2 weeks research experience in Mexico at the end of the spring semester, where students took an introduction to research course and explored various research sites. The program continued throughout the summer with an online learning community class where students were guided on how to write a research proposal. To close the program student participated in a poster session where they presented their research proposal to a group of faculty members, peer students and administrators of the college of engineering.

This paper presents how the program was implemented, the outcomes of the program and the impact on the students based on the analyses of a pre and two post surveys. The focus of this paper is on the global competencies developed by the students as a result of this program.

Keywords : *Global, International, First Generation*

P_IT_05

DEVELOPMENT OF SMART 3D EDUCATION SYSTEM

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ABSTRACT

The goal is to increase interest to education and improve quality and concept of educational content itself. 3D techniques and augmented reality technologies bring opportunities to represent knowledge media in smart(interactive) 3D models. Development idea's concept is to target camera (web camera, smartphone, tablets) to educational materials, and AR technologies will recognize and build interactive 3D models in a display, allowing audience to interact with models and monitor the process. First results would be able to use without additional hardware requirements, excluding available target audience's smartphones or tablets.

Development of smart 3D education concept includes next steps:

- Analyzing target media elements for 3D representation
- Develop interactive 3D models of target educational media e.g. physical and chemical processes, biological units, historical characters or events, math's multidimensional graphs
- Publish or edit appropriate books or booklet base
- Prepare final interactive software solution

Interactive content including rotations, possible hand/object manipulation of 3D models will increase educational process' interest and audience's concentration, and 3D visual experience will promote long term memorization of knowledge content among pupils and students.

Keywords : *Interactive Education, 3D Media, Augmented Reality*

P_IT_07

A Study on the System Analysis and Design of Competency-based Mentoring system

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ABSTRACT

Highly skilled engineering human resources are the driving force that sustain all industries and societies, and are a valued resource that are at the fundamental basis of our societies. This research conducted system requirement analysis with the objective of implementing a successful experience development system that could foster highly skilled engineering human resources. A successful experience development system provides a "general use, effective and efficient" system while providing differentiated benefits to the users of the system including students, teachers and professionals etc., and must also provide them with practical help. This research study was conducted with a focus on the case study of University A. A successful experience development system provides a "general use, effective and efficient" system while providing differentiated benefits to the users of the system including students, teachers and professionals etc., and must be provided as a digital system that can provide practical help in terms of the experience development and academic progress of students. In the future there must be effective implementations and evaluations of mentoring system based on system analysis and design.

Keywords : *HRD, competency, System Analysis and Design*

P_IE_01

Engineering Leadership: An Explorative Qualitative Study Based on the Four Capabilities Model

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ABSTRACT

Constant-changing industrial needs require engineers who possess prominent leadership capabilities. In response to the new demands for excellent engineers, a number of universities and engineering colleges in different countries have launched engineering leadership programs. A prior extensive comparison of these programs suggests that Gordon-MIT Engineering Leadership Program appears to have built their program on a comprehensive theoretical framework- the Four Capabilities Model(4-Cap Model), which composes of four core capabilities for future engineers. This framework has allowed a more systematic leadership training of their engineering students in varied skills and traits encompassed within the framework.

To understand the essence of engineering leadership, this study applied the 4-Cap Model to understand the core capabilities required for engineers from different industries. The 4-Cap model is composed of four dimensions in defining leaders' capabilities, that is, sensemaking, relating, visioning and inventing. By qualitative analyses, this study identified some key skills or attributes for engineering leadership within the framework, such as, system thinking, understanding others' ideas, visualizing visions, possessing and updating engineering knowledge and skills, etc. This work illustrates practical examples for these skills and attributes based on six interview transcripts. Future study will include further analyses on interviews from engineers of different industries. The expected results will explore practical applications of the 4-Cap model in a Chinese industrial context and deepen our current understanding of engineering leadership in different cultural contexts.

Keywords : *Engineering Leadership; Chinese Industrial Context; Four Capabilities Model*

P_IE_02

Simulation of structural GFRP Sections encased in Concrete Columns Subjected to axial load

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ABSTRACT

Replacing GFRP section instead of steel section is a new trend in researches to get economic sections having special features such as light column weights which leads to relieve structure dead load and get rid of problems arising from steel corrosion. A new composite column composed of (GFRP) section, concrete and reinforcing steel is proposed. The object from the research is to propose an easy and simple method for calculate the strength of different GFRP profiles encased in concrete composite columns. Numerical model is developed to predict the behavior of pin-ended concrete encased GFRP section composite columns under concentric Load. The initial overall (out-of-straightness) geometric imperfection was carefully incorporated in the model. Linear buckling analysis is carried out for proposed composite column to verify the analytical method by conduct a comparison between critical buckling load calculated from proposed analytical method and critical buckling load predicted from numerical model. The comparison shows good agreement between two values.

