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REFLECTIONS OF A COMMUNITY PROJECT USING INFORMATION TECHNOLOGY

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Abstract

This paper describes the undertaking of a community project as the semester project for the second year students of Diploma in Information Technology (DIT) in School of Information Technology (NYPSIT). It shares the experience of the collaboration with a non-profit organization, Food From The Heart (FFTH), to provide an applied learning environment for the students to solve a real life problem. The paper also evaluates the effectiveness of the learning environment against an authentic assessment framework. In semester 2 of 2013, SIT works with FFTH, to develop an enterprise web application to support the day-to-day operations in their warehouse. FFTH aims to reach out to the less-fortunate and brighten their lives by alleviating hunger through a food distribution programme. The students spent 15 weeks gathering requirements from the users, analyzing them and working in groups of 4 to 5 to develop their proposed solutions. The development platforms of the web application could be using Microsoft .Net or Java Enterprise. The users from FFTH were invited to attend the presentation by the selected teams during prototype review and final project presentation. The best solution was selected to continue as a year 3 final year project. The purpose was to enhance the application for live deployment at the warehouse. By successfully completing the project for FFTH, the students had also contributed meaningfully to the community. The reflections highlighted in this paper focused on how the authentic learning environment has enabled the students to analyze and synthesize the range of skills and knowledge to produce the final product. Some quantitative measurements were collected from the student feedback that includes the learning experiences and the changes in their personal values towards contributing to community services. Finally, the paper concluded with an evaluation against the critical elements of an authentic assessment framework of how well the learning environment that FFTH project had provided.

Keywords: *community, semester project, authentic assessment, information technology*

Introduction

Nanyang Polytechnic (NYP) is a premier tertiary educational institute in Singapore whose vision is to provide quality education and training in supporting the nation's technological, economic and social development. The Teaching Factory ™ (Lin Cheng Ton, 2002, About Teaching Factory™ in NYP, 2009) is the unique teaching concept in NYP to addresses the hitherto unmet challenge commonly faced by institutions in trying to emulate a real world environment within a typical institutional setting. It provides a platform for staff and students to work together in creating an environment for teamwork, innovation and establishing strong linkages with the industry.

Semester Project Modules

The semester project module is offered to the students in DIT as a core module. It is designed to let students form teams of 4 or 5 to complete a project development work throughout the 15-week duration. The semester project, together with the relevant modules in that semester, forms an integrated learning environment for the students to complete the project assignment. Through this integrated approach in the 3-year diploma curriculum, the students familiarize themselves with the various phases in software development life cycle and gain experiences in problem solving, cultivating good team work and effective communication skills. When the students graduate from the course, they will be more competent in handling industry projects in their careers.

In this case, the scenario from the discussions with FFTH to develop an enterprise web application for their day-to-day operations in the warehouse was adopted as the project scenario for about 120 students from DIT stage 2 in 2013/14 semester 2. The following sections explained the details about the project executions.

Understanding the current situations at FFTH

A meeting was set up with FFTH and the project supervisors before the start of the semester. In the

meeting, the team discussed the scope to focus on the following four areas:

- **Event management** – This is the administrative functions to allow TTFH staff to schedule delivery, collection, sorting and packing sessions so that the manpower and resources can be allocated more efficiently. Currently, the planning is done manually on a big white-board.
- **Volunteer management** – The FFTH volunteers should find this function useful as the events published will enable them to sign up and register their available time to help in the activities. Currently the staff answers calls from the volunteers to register them for events.
- **Sorting process** – The current sorting of all donated items is manually carried out: each item is sorted into different categories; the descriptions and quantity are then recorded separately on papers; the FFTH staff then enters these records into Microsoft Access database. The process is time consuming and error prone.
- **Packing process** – This process is to pack the donated items according to some standard packing lists to be distributed to the various beneficiaries.

When the term had started, a field trip was organized to visit the FFTH warehouse. Due to the space constraint at the warehouse, only the project team leaders were invited for the visit. During this trip, the FFTH staff orientated the students on the layout of the warehouse to understand how the donated items are stored. A session to sort the donated items was also arranged to let the students understand the current sorting process. The students segregated the items in different categories and recorded the item details manually. They also took videos and photos so that the information can be shared with those were not able to visit the warehouse. Towards the end of the visit, the students interviewed the warehouse staff for more clarifications. We observed that the half-a-day visit had stimulated the students' interests to find out more details and the hands-on sorting activity made them understand the challenges faced on the ground. The experiential learning at the warehouse had made the students more empathized with the users and enables them to think of more innovative and creative ideas in their project proposals.

Proposing the ideas

Many project teams had proposed good ideas to meet the FFTH requirements. Some of the innovative ideas that we noticed from their proposals were:

- **Bar code scanning using mobile devices** – one project team suggested having an application in the mobile phone to scan the bar codes of the donated items. The details of the items will be captured and then uploaded to the backend server. The idea replaced the current way of manual recording and would increase the productivity of the sorting process with higher accuracy.
- **Grouping of similar donated items** – currently each donated items is recorded as an individual item. One project team proposed a product hierarchy to group the donated items for easy searching and retrieving of items. For example, the category "Vegetarian Soup" will include all can soup that are vegetarian from all brands.
- **Finding equivalent substitution** – the suggestion was to solve the situation when a particular type of donated item did not have sufficient stock for distribution and it helps to find suitable substitutions. For example, a 20-packet Cafe21 coffee pack can be substituted by a 20-packet Supper coffee pack in the category "Hot Coffee Drink".
- **Predicting future demands** – with all records captured in the database, the analysis of how the donated items are being distributed can help to predict the demand in usage. It provided a piece of vital information for FFTH to plan their food drive activities to collect more of these highly demanded items from the public.

The suggestions from the students had shown critical thinking to synthesize the users' needs and to be able to empathize with them. This is one of the valuable learning outcomes that the students had demonstrated from this community project. The FFTH representatives who attended the mid-term prototype presentation commented that the students showed good understanding of the operational needs and the proposed features were relevant and innovative. The good impression had made the FFTH representatives looking forward to see their ideas being implemented in the final application.

During the final project distinction presentation, a total of 6 students from 4 project teams were nominated to present their outstanding implementation to all project supervisors and the FFTH representatives. The following features were demonstrated:

- **Calendar based event management** – to allow the administrator to create events for FFTH and each event is linked to the volunteer registration page.
- **Volunteer Management** – to allow the volunteers to register online for published events. SMS reminders will be sent to them nearer to the event dates
- **Bar-code scan by android phones** – to allow the volunteers involved in the sorting session to scan the donated items and records will be inserted into the back-end database.
- **Inventory dashboard** – to visually display the quantities of the donated items in the warehouse and with indications when the stock level falls below a predefined threshold value

These demonstrations had shown clearly the use of technologies to make the warehouse operation more efficient and effective. The FFTH representatives were very impressed by the students' work. In fact, they reflected that they gained better understanding and had a clearer picture of what could be achieved through attending these presentations. They also found the interactions with the students had helped them to shape the requirements more clearly. The students felt sense of achievements by their encouraging commendations.

Learning Experience by the students

An online survey was conducted to gauge how the students feel about this community project. Four questions were asked and 54 students responded. The summary of the findings is presented below.

- Is this the first time you developed an enterprise application to help a community like FFTH? (Figure 1). The survey result shows 96% of the students were doing this project as their first community project.