Keywords : *Composite Column – Analytical Method – Finite element model – Geometric imperfection – GFRP sections – Numerical model – Linear Buckling Analysis – Critical Buckling Load – Euler Buckling – Concrete GFRP interaction*

P_IE_03

I AM AN ENGINEER. WHAT BRAZILIAN INDUSTRY WANTS FROM ME?

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ABSTRACT

One of the main questions from students after conclude the university is related to hooked up their skills and industry needs, and also how good they are among others students to face a new step in their life in terms of get a new job. In this paper, we are considering Brazil as the case of study.

Once you start to search for job position, it is easy to verify a common list of requirements between skills and competencies required by the industry, and it makes hard to become singular among others candidates. The Brazilian industry is mainly interested to get students able to attend all their needs in terms of tools proficiency (including software, instruments, and so on) and also able to speak more than one language, such as English mainly. In certain cases, this experience requires several years and companies know it, however they insist in try to search for people attend only those requirements instead of identify people with potential to do much more.

This is the point where any extra experience becomes a differential, which includes extracurricular activities, non-related previous experience; speak a different language, etc. It is also important to mention that oral and behavior skills are an important factor that can get you in the company or not.

Inside the industry, it is possible to verify how flexible are a few jobs in terms of requirements to attend a specific position. It happens when it is hard to find qualified students, and this is the moment when singular skills can be the difference between to get accepted or not.

However, there is a problem to spread out this information to students before they leave the university. It impacts the student purpose towards to a desired position. This paper intents to provide a overall approach about industry from a personal point of view based on previous experiences in order to show a different perspective about this relationship between universities, students, and industry. It will also highlight old aspects in terms of how we can shape a new method to getting close both institutions in order to motivate engineering students and stimulate new students to become part of engineering world.

Keywords : *education, engineering, Brazilian industry.*

P_IE_04

EFFECT OF MOTIVATIONAL EDUCATION PROGRAM OF ELECTRICAL AND ELECTRONICS FOR PROSPECTICVE ENROLLEES IN COLLEGE

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ABSTRACT

We are beginning to provide supplementary programs to help students who did not attain the necessary level of learning in high school, as well as providing advice about their upcoming life at the university, support before entering the university, education aimed at boosting motivation, and other unique support programs targeting incoming students.

In the Electrical and Electronics Engineering Department of our college, we have been asked by high school instructors to supplement areas of learning that students did not fully master in high school at the college level, early on, as one facet of the liaison relationship between high school and college. Every year, some 80% or more of students entering the institute participate in the course. The courses are held in the end of March, during a four-day period.

The results of a survey on the course showed that 95% of respondents were satisfied with it. Moreover, students that had taken the course in the past reported that even after they graduated from college and started working, the friendships they had formed during the course had continued. Also, since the course was introduced, there have been fewer dropouts. We introduces the course and reports on its educational effect.

Keywords : *Introduction of Electrical and Electronics, Engineering Education, Support Program*

P_IE_05

A Case Study on Analysis of C2R2 Human Resources Training Advanced Track

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Abstract : *The share of Korea is increasing day by day in the world electric device industry. Hereupon the technical competitiveness, it will be able to compete with the enterprises of the world, however, there is no human resources training system for the supply of core workers. Therefore, the training needs of researchers combine the knowledge and values that this company needs is increasing. In Hanyang University is to promote corporate demand oriented researcher, Human Resources Research Center was opened. The research center is developing, and operating programs for research and training.*

This paper contains information on the introduction and analysis of the operating practices C2R2 (Creative, Convergence, Reality, Revolution) Human Resources Training Advance Track for industry-specific workforce electrical equipment. The program is jointly established an education system and R&D collaboration performing between participating laboratories of the research center and the company, it aims to provide the 3D printing industry and technology of equipment design, control applications with positive growth of the country's industry leading. Furthermore, by developing a curriculum to train professional now demand-oriented electrical equipment that can lead the next generation, it provides a Creative, Convergence, Reality, Revolution educational experience for graduate students. Course curriculum that only differs from the existing course deals with major general theory, be aware of the problem and help company, and to study the major knowledge required to solve the problem, the opening of new courses. Existing curricula in Electrical Engineering and Materials Engineering has been made, in addition to the Mechanical Engineering curriculum, strengthen the electrical equipment for production and test evaluation training using 3D printing. In addition to step-by-step process intensified from common subject, learning theory and practice, as well as strengthen and operated company contact type courses for Human Resources Require by the company.

Keywords : *Human Resources Training, Hanyang University, 3D printing industry, graduate student education*

INTRODUCTION

The share of Korea is increasing day by day in the world electric device industry. Hereupon the technical competitiveness, it will be able to compete with the enterprises of the world, however, there is no human resources training system for the supply of core workers. Therefore, the training needs of researchers combine the knowledge and values that this company needs is increasing. In Hanyang University is to promote corporate demand oriented researcher, Human Resources Research Center was opened. The research center is developing, and operating programs for research and training.

OBJECTIVES

This paper contains the content of the introduction and analysis of the operating practices C2R2 (Creative, Convergence, Reality, Revolution) Human Resources Training Advance Track for industry-specific workforce electrical equipment.

METHODS

The analysis data used in this paper is a survey conducted by the graduate students who participated in this track. Based on the survey results, we analyze the factor in which the program has an effect on the research human resources. As a result, we drew the implications for the future operating method of C2R2 Human Resource Training Advanced Track.

RESULTS

The result of the research, the students taking an C2R2 Human Resource Training Advanced Track showed the greatest satisfaction in the colloquium style class and learn the various major's knowledge. However, some students were hostile to the in-depth contents about other majors. In addition, almost student has expressed to rejoin the track.

CONCLUSION

The first year of operating result and survey result, the improvement of C2R2 Human Resource Training Advanced Track was identified. To improve human resource track reflecting the opinion of survey respondents. Rather than in-depth major classes through the class of the main content. A class of basic contents rather than in-depth contents, it will induce the active participation of the graduate student. This is expected to be human resource with differing abilities that companies demand.

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P_IE_06

Effect of Undergraduate Research Innovation Program of Department of Material Science and Engineering of Hanyang University

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Abstract : *Currently engineering colleges are cultivating a global engineering with the aim. The global engineer says the person processing the inventive thinking skill and engineering administrative ability. Hereupon from the Hanyang University it does the fusion technical base core subject material field global leader cultivation for the next generation growth engine industry with the aim. When students are given to the tasks related to their major from industrial site or laboratory or graduate school, they need certain abilities to solve the problems actively. Thankfully, this program can improve the above abilities so that it makes students grow up as future engineering leaders. These abilities include analytic ability, creativity, speech ability, persuasive power, etc.*

This paper is about an effect of Undergraduate Research Innovation Program (URIP) where it is Hanyang University, and effect of the adaptation over the course. URIP is not traditional study-centered lessons, students participate directly in the research project. The students participate to a research subject directly and form makes the design, production, experiment, result report. The subject stated in Fair form at 2006, at 2010 settle regular subject. Study method is parallelism with the majors in the semester and it prepares a theoretical base, and go side by side with experiment and it acquire the experimental method. All classes a topic through the interview with the academic advisor, and proceed the class, experiment and analysis about the selected topic in PBL (Project-Based Learning) method. Students discuss about the research that they proceed about one semester, they submit the final report or an end product through the feedback task. This class culture which is inventive and active, can get the effect of personality education which they could not get in the existing simplicity education. And as a result, URIP contribute to cultivate of the engineer preparing to the liberal arts knowledge.

The effectiveness analysis of the program, we performed by the result of survey targeting undergraduate student. An URIP arranged an adaptation after graduation and improvement plan through this data.

Keywords : *URIP, Undergraduate student, Project-Based Learning, Hanyang University, Engineering Education*

INTRODUCTION

Contemporary modern society demands a global engineer with creativity and scientific management capacity. In order to promote the global engineer, the demand-driven education and outcomes-based education rather than a discipline based curriculum are needed. In Hanyang University it has operated URIP program to train creative global engineer.

OBJECTIVES

In this paper, there are purpose to conduct the effective analysis of the URIP program. The contents of effect analysis are performance structure and influence on the undergraduate student of URIP program.

METHODS

In order to understand the influence of the program, we performed a survey about an effect and learning satisfaction level for the undergraduate student. We collected that result and implemented the analysis. We performed research by integrating research which analyzes a quantitative data and a qualitative data together, however, we give importance to quantitative data in order to search for the factor an effect on the program in the student point of view.