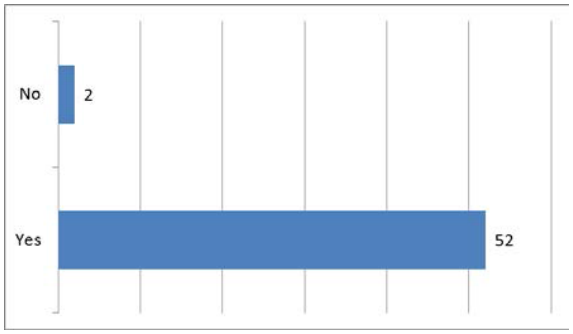

Figure 1 – More than 90% of the students are first time involving in community project

- How is your experience in developing the enterprise application for FFTH? (Figure 2). We were glad to see that 85% of the students could manage the project challenges either by solving the problems individually or working out the solutions with their peers. It shows that the students possessed good problem solving skills for real life problems and good team work to help each other. Many students realized that they have to synthesis and construct their understanding like professionals in order to design the enterprise applications to meet the operational requirements. It was a challenging project to many of them but they see the values of putting efforts to develop useful applications for the users.

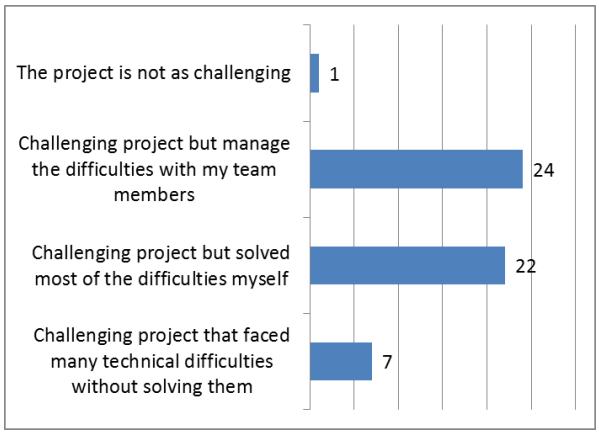

Figure 2 – Overall experience for the project development for FFTH

- Does this exposure help you changed your values and opinions towards better contributing to community services? (Figure 3). 85% of the students indicated they were more willing to be involved in community service. In fact, many students shared their views that they were in a better position to advise their relatives and friends of the appropriate items to donate to charity and they also realized that many non-profit organizations need technologies to help them to function more effectively so that more needy people can benefit from their services.

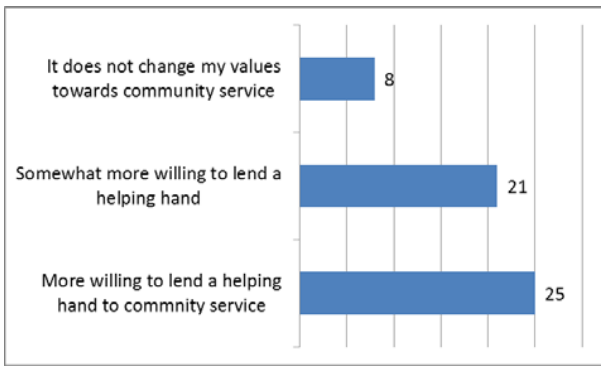

Figure 3 – Change of personal values towards contributing to community service

- Would you recommend more community projects in future semesters? (Figure 4). Though many students found the project challenging but they strongly recommended similar arrangement be carried out for future semesters. The reason is obvious: to have a deeper understanding and high-order thinking in solving real life problems!

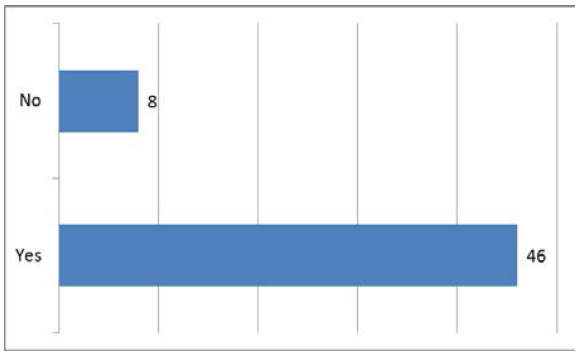

Figure 4 – Recommendation of real-life projects for semester projects

Below are comments from some of the students describing their views about their learning experience.

- "I learn that the projects in the previous semesters were much simpler compared to this one because this project really requires a lot of thinking and it is challenging as we need to listen to real customers' requests and manage to do it for them to help them out."
- "The business logic that we have to think about was not easy as we might not be as experienced as the users."
- "During this project, I have learnt that many non-profit organizations may need software systems to help them in their work. So by doing this kind of project, we can help them in one way or another to improve their situations. Secondly, I think I had improved my programming skills."

Linking to Authentic Assessment

With the recent review to enhance the applied education model in polytechnics, the integration of classroom learning from real-life applications and the need to creatively apply concepts to practical problems are again re-emphasized. This is particularly important as one important objective of the polytechnic education is to build up the students' skills and competencies required to thrive in the economy of the future. Therefore, to align our graduate profiles to meet the expectations of the industries, it is not about using the assessments to determine the skill mastery but a shift towards assessing the performance of their knowledge that is demanded in the diverse and rich context of real life situations. The project that we had collaborated with FFTH aligns the purpose of this shift and this links to the topic of authentic assessment.

The basis of authentic assessment as mentioned by (Wiggins,1993) and (Wehlage, 1996) denotes that students can prove their knowledge through applying what they have learned to the real world. They are able to demonstrate what they learned in a unique way that showcases their strengths. The characteristics of authentic tasks are in general real-world relevant but poorly-defined. Therefore, the students are required to organize, interpret, evaluate or synthesize the prior knowledge in order to complete the activity. There are many possible competing solutions to provide a wide diversity of outcomes. This creates values beyond the classroom because the students have made connections between substantive knowledge and the real world domains.

The practical framework proposed by Kelvin Ashford-Rowe (2013) to guide the design of authentic assessment has highlighted eight critical elements from the literature to maximize the desired learning outcomes. The following table shows an attempt to evaluate how well the learning environment that FFTH project had provided against this framework. The evaluation also helps to identify rooms for improvements similar opportunities in near future (Table 1).

Critical Elements	FFTH Project Execution
1. An authentic assessment should be challenging (To what extend does the assessment activity challenge the assessed student?)	The project scenario is a real operational situation at FFTH. The degree of challenge is fully reflected in real world situation to all project teams. [Criteria fulfilled]
2. The outcome of the authentic assessment should be a performance or a product (Is a performance or product requirement as a final assessment outcome?)	The students have developed working prototypes to illustrate fulfilling the requirements by FFTH and some demonstrations were viewed by the representatives from FFTH. [Criteria fulfilled]
3. The authentic assessment design should ensure transfer of knowledge (Does the assessment activity require that transfer of learning has occurred, by means of demonstration of skill?)	The project encompassed all disciplines and activities to be carried out in a complete software development life cycle. The students not only had to apply the software engineering knowledge for developing the system but also have to understand the operational needs of FFTH. The assessment of transferring the theoretical knowledge to the design and development of

	workplace system had taken place. [Criteria fulfilled]
4. Metacognition as a component of authentic assessment (Does the assessment activity require that metacognition, s demonstrated, by means of critical reflection, self-assessment or evaluation?)	There were project milestones and check-points where the students' progress and performance were evaluated. In some occasions, the representatives from TTFH were invited to the review sessions. However, the emphasis of getting the students to reflect critically and assessing their own performance were somehow lacking. This is one area that should be improved in future. [Criteria partially fulfilled - probably a learning journey for each student should be maintained throughout the whole project.]
5. The importance of requirement to ensure accuracy in assessment performance (Does the assessment require a product or performance that could be recognized as authentic by a client or stakeholder?)	There are 2 aspects in this criterion. Firstly, the ability to elicit the users' requirements completely and accurately. Secondly, to be able to assess the final product built according to the requirements. In this case, the students visited the warehouse to have a hands-on experience on the actual operation and numerous interviewing sessions with the users satisfied the first criterion. Due to time constraints, only selected prototypes were evaluated by the representatives from FFTH. But the project supervisors, who function as a client, assessed on all project teams. [Criteria fulfilled]
6. The role of assessment environment and the tools to deliver the assessment task (Is fidelity required in the assessment environment? And the assessment tools (actual or simulated)?	The tools used to develop the application for FFTH were either Microsoft .Net Enterprise platform or Open source Java Enterprise platform. These are the actual platforms where software systems are developed in the real world. However, the final working prototype was not evaluated to see whether it could meet the actual operational environment. But the development was continued as final year project to enhance and refine the application further so that it is more robust to operate in the actual warehouse environment. [Criteria partially fulfilled -]
7. The importance of formally designing in an opportunity to discuss and provide feedback (Does the assessment activity require discussion and feedback?)	The review and feedback on the progress and performance were mainly technically focused. The reflection and feedback to go beyond evaluating the personal growth is somewhat lacking. [Criteria partially fulfilled – as recommended in (4)]
8. The value of collaboration (Does the assessment activity require that students collaborate?)	The socio-cognitive value of collaborative learning is happening within and among the project teams: group problem solving that each student learns from one another; communication skills and teamwork skills are all practiced. [Criteria fulfilled]

Table 1 – Evaluation of learning environment provided by FFTH project against the proposed Authentic Assessment framework

Results and Discussion

The collaboration with FFTH in the semester project has linked the academic study and the community service to develop the students' technical skills and personal growth. The experiences that the students acquired from this project serve as their job preview to solve real world problems when they join the industries upon graduation. It also provides opportunities for students to carry out the activities for authentic assessment within a project module in a diploma program. The following summarizes the learning

experiences in this community project from the students' point of view:

- it enables the students to demonstrate their ability to analyze and synthesize the range of skills and knowledge to produce the final product
- it deepens the critical thinking skills set up by the boundary conditions and better prepare the students for their work role
- it allows the students to contribute to the community meaningfully using Information Technology

As for the teaching team, it is the first time a problem involving real users is being adopted as the semester project scenario. There is no problem for the project supervisors to provide technical advices to the student in the implementations of the enterprise application. However, there were challenges faced with the students along the way, especially issues pertaining to domain knowledge in the warehouse operations and business process for sorting and packing the donated items. Nonetheless, the overall experiences had been enriching to all project supervisors. The team had identified the following critical factors contributed to the success of running the project module:

- instead of providing the students with detailed requirement specifications, let the students directly involved in the gathering of the requirements through actual site visit, interviewing and clarifying with FFTH staff
- enthusiasm, strong support and commitment by FFTH representatives to provide clarifications to the students' quarries
- involvement of FFTH representatives in the review of the prototypes and providing feedback to students so that they understand what the users really need
- good team work and perseverance within project teams

To maximize the desired learning outcomes for the students when such collaborating opportunity arises in near future, the teaching team recommended the following guidelines:

- to adopt the authentic learning experience for year 2 students either in semester 1 or 2 as the students are more ready to handle real world projects
- to continue as final year project or internship so that the working prototype can be enhanced to meet the needs in deploying the product at the actual operational environment
- to maintain an online student learning journey to let share, discuss and learn from each other

Conclusion

This paper first presented the details of the collaboration with FFTH to provide a real world scenario for the semester project in DIT stage 2 students. Next, the learning environment provided by the project is compared to the authentic assessment framework to measure its effectiveness and the recommendations for future improvement were also identified. The reflections from the teaching team on the success factors and recommendations to maximize the learning outcome in authentic learning were also highlighted. In conclusion, we believe that as educators in the institutions, we are in powerful position to influence the students' approaches to learning. By providing an adequately challenging real world problem as the scenario to project modules, the students are able to adopt their own strategies in the authentic learning environment to achieve 'success' in developing the desired product. Overall, it was an encouraging experience for both the students and the teaching team.

Acknowledgements

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TEACH FROM PROJECTS: CREATING YOUR OWN CASE STUDY IN CLASSROOM

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Abstract

Case studies have long been used in law, business, and medical school. It has become popular in engineering and social sciences school. The use of case studies is a very effective classroom technique as it incorporates many of the features and advantages of discussions, group work, cooperative learning and research skills (Killen, 2006). It also encourages students to reach a deeper understanding of the concepts and issues than they would from just reading or listening to a lecture (Volpe, 2002).

This paper describes the use of case studies created in-house from final year projects in classroom teaching. Archive of final year projects is brought to life by interweaving them into course materials for teaching and learning. Final year projects are adapted and tailored as teaching materials to explain a topic or concept in modules. Rather than learning about project content in the form of archive, students learn about a topic through the real world projects.

The use of customized case studies for teaching was introduced in 6 engineering modules across year 1, 2 and 3. The benefits include allowing for association to be established between concepts and real life applications, leveraging on wide repertoire of projects to accelerate learning and engaging students to construct holistic knowledge through proper scaffolding of building blocks. It has also increased student learning motivation through connecting to real life projects, cultivated thinking and problem solving abilities and developed student readiness for final year projects through infusion in early stages. The use of final year project as case studies has also piqued students' interest beyond the topic. More than 60% of the students went on to find out more about the final year projects done by their seniors.

Infusing real world project closer to home into modules has served as an enabling tool to enhance students' learning experience by nurturing their enthusiasm for their subjects, developing deep understanding for the topics, building their metacognitive skills and preparing them for solving real as well as complex problems (Boehrer, 2002).

Keywords: *project, resources, case study, archives, engineering*

Introduction

This paper describes the use of case studies created in-house from final year projects in classroom teaching. Archive of final year projects is brought to life by interweaving them into course materials for teaching and learning.

Materials and Methods or pedagogy

Case studies are commonly used in business schools, law schools, medical schools and social sciences. They have been proven to be effective classroom techniques in encouraging students to apply what they have learnt to tackle real-world problems.

A case study is a representation of a real-life situation. A simple case study consists of a scenario (the context), a statement of the issues (the focus of the case), the task (the open problem) and any resources needed for the task. Additional supporting materials such as articles or videos may also be provided (Cox, 2009). Case studies are used as a teaching tool to show the application of a theory or concept to real situations. It also provides a rich basis for developing students' problem-solving and decision making skills. They "bridge the gap between theory and practice and between the academy and the workplace" (Barkley, Cross, and Major, 2005).

In Nanyang Polytechnic, all industrial projects are archived in the in-house developed system named Accumulated Experience Sharing (AES®). More than 5000 projects have been uploaded and stored in AES® since its inception for the purpose of knowledge management. The rich archive of projects has served as a useful reference for all staff and students to learn about and learn from past projects. Course materials have also provided links to relevant projects in the AES® for students to explore and learn how certain concepts are applied in real-life situations (see Figure 1).

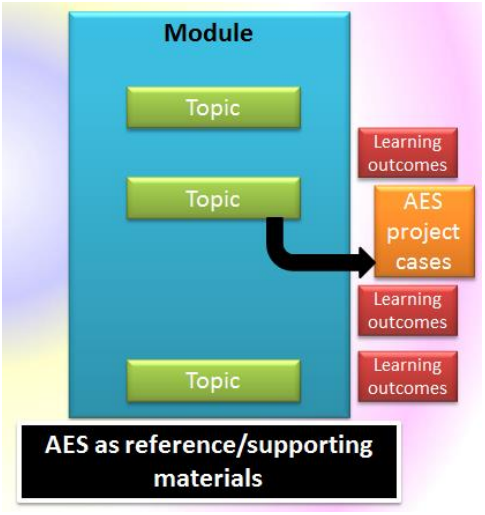

Figure 1: Linking project cases to course materials

AES® becomes a useful resource to tap upon. No longer a project needs to be commenced from zero base each time a fresh batch of students begin their 3-month full-time final year projects. AES® enables staff and students to learn past experiences from their peers, ensures greater continuity of projects and reduces start-up and learning curve for both staff and students. At the same time, the AES® serves as a base from which innovative ideas can be generated and new products & services created.