RESULTS

The result of the research, the students taking an URIP showed the showed the greatest satisfaction in the in the practical experience. They realize the team-based project as the chance to improve the ability. However, there were some negative opinion about uncooperative participation and lack of experimentation time.

CONCLUSION

In order to understand the influence of the program, we performed a survey about an effect and learning satisfaction level for the undergraduate student. We collected that result and implemented the analysis. As a result, the student satisfaction is quite high, however, some limited factors and negative opinions on the need to improve participation was confirmed.

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P_IE_07

ENGINEERING EDUCATION FOR INDIA – PRESENT AND FUTURE

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ABSTRACT

Currently, engineering education in India is suffering because a good percentage of the faculty who have graduated during the last decade in majority of the Private Indian engineering colleges are neither trained in Industry nor they have that much practical knowledge to inspire students. Such members were only easily available for the engineering colleges when Engineering Education in India was opened to the private sector in a big way because they did not get job elsewhere, as they were not employable in Industry. Opening more IITs, IIITs and NITS in India by the Union Government should have been done prior to opening Engineering Education in a big way to ensure availability of Faculty with required skills and Knowledge. The data about the number of Faculty hired from abroad during the last two decades is also insignificant. One of the major reasons for the failure is due to the absence of a good Engineering Education Plan for the Country. This paper discusses the various issues related to the present crisis and proposes how engineering education in India could be pulled out of the abyss.

Keywords : *Engineering Education in India, Faculty improvement, Engineering Education Planning*

P_EE_01

THE PROBLEMS OF PROVIDING ASSISTANCE TO MIGRANTS WHO COME TO RUSSIA WHEN THEY PASS THE EXAM FOR OBTAINING PERMISSION FOR TEMPORARY RESIDENCE, WORK, PATENT AND RESIDENCE PERMIT

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ABSTRACT

Together with the international community Russia is building a common future including implementing effective assistance to visiting foreign nationals. There is a need to ensure that annual migration flows at the level of 300 thousand people in Russia. As a highly developed country, Russia suffers a shortage of specialists including people with engineering education. Migrants are one of the sources for manpower replenishment. Migration processes in Russia develop rather intensively so in 2015 the territorial bodies of the FMS of Russia registered 8,7 million foreign nationals. Currently there are 298 courses of Russian language for foreign citizens in Russia, 99 of them work on a Pro Bono basis. By the decree of the President of the Russian Federation on the 7th of May 2012 № 602 "On ensuring ethnic harmony" was provided for the introduction of mandatory exams in Russian language, history of Russia and basics of Russian legislation for migrant workers, except for highly qualified specialists.

According to the article 15.1 of the Federal law from 25.07.2002 № 115-FZ "On legal status of foreign citizens in the Russian Federation" certificate of foreign citizens in the Russian language, knowledge of Russian history and fundamentals of legislation of the Russian Federation, the Federal law from 20.04.2014 № 74-FZ, a foreign citizen when applying for the permit for temporary residence, residence permit, work permit or patent, will be obliged to confirm the Russian language proficiency, knowledge of history of Russia and fundamentals of legislation of the Russian Federation, in particular the certificate of proficiency in Russian, knowledge of Russian history and fundamentals of legislation of the Russian Federation. The Russian Federation consists of republics, territories, regions, Federal cities, Autonomous oblasts, and Autonomous areas are equal subjects of the Russian Federation.

There are different requirements for the exam which is a significant problem of providing a real assistance to migrants for obtaining a temporary residence permit, work permit or patent, or a residence permit provided for by two Federal laws governing Federal and regional systems for the comprehensive exam.

The first is the Federal system the comprehensive exam in the Federal law of 20.04.2014 № 74-FZ "On amendments to the Federal law "On legal status of foreign citizens in the Russian Federation".

The second is regional the examination procedure by the Federal law of 24.11.2014 No. 357-FZ "On amendments to the Federal law "On legal status of foreign citizens in the Russian Federation" and certain legislative acts of the Russian Federation".

These procedures are not uniform, so we cannot establish a single education space for foreign nationals wishing to live and work in Russia.

Attention is paid in the article to a number of contradictions that creates enforcement problems in these laws.

First, the Federal system comprehensive exam (FS) provides for unity of methodological requirements, the amount of knowledge of foreign citizens and united organizational and methodical conditions for all local centres of testing and in the regional procedure of exam requirements for level of proficiency in russian language as a foreign language, the amount of knowledge on the history of Russia and basics of Russian legislation for foreign citizens vary depending on the subject of the Russian Federation.