To further utilize the rich knowledge resides in AES®, a pilot trial was done to create in-house case studies from the archive. 6 modules across Year 1, 2 and 3 under School of Engineering were selected to pilot the project. Instead of using published material, final year projects are selected from the AES®. The relevant sections are then rewritten and tailored as case studies and embedded in the course materials for teaching (see Figure 2).

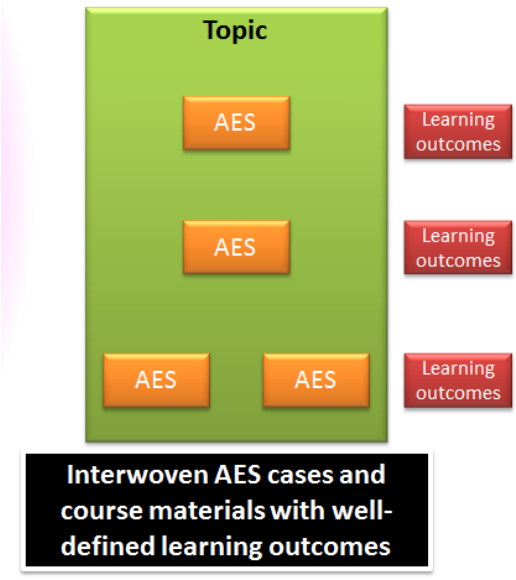

Figure 2: Embedding project cases in course materials

These real world projects are adapted for a few purposes - to illustrate theories, explain concepts or show working principles (see Figure 3).

Figure 3: Project is rewritten as case study

This can be done by using these case studies to show calculation or application and as an example for comparison or discussion (see Figure 4).

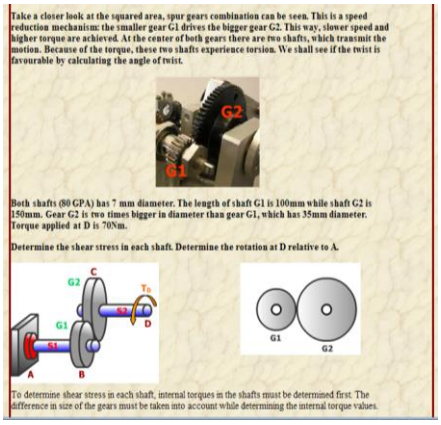

Figure 4: In-house case study used for tutorial

With the case studies designed in-house, the benefits on teaching and learning includes:

- Together with problem-based learning, co-operative learning, group learning, inquiry-based learning, pair-sharing, case-based learning is one of the approaches used for active learning (Michael, 2006). Teaching styles are transformed from a transmission approach to teaching through an approach that would help students to think critically and enable them to solve problems while content is being imparted at the same time.
- Archive of final year projects is brought to life by interweaving them into course materials for teaching and learning. A wide repertoire of projects can be leveraged to accelerate students' learning of concept.
- Case-based learning is embedded in constructivist theory as students make meaningful connections between their prior knowledge and the case materials (Martin et

al., 2008). The case study is used to engage students in constructing holistic knowledge through proper scaffolding of building blocks. Specific learning outcomes are linked to each case study devised and used in explaining the concept.

It is also envisioned that the students will benefit from the in-house case studies because:

- The learning motivation of the students can be enhanced through connecting to real life projects. As the projects are done by their seniors, they can immediately see how the concept they are supposed to learn be applied in real life. The theory does not remain as theory on books and the relevance of the theory becomes immediate. With that, the intrinsic motivation to learn can be ignited by the interest in the projects. Deeper learning can be achieved when the students are able to establish association between concepts and real life applications.
- Case studies connect students to real life experience, sharpen their thinking and inform their decision thinking (Breslin & Buchanan, 2008). Critical thinking and problem solving abilities can be cultivated through the case studies similar to the approach taken in final year projects. When the students are actively engaged in figuring out the principles from the examples, they can also be introduced to the use of analytical tools, be it quantitative or qualitative, depending on the case.
- Readiness for real life projects can be developed through infusion in early stages. As the students are introduced to segments of final year projects continuously in Year 1 and 2, the exposure makes learning of the concept authentic and prepares them for their capstone final year project. They will also get to understand that learning goes beyond solving tutorial questions and extends into solving complex problems in real world.

Two surveys were conducted at the end of the semester on lecturers and students.

The survey on students collected feedback on:

- Ease of understanding
- Usefulness in connecting concepts
- Effectiveness in linking concept to real life application
- Increase in learning motivation

The survey on lecturers collected feedback on:

- Ease of finding cases
- Usefulness in explanation of concept
- Effectiveness in linking concept to real life application
- Value in accelerating learning

Results and Discussion

Survey done by 331 students across Year 1, 2 and 3 involved in the pilot modules gave the following results:

1. 84.9% find the AES® case study useful.
2. 80.7 find that cases have helped in their understanding of the topic.
3. 81.0% see the connection between the concepts of the topic and its application in real like projects through AES® cases.
4. 78.5% feel that seeing how theory is used in real life project encourages them to learn about the topic.
5. 82.5% feel that the AES® cases were used effectively by the lecturer to enhance their understanding of the topic.
6. 82.2% feel that the examples used in AES® cases are clear and concise.
7. 80.4% feel that the examples used are pitched at an appropriate level.
8. 67.0% go to the archive to read up more about the project.

From the survey, results similar to those reported by Jennings (1997) can be observed in that despite the availability of published material there are benefits in instructors researching and writing our own cases.

The in-house developed case studies helped the students in their understanding of concept, connecting concepts to real life application and accelerated the learning. More than half of the students also went on to read up and find out more about the projects done by their seniors.

Feedback was also obtained from the lecturers. It was unanimously agreed that the use of case studies developed by them helps in building effective scaffolding that supports competence and motivation. However, despite the huge number of final year projects, it can be challenging to find appropriate ones to explain the concepts and to re-write these projects to an appropriate level for Year 1 and 2 students. Still, some reported that the process of writing case study has encouraged them to rethink the ways in engaging students' learning.

Moving on, the initiative will be expanded to involve more engineering modules in making use of case studies that are developed from project archive for teaching and learning.

The use of case study for teaching will continue to be an effective tool in helping the students to achieve deeper learning. What deeper learning calls for is not the accumulation of information and knowledge, but thorough understanding and the ability to innovate and solve real-world problems under new contexts (Ng, 2008).

Conclusions

The in-house developed case studies encourage students to reach a deeper understanding of the concepts and issues than they would from just reading or listening to a lecture (Volpe, 2002). They also have

served as an enabling tool to enhance students' learning experience by nurturing their enthusiasm for their subjects, developing deep understanding for the topics, building their metacognitive skills and preparing them for solving real as well as complex problems.

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FLIPPED CLASSROOM FOR DIFFERENTIATED LEARNING IN SOFTWARE ENGINEERING

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Abstract

A flipped classroom is a model of blended learning that rearranges how time is spent in and out of classroom by moving lecture outside the classroom to free up valuable class time for active learning and students engagement. In typically flipped classroom, students watch instructional videos, listen to podcasts or read e-book outside of class time but participate in group learning activities in class. This allows the students to assume the ownership of learning by learning on their own time and pace outside classroom while the class becomes the place for them to work through problems and engage in active learning with the presence of an instructor to provide timely feedback. Differentiated learning is ways to teach diverse learners based on differentiation of their readiness, interests and learning profiles through differentiation of content, process and product. This paper shares the experiences of the authors in using flipped classroom for differentiated learning for students with different learning abilities and needs in Software Engineering module. Process differentiation in Self-Directed Learning (SDL) prior to class in the form of various instructional mediums including videos and e-notes are designed to cater for the diverse learning profile and learning style of students. Students can choose to watch instructional videos and/or to read e-notes available on a Web-based Learning Management System where students can view and review them at their own pace and time. Moreover during SDL, students have to complete a worksheet related to the viewed content to help students attain the required foundations before attending the class. Participation marks are awarded to students who completed the worksheet to entice students to do their due diligence during SDL. During class time, active learning strategies such as tiered instruction, anchor activities and cooperative learning are used as content differentiation to allow students with different needs and abilities to maximize learning. Through active engagement and interaction with students during class, the lecturer is able to differentiate and monitor individual student's learning to provide immediate feedback and to identify students who needed more attention and provide them with the necessary help. The minute paper or exit card at end of class where students submit a short paragraph on what they have learnt or raise question they might still have, allows lecturer to differentiate and respond to students who still have doubts and misconception on the topic discussed in class. The feedback and comment in the minute paper are also used to tailor and fine tune the contents of the following week's lesson for diverse learners based on their interests and readiness. The authors also share their findings on the effectiveness of using flipped classroom in the teaching of Software Engineering module using measurement metrics of learning effectiveness, student satisfaction and lecturer satisfaction. Challenges and issues as well as recommendations for a more effective differentiated learning using flipped classroom model will also be discussed

Keywords: *Flipped Classroom, Differentiated Instruction, Self-Directed Learning, Learning Management System, Active Learning, Higher Order Thinking, Tiered Instruction, Anchor Activities, Cooperative Learning, Minute Paper.*

Introduction

The flipped classroom (also called Inverted classroom, flipped teaching) is part of a larger pedagogical movement that overlaps with blended learning and other instructional approaches that are meant to be more flexible, active and engaging for students (NMC Horizon Report, 2014). It refers to a model of learning that rearranges how time is spent in and out of classroom by moving lecture outside the classroom to free up valuable class time for active learning**.** In the flipped classroom model, teachers shift direct learning out of the large group learning space and

move it into the individual learning space with the help of technologies (Hamdan & McKnight, 2013). The traditional way of teaching has been to have students listening to lectures in class while having them reading textbooks and working on assignment outside of classroom. In a flipped classroom, teachers assign pre-class homework consisting of brief, recorded lectures and presentations, digital readings with collaborative annotation capabilities, and discussion board participation (Demski, 2013). This allows the students to assume the ownership of learning by learning on their own time and pace outside classroom in the form of Self-Directed Learning (SDL). This frees up classroom time to promote active learning through cooperative and team-based learning activities that aim to deepen students' understanding of the topic with the presence of an instructor to provide timely feedback and clarification (Bergmann & Sams, 2012).

Differentiated leaning (also commonly known as differentiated instruction) has been described as a teaching philosophy based on the premise that teachers should adapt instruction to student differences. (Willis & Mann, 2000). It is a way to teach diverse learners based on differentiation of their readiness, interests and learning profiles through differentiation of content, process, product and learning environment (Tomlinson, 2001). In this paper, the authors discuss and share their experiences in using flipped classroom for differentiated learning on a specific topic in Software Engineering, a year 2 module read by Diploma in Information Technology students from School of Information Technology, Nanyang Polytechnic.

Background

Using traditional teaching methods of lecturing to teach software engineering has limitation in cultivating the student's ability to apply theory to solve problems through collaboration to develop real-world software (Choi, 2013). The training of future software engineers will require students to be active learners and gain knowledge and experience not in isolation but in the presence of other learners and under the mentorship of instructors and practitioners (Gannod, Burge & Helmick, 2008).

In the School of Information Technology, Nanyang Polytechnic, Software Engineering is a 60-hour core module for the year 2 student of Diploma in Information Technology. The module had adopted a traditional teaching approach where topics were delivered in a lecture theatre using presentation slides to 120 or more students, coupled with corresponding tutorials with class size of 20. The diverse learning abilities and needs of the students made this heavily conceptual and theatrical subject even more arduous, with students scoring less than satisfactory results in certain topics in the examination. Against this backdrop, the authors identified the topic 'SCRUM Methodology' for our action research to investigate the effectiveness of using flipped classroom to incorporate SDL and active learning for differentiated instructions to cater for the diverse learning profiles of the students.

Methods

To investigate the effectiveness of flipped classroom for differentiated learning, the authors identified the class of 128 Diploma in Information Technology year 2 students as the experimental group who would be undergoing the flipped classroom method of teaching and learning in AY2013 Semester 2. The control group is the class of 147 Diploma in Information Technology year 2 students who had undergone the traditional lecture teaching method in AY2012 Semester 2.

In the flipped classroom experimental group, students were informed at the start of semester that the topic on 'SCRUM Methodology' will be conducted differently with the given schedule below:

Week 2: Briefing to students
Week 3/4: SDL on the specified topic
Week 5: Active learning activities in tutorial classes
Week 6: Feedback and clarify doubts of students

During SDL week, the students were given instructions to access the following bite-size instructional videos from YouTube:

- Introduction to Agile SCRUM
- Explanation in Agile SCRUM in summary
- Comparison between Agile SCRUM and Waterfall Model

The students were instructed to view and review these videos as many times as necessary to understand the concepts and practices of SCRUM. They were also encouraged to read the complementary e-notes available on Blackboard (a Web-based Learning Management Systems) at their own pace and time as well as participate in the discussion board on the Blackboard. By presenting information in multiple ways and allowing students to learn at their own pace, it helped to cater for the diverse learning profile and learning style of students in the form of **process differentiation**. In addition, each student has to complete an individual worksheet consisted of the following 4 questions related to the viewed contents before attending tutorial class on week 5:

- Match the common terminologies used in SCRUM
- Describe the framework of SCRUM
- Describe the technique of monitoring and controlling the progress in SCRUM
- Highlight critical considerations for adopting SCRUM in projects

To entice students to do their assigned tasks during SDL, two participation marks will be awarded to students who completed the worksheet. With this incentive, there is a better chance that students will complete the worksheet and come to class with the same level of understanding to be able to participate and contribute actively in class. This is crucial as flipping required the students to attain a foundation of competency before they engage in the classroom learning experience (Bristol, 2014).

With the bulk of content of the topic done outside of class time, the lecturer and tutors were then able to engage students in active learning activities during tutorial classes. During the tutorial classes on week 5, the students were given a case about developing a video conference web application (Pham, 2011). Students cooperated and worked in team of 4 or 5 members to discuss and analyze the adoption of SCRUM methodology and to plan for the Sprint backlogs in a number of iterations for the given case. As software engineering processes are highly iterative, the team-based cooperative environment provided by flipped classroom offered the opportunities to use iteration to refine artifacts and thus reinforce student knowledge and capability (Gannod, Burge & Helmick, 2008). The following active learning strategies were deployed as **content differentiation** to allow students with different need and abilities to maximize learning in class.

- Tiered Instruction – tiered activities designed to teach the same skill or concept but at varying levels or degrees of challenge, taking into account individual students needs and abilities.
- Anchor Activities – activities that students performed when they have completed present task or when the instructor is busy with other students. They provide the instructor with time to offer specific help and small-group instruction to students requiring additional assistance.
- Cooperative Learning – each member of the team is responsible not only for learning what is taught but also for helping team members learn. Students work through the task until all team members successfully understand and complete it.

During class time, the tutors assumed the role of facilitators and moved around the room to guide teams that might need help or clarification as well as to encourage interaction and cooperation among team members. Through active learning activities during class, the tutors were able to differentiate and monitor individual student's learning to provide immediate feedback and to identify students who needed more attention and additional help, allowing students' misconceptions to be corrected well before they emerge in the final assessment (Berrett, 2012).