For example, we identified a number of significant violations of the minimum level of knowledge of foreign citizens placed in accordance with the order of the Ministry of education and science of the 29th of August 2014 № 1156. In particular, in the framework of a regional arrangement established in Moscow and the Moscow region does not comply with the provisions of paragraph 2 of annex № 2 of the Ministry of education of Russia. Conducting subtests "Speaking" and "Writing" are not set.

Second, under Federal rules the development and regular updating of test materials and educational documents are conducted under the supervision of the expert community and the Ministry of education and science of Russia and development and update of test materials are not regulated in the regions.

Third, the Federal rules established a single form and procedure of examination which ensures certainty and uniformity of conditions of the exam while the regional form and conduction of examination in different subjects of the Russian Federation are different.

We identified general shortcomings in the regions. There are no road maps for the organization and administration of the exam, there are no selection criteria educational organizations involved in the exam, no exam papers or an insufficient number of them, there are no regulatory-methodical documents as well as the accounting system of the examination results.

Fourthly, a central registration of certificates and persons who passed the exam is set up at the Federal level and at the regional there is no such thing.

Fifthly, there is the rapid exchange of information with regional divisions of the FMS of Russia according to Federal acts and after the exams in the regions, Federal migration service of Russia has no information about the authenticity of documents on the exam that generates the circulation of counterfeit certificates.

However, these problems require the development of a comprehensive unified methodology for conducting the foreign nationals' exam on both the federal and the regional procedures. RUDN University is one of the five Russian core facilities with accreditation to hold testing for foreign citizens and to issue the certificates. In University the experience of this test in all regions of the country is generalized and a new method of conducting a comprehensive examination for foreign nationals is developed. This technique ensures: the unity of requirements to the level of knowledge and transparency in the examination procedure, the use of electronic testing and assessment materials, electronic interaction between the testing centers and government bodies, the organization of preliminary preparation of candidates through the Internet.

In general, great methodological and informational assistance in preparing for the exam has been made for foreign nationals. Therefore, RUDN had published bilingual vocabularies of historical, legal and cultural terms for foreign citizens who pass Federal system comprehensive exam. Furthermore, published works on Russian history and the basics of the Russian Federation law, in particular, translated into Romanian, Tajik, Uzbek (Cyrillic and Latin), Vietnamese, Turkish, Chinese, Korean, Kyrgyz languages).

This Presentation is devoted to features of innovative techniques, the basic prospects of its implementation and the potential benefits of its use for attracting qualified personnel in Russia.

Keywords : *migrants, Russia, comprehensive exam, test materials, rapid exchange of information*

P_EE_02

TARGETED INTERNATIONAL GRADUATE RECRUTING – A CASE STUDY FOR RECRUTING MEXICAN STUDENTS

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ABSTRACT

Advantages of having international students enrolled in graduate degree programs at US universities includes developing international ties, bringing financial resources, maintaining a diverse intellectual pool of students and fulfilling a shortage of engineering talent in the US. Recruitment and retention of international graduate students have been more challenging recently with increased competition from other host countries such as Australia, the UK and Germany. Several approaches have been reported to ensure that the number of international students on campuses does not decline including collaborations, additional efforts in recruitment, and new funding for marketing and program promotion. However, research indicates there is a need for coordinated efforts to secure the highest quality international students.

This paper presents a case study of such a coordinated effort – to increase the number of high quality students from Mexico into a large college of engineering in the South of the United States – with results from three years of the program. Even though Mexico and the United States are neighbors with strong economic ties, during 2013, according to the Mexican government out of 224 students sponsored by CONACYT in the information technology area who were selected to study abroad, only 20 students came to the United States (less than 10%). During the Fall 2013, at the authors' institution, although a very large college of engineering with geographical closeness to Mexico, only 32 graduate students from Mexico were enrolled out of 1,958 international students (less than 2%).

With the pilot program implemented during summer 2014 this numbers has significantly increased. The pilot program was implemented during summer 2014 in partnership with two states in Mexico (Yucatan and Zacatecas) and a large sponsoring body from Mexico. The program was also implemented during the summers of 2015 and 2016. The goal of the sponsor agency is to improve the human capital development in Mexico in the IT sector. This paper describes the recruiting and selection process, the implementation and the results of the three years of the program. Insights into this project can serve as a model for international student recruitment.