The flipped classroom was concluded with a minute paper (also known as 'exit card') where each student has to reflect on their learning experience and to summarize what they have learnt or to raise doubts that they still might have. The minute paper allowed the tutors to assess the level of understanding of students as well as their readiness and interests. Students are awarded one participant mark of handling in the exit card as an incentive for participation where the feedbacks and comments are used to tailor and fine tune the content of the following week's lesson for diverse learners based on their interests and readiness.

The success of a teaching method or pedagogy does not rest only on its ability to improve learning effective of students but also depend on student satisfaction and lecturer satisfaction. The authors thus adopted the following facets of measurement:

- Learning Effectiveness
- Student Satisfaction
- Lecturer Satisfaction

For learning effectiveness, the authors examined the passing rate and mean score of the question on SCRUM methodology in final examination for both control and experimental groups. In addition, the effect size of the mean score is computed to measure the magnitude of difference in results between the two groups. Student feedback was conducted to measure the student satisfaction on flipped classroom method using survey. The authors conducted focus group discussion with the tutors who were involved in flipped classroom to gather feedback on their satisfaction level as well as to deliberate on issues and challenges faced in the implementation of flipped classroom for differentiated learning.

Results and Discussion

In this section, the authors share their findings on the measuring metrics of learning effectiveness, student satisfaction and lecturer satisfaction to appraise the level of success of implementing flipped classroom for differentiated learning in software engineering.

Learning Effectiveness

Learning effectiveness encompasses quality of flipped teaching being at least comparable to quality of traditional teaching method. In this aspect, the authors compared the scores of the examination question on 'SCRUM Methodology' between experimental group and control group, focusing on the passing rate (Chart 1) as well as the mean score (Chart 2).

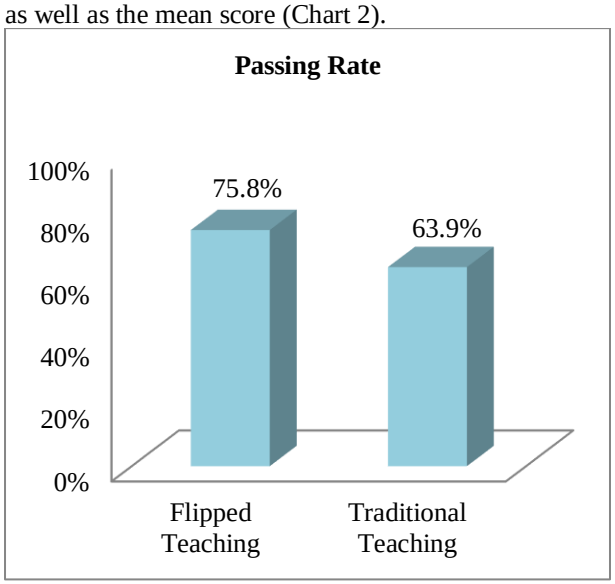

***Chart 1**: Comparing passing rate of exam question on 'SCRUM Methodoloy' between Traditional Teaching and Flipped Teaching*

Chart 1 depicts the result of the passing rate of flipped teaching group (75.8%) and traditional teaching group (63.9%). From the chart, we can see that there is a

significant improvement of 11.9% in student passing rate for flipped teaching compared to that of traditional teaching. The authors also compared the mean score of the topic assessment between the traditional lecture group and flipped teaching group and the result is depicted in Chart 2.

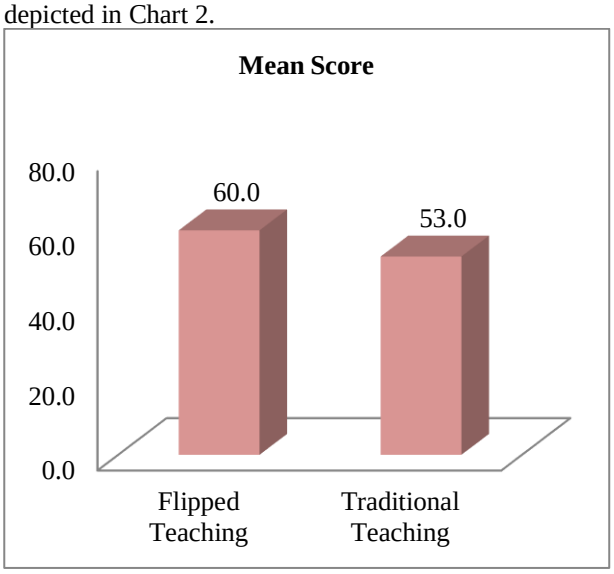

***Chart 2**: Comparing mean score of exam question on 'SCRUM Methodology' between Traditional Teaching and Flipped Teaching*

From the above chart, we can see that the flipped teaching has provided students with a learning environment that is superior to that of traditional teaching, with flipped classroom group achieving a mean score of 60 marks over traditional learning group of 53 marks, an improvement of 7 marks. The effect size of the mean score (Cohen's d) for measuring the magnitude of difference in mean between the two groups is computed to be 0.5025, indicating a medium effect of flipped classroom in the improvement of mean score. The improvement (albeit a moderate one) in mean score of can be attributed to the learning effectiveness of flipped classroom where students can view and review the videos at their own learning pace and benefit from active learning activities during class as well as the immediate and personalized feedback they received from tutor on their performance in class.

Student Satisfaction

The level of student satisfaction was based on the student feedback collected from the flipped classroom group in the form of survey. The survey result is depicted in Chart 3 below.

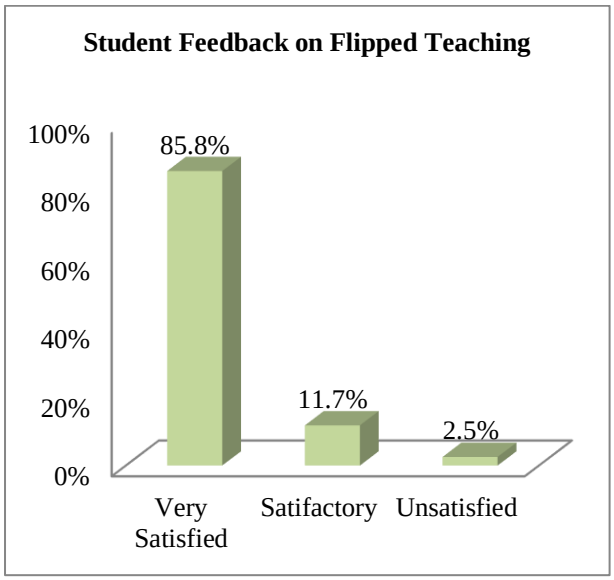

***Chart 3**: Measuring student satisfaction in Flipped Teaching*

The result of the student satisfaction feedback survey reinforced the authors' belief in the implementation of flipped classroom to enhance student learning, with 85.8% of the surveyed students satisfied with the use of flipped classroom in the teaching and learning of the topic 'SCRUM Methodology'. 11.7% of the students found this way of learning acceptable while 2.5% of them expressed dislike for flipped teaching.

Lecturer Satisfaction

The academic staff who involved in flipped classroom teaching concurred unanimously that they have experienced high level of job satisfaction using flipped teaching. The finding of high level of satisfaction amongst academic staff is not surprising given that flipped classroom focuses on the part of teaching and learning that lecturers and tutors find most rewarding, which is interaction with students.

Conclusions

The authors recognized that the success of flipped classroom is dependent on the available class time and ability of the tutors to interact with the students during in-class active learning activities. It is thus crucial that all tutors are well briefed and able to transform their roles as instructors to that of facilitators. It is also vital to have well-designed active learning class activities that focus on higher-order thinking rather than having too many knowledge recall activities.

There are many benefits of using flipped classroom as a learning platform for differentiated instructions. As the content is delivered asynchronously where students access the learning content in multiple instructional mediums including videos, e-notes and discussion board during SDL outside of class, there is no limit imposed by a finite number of class minutes and more importantly, students can access and review the content at their own learning pace. This form of process differentiation has proven to be effective in meeting the needs of students with a wide array of academic skill levels and with different learning styles. It is essential to construct an accompanying worksheet alongside the online instructional materials and to provide incentives to entice students to complete the worksheet prior to attending tutorial class. With this approach, there is a better chance that students will arrive at the tutorial class with the same level of understanding to be able to participate and contribute actively in class.

The deployment of active learning strategy such as tiered instruction, cooperative learning and anchor activities has been effective in addressing diverse learners with different needs and abilities in the form of content differentiation. Students discussed and worked on the assigned tasks in a team, cooperating with and helping each other. Teams that progressed faster were given additional more challenging task to perform to deepen their understanding of the subject. For students who needed help, the tutors were around in class to help to clarify doubts. Content differentiation through the clever use of active learning activities has proven to be effective in helping all students to maximize learning in class and facilitated higher-order thinking.

It is equally important to provide incentives to entice students to complete and submit the exit card at the end of the class. The exit cards provided valuable feedback for the lecturer and tutors to gain insight on student interest and readiness on the taught subject in order to tailor and fine tune the content of the following week's lesson for students with diverse interests and readiness.

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A COMMON FRAMEWORK FOR INTEGRATED MODULES USING DESIGN THINKING

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Abstract

This paper describes an initiative by the School of Information Technology (IT), Nanyang Polytechnic, to create an Integrated Module Framework using Design Thinking approach. The framework streamlines core modules with the corresponding semester projects into an integrated module for better learning outcomes.

The Design Thinking approach originated from Stanford University's School of Design. There are 5 stages to this approach- Empathize, Define, Ideate, Prototype and Test. This approach was adopted by School of IT as it resolves real world problems with a tinge of creativity and innovativeness. It enables the students to propose solutions that were innovative and yet resolves the problems at the technical level. The solutions proposed and implemented focuses on the needs and the user-experience of the targeted audience. This empowers the users to experience a holistic solution to the problem.

A few instruments were created to collect data for the proposed. A pre and post-survey was conducted to measure the effectiveness of the propose Design Thinking approach on the Independent variable, "Interest in IT" using a Likert scale of 1 to 3. The two groups of data were than constructed and analysed. Key points were noted from the students' learning blogs written for their reflection exercises and 3 focus group discussions were conducted with the Lecturers to gain insights. These data were then cross-referenced to ensure internal validity.

The paper concludes with the presentation of the survey result based on the methods mentioned. The preliminary result indicates that the Integrated Module Framework has shown to achieve significant statistical improvements on engaging students and improving their interest in IT.

Keywords: *design thinking, project, applied learning, innovation, creativity, peer assessment, reflection, information technology, motivation, contextual teaching and learning.*

Introduction

Nanyang Polytechnic, School of IT (NYPSIT) was established in the year 1993. Since its establishment, NYPSIT had been an advocate of project-based learning. The school promotes the applications of concepts and skills acquired by the students. This is also in line with the Polytechnic's drive for contextual teaching and learning.

For NYPSIT, contextual teaching and learning is manifested in the form of student projects occurring in every semester. Studies from previous scholars indicates that contextual teaching and learning improves students' ability in terms of their problem solving skills, critical thinking and trains them to become divergent and evaluative (Suryawati et al., 2010). The students are able to assimilate the concepts learnt within the semester through the project work.

The school attempts to develop a framework which enhances the students' learning and interest in IT through hands-on practice.

The developed framework was piloted with students from the Diploma in Business Enterprise IT and data was collected to measure the outcome.

Literature Review

Integrated Module

The Integrated Module (IM) allows the students to practice what they had learnt in the other modules within the semester. The IM is designed to focus on the students' learning. Regular feedback sessions, students' reflection blogs and engagement through social media platforms allow the educators to monitor and ascertain their learning. The students' progress is also verified through tests, assignments and project assessments. This set of activities provided an environment focused on the students' learning. They are able to strive and learn best if they have an environment that is centred around them (Land & Hannafin, 2000). The school also recognises the benefits of project-based learning as they are well researched and known (Grant, 2011). These benefits can include (not limited to): engaged students, reduction of absenteeism, team work, and improve academic

performance (George Lucas Educational Foundation, 2001). These benefits have lauded the emphasis on in-depth investigations over memorization of broad content knowledge (Helm & Katz, 2011).

In each semester, the project module will have an anchoring academic module which enables the students to learn about the desired contents and concepts. For instance, in the Diploma of Information Technology, there is the academic module "Interactive Web Applications Development" and the corresponding Semester Project, "Interactive Web Applications Development Project" for Year 1 students.

Through the proposed Integrated Module Framework, the school is able to synergise and integrate these 2 modules into a single module through the adoption of the Design Thinking approach as its pedagogy.

Applied Learning

An approach that instructs teaching curriculum concepts through a project often yields applied learning. The students are exposed to the various concepts intended for learning through hands on practices while they work on the project. The curriculum can be guided by questions that drive research and allow the students to apply the concepts (Bell, 2010).

Project-based learning is not a newly formed pedagogy. It had been researched and adopted by educational institutions. It had been in the educational system for decades (Kjersdam et al., 1994; Luxhol & Hansen, 1996).

Studies had shown that through applied learning, students are able to demonstrate a good understanding of the concepts and are able to perform better using traditional tests (Thomas, 2000).

Design Thinking Approach

There have been many attempts to incorporate creativity and innovation into the Information Technology's System Development Life Cycle (SDLC). In recent development, companies are marrying agile development with the Design Thinking concept development (Lindberg et. al, 2011).

With the merger of Design Thinking and requirements engineering, the impact will diverge the human-oriented model and the technically driven perspectives (Vetterli et. al, 2013). This enables the development team to bring user-needs (features) and user-wants (desire to use) into the solution.

We desire to train the students to create breakthrough solutions which are inspired by a better understanding of users' lives and their needs. In this case, Design Thinking suggests creative alternatives and proposes novel ideas (Brown, 2008).

Theoretical Framework (Integrated Module Framework)

In this paper, we explored 3 components, Design Thinking Approach, Integrated Module, Applied Learning and how they can affect the "Interest in IT".

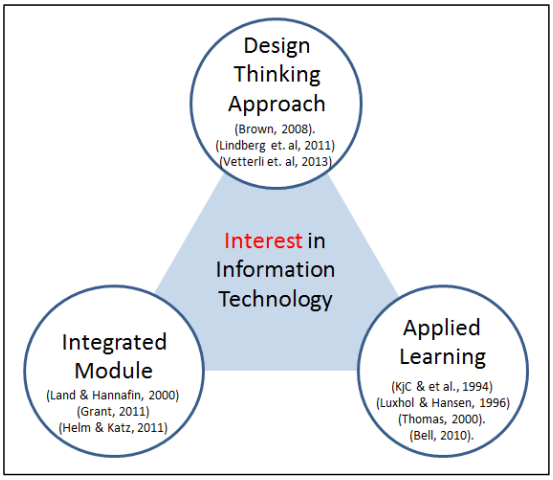

Figure 1: The Integrated Module Framework

We understand from our literature review that creativity and innovation can be infused through a process which may have a positive effect on the end product. Through the introduction of the Integrated Module, the students are able to practice what they had been taught and achieve better learning. The Integrated Module also adopts the Design Thinking Approach to address the need for creative solutions.

Using the Integrated Module as a platform, we attempt to measure if this framework has any impact on the "Interest in IT".

The Theoretical Framework is built from the basis of the Literature Review. Thus, the 3 components will be used as key ingredients for the construct of the Integrated Module Framework. We propose the framework shown in Figure 1. We hypothesise the following: *The Integrated Module Framework will raise the students' "Interest in IT".*

The students identified in the pilot run of the Integrated Module Framework were from the Diploma in Business Enterprise IT. They were in their first year. There are a total of 60 students that took part in the pilot run but only 55 (26 Males & 29 Females) surveys were found to be usable [1] . The Integrated Module was conducted in the Academic Year 2013, Semester 1.

[1] Some of the students participated in either the pre or post-survey. Only 55 students participated in both surveys.

Methodology

The research methodology is a combination of surveys, focus group discussions, observations and quantitative analysis.

Pre & Post-Surveys

In an attempt to measure the change in "Interest in IT", through quantitative means, we constructed a set of survey instrument to capture the pre and post state of the students' mind set.

The students were requested to participate in the survey before the start of the first lesson in August 2013 for the pre-survey and in March 2014 for the post-survey. We will present the results of the surveys in the results section.

Focus Group Discussions

2 group discussions were conducted with the Lecturers who were involved in conducting the Integrated Module and 1 group discussion was conducted with the Lecturers involved in teaching this group of student outside the Integrated Module. We will present the result of the discussions in the results section.

Observations

We noted key observations from the students' learning blogs. As part of their learning and assessment, the students are required to write a blog for their learning reflection exercises. We will present the results of the observations in the result section.

Results

We wanted to analyse if there are any significant differences in the pre and post-survey responses. We expected that this survey mechanism would indicate an improvement in the interest towards Information Technology, and thus reflect the effectiveness of the design thinking pedagogy for our sample. This survey is essential to explore our hypothesis that Integrated Module Framework helps to increase students' interest in information technology.

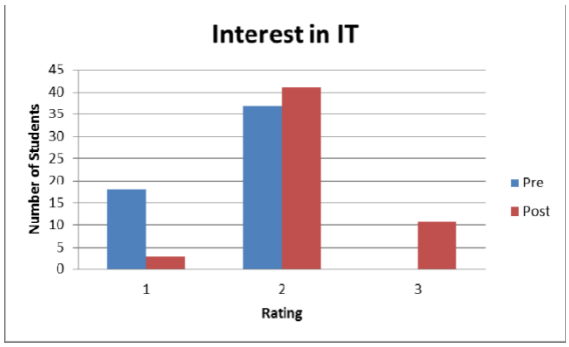

Figure 2: Interest in IT

Students were asked to give rating on their interest in Information Technology on a rating of 1 to 3 with 1 having the least interest and 3 with the most interest. From Figure 2, we observed that the interest in IT has increased in the post-survey.

Hypotheses Testing

In order to examine the proposed hypothesis, the first experiment was designed to study if there are any significance difference in the mean for the pre and post-survey on the interest in IT. We conducted a paired t-test and the results are shown as follows:

	Post-Survey Interest in IT	**Pre-Survey Interest in IT**
Mean	0.9454	0.6727
Variance	0.0525	0.2242
Observations	55	55
Hypothesized Mean Difference	0	
t Stat	4.5	
P(T<=t) one-tail	0.0000018	
P(T<=t) two-tail	0.0000037	

Table 1: Results for the Paired t-Test

Table 1 clearly states the mean difference between pre-survey interest in IT and post-survey interest in IT is significant ($t = 4.5$ and $p = 0.0000037$). Therefore, we can reject the null hypothesis that the underlying variances of the observations are equal. Thus, the Integrated Module Framework has a positive effect on the "Interest in IT".

Internal Validity

To ensure internal validity, we cross-referenced the results from each of these instruments. From the group discussions with the Lecturers, we noted that there is an increase in classroom and laboratory participation. Students were generally more motivated to ask questions and seek help on their own accord.

The reflection blogs written by the students indicated a positive trend towards learning and a desire to learn more.

One of the students, Student 1, wrote the following in his blog: *"I think that this is an interesting module and I have learnt a lot from my tutor. During the start of the projects, we had to interview students from NYP to find out what are their needs. It was quite scary at the start because this is our first time interviewing people."*

Quoting another, Student 2, wrote the following in his blog; *"Nevertheless, I feel a sense of satisfaction when I think about how far our group have come."*

The results from the different instruments indicated a change towards positive trends. We observed that the Integrated Module Framework does have a positive effect on the "Interest in IT".

Limitations

We noted that the there were 3 Lecturers in the conduct of the Integrated Module. The delivery of the module may have slight variation although the materials are similar.

The 60 students who took part in the pilot run have similar academic caliber. They gained entry to the Diploma in Business Enterprise IT through the Minstry of Eduction's initiative, Joint Admission Exercise. They obtained similar academic standard of L1R2B2 of 19 points. Hence, external validity may be affected.

The pilot run of the framework was conducted as part of an academic module. The students may be swayed to portray a postive mindset due to fear of being penalized.

There is much work to be done in this area as more instruments and data can be collected to verify the hypothesis that the Integrated Module Framework using the Design Thinking approach has an postive effect on the "Interest in IT".

Conclusions

The Integrated Module Framework is developed based on former literatures developed by scholars. The framework encapsulates the students' learning, "Interest in IT" and hands-on project practices. The framework is focused on students' learning and it is enabled through the process-centric pedagogy which assists students to achieve creative solutions with applied learning.

The hypothesis that Integrated Module Framework will raise the students' "Interest in IT" is accepted. This is indicated by the survey results and the results were the cross-referenced with the other instruments.

NYPSIT's intention to motivate and engage the students is achieved as indicated by the rise of the students' interest in IT.

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DEVELOPING AND APPLYING RUBRICS FOR COMPREHENSIVE CAPSTONE PROJECT ASSESSMENT

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Abstract

The capstone project in the Diploma in Multimedia and Infocomm Technology trains final year students to put their technical and soft skills into practice, through the development and presentation of their applications and solutions. This paper presents the design and implementation of a suite of comprehensive rubrics-based assessments for the capstone project. This suite includes three assessment components: presentations, documentation and product. While it is common to assess projects using scoring guides and rubrics, the varied nature of the projects and the personalised nature of the supervision methods used, presents differing operational considerations of applying such rubrics in assessments.

Rubrics are rolled out and tested in phases over a period of one and half year across six batches of students (approximately 300 students). Before the implementation of the rubrics, lecturers supervising and assessing the project students are briefed about the usage of each set of rubrics. This briefing and feedback session helps them to have a common understanding of the standards as well as to coach their students better for their assessment. The rubrics are also presented to the students before their assessment so that students are aware of what they are being assessed on. Students are also scored on the rubrics during the interim checkpoint, providing them with feedback on how well they have done so far.

Feedback from both the students and faculty were encouraging; for the presentation rubric alone, 90% of the students reported that they were able to identify their strengths and areas for improvements based on the rubric and the feedback that were provided to them. The faculty also noted that with the awareness of the assessment criteria, students' sense of innovation and work rate has improved.

In conclusion, the rubrics have served to highlight the capstone project's assessment criteria and act as guiding posts to train students to achieve the course learning outcomes in the process. The rubrics and its application process work hand-in-hand for fair and comprehensive assessment of students in their capstone project

Keywords: *assessment, rubrics, pedagogy, caostine project, outcome-based*

Introduction

In their final year of studies, students from the Diploma of Multimedia and Infocomm Technology (DMIT) in School of Engineering (SEG), Nanyang Polytechnic (NYP) are required to complete a 12-week full-time capstone project. The capstone project enables students to put into practice the knowledge and skills that they have acquired from the course to develop real-life innovative solutions. Project specifications range from industry or competitions' requirements to lecturer or student-proposed projects. Industry projects are usually exacting in nature with well-crafted specifications while competition projects allows a greater degree of creativity and innovation. Lecturer-proposed projects are usually geared towards a specific technology area while allowing students some freedom in terms of application scenarios. We also encouraged students to propose their own projects as this would enhance their sense of project ownership.

Students work closely under the mentorship and supervision of lecturers (also known as supervisors) in