Keywords : *International Recruiting*

P_EE_03

DETERMINATION OF CONCENTRIC COMPRESSIVE FORCE OF GFRP SECTIONS ENCASED IN CONCRETE COLUMN

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ABSTRACT

This paper presents new composite column in which the steel cross section is replaced by GFRP section. Pultruded GFRP profiles are manufactured as a prismatic section similar to hot rolled steel sections so that they can be used in the structural members instead of steel. The significance of replacing steel sections by GFRP sections is to present economic and light sections because of the high strength to weight ratio of GFRP material as well as getting rid of problem arising from steel corrosion. The significant research is to propose a practical and simple method for computing the strengths of different GFRP profiles encased in concrete composite columns. Numerical model is presented to clarify the behavior of pin-ended concrete encased GFRP section composite columns under concentric Load and obtain the ultimate strength and failure mode of the new composite columns. The initial overall (out-of-straightness) geometric imperfection is carefully incorporated in the finite element model. Good agreement is observed between the ultimate compressive loads calculated from proposed method and failure buckling loads obtained from numerical model. Finally, a comparison is conducted between numerical model of 3D pin-ended axially loaded concrete encased steel columns and 3D pin-ended axially loaded concrete encased GFRP section columns using the same dimensions and section properties to obtain the critical buckling load for two composite columns. The output result of compressive strength capacity showing about 25% reduction.

Keywords : *GFRP profiles; Composite column, Euler buckling Load, Finite element model, Axial Compressive strength, Analytical method*

P_EE_04

DIGITAL MATERIALS PLATFORM

Jisun LEE

MnL is an abbreviation of Materials Library, which precisely indicate Digital Materials Platform. As digital fabrication has flourished thanks to recent technology development, materials have taken more critical roles than ever before. In the individual domain, 3D printing opens the possibility for individuals to build their own product. If the so-called third industrial revolution is bringing individual producers, the potential needs from makers and prosumers cannot be underestimated.

Also, in the industrial domain, there still a gap between creative products and the new materials to be used in these products. Those restrictions mainly come from when high-performance materials are needed. They may be difficult to be applied due to their structural complexity, high functionality, affordability, and etc. To take a further step from individual/laboratorial domain to the industrial domain, a linkage between labs to market is required. By putting materials at the core of innovation, MnL would become a possible linkage to leverage the gap between materials researchers and designers.

With this project, a materials library would aim to give up-to-date information on various materials, so that people can get useful information in order to foster their creative projects. We would like to look into broadening and deepening the materials world by linking them to the following fields: construction, architecture, energy and environment, digital fabrication, and contemporary design. By doing so, I would like to see cooperation improve between prosumers, makers, designers, architects, engineers, and materials researchers to develop and bring innovative products to the market. And furthermore, MnL platform could discover the future possibility to promote collaboration between materials research and creative industries to drive faster, innovative and sustainable products and architectures development.

P_ML_01

A CASE STUDY ON MULTIDISCIPLINARY PROJECT IN DEPARTMENT OF INTERDISCIPLINARY AT GRAD SCHOOL OF KOREA

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ABSTRACT

Reduced human resource demand in relation to Humanity major in domestic economy is issued. Because, that major has had job application continuously. However the Humanity increase in value through the melting design, engineering together. A popular example can be the Steve Jobs who change the world and paradigm by combining IPHONE with humanity and design. Present day which come from saponaceous civilization development has a saturation in novelty engineering and technical progress. Likewise, in global economic competition, a discovery of innovative idea or item is not easy. These phenomenon suggest meaning that the possibility of innovation with just fragmentary knowledge, thought cannot be survived. In the enhancement of awareness about these, the government of Korea asserted the cultivating people of multidisciplinary ability and would not treat the liberal arts, natural sciences, art, design, music and physical education independently more.

Lately, the Ministry of Trade, Industry and Energy in Korea established the department of interdisciplinary at Hanyang Univ. Sungkyunkwan Univ. Konkuk Univ. Dankook Univ. Chosun Univ. Hoseo Univ. Seoul National Univ. of Science and Technology for master course student. For many years, that laboratory has been working on the interdisciplinary project. Based on these fact, this paper analyze the case of multidisciplinary project and set a goal of get objective view about domestic interdisciplinary education.

The case study is bounded on the Hanyang Univ. Hanyang Univ. has a department of interdisciplinary systems and 40 master course student are in school. In laboratory, various major who undergraduate studies like electronics, mechanics, the Korean literature course, Business, industry management engineering, and design are stationed in. Thus, several of multidisciplinary project is done or being done. In order to get the goal, questionnaire method and quantity analysis would be chosen.

Keywords : *Case study, Interdisciplinary Project, Department of interdisciplinary, Grad school, Questionnaire, Quantity analysis*

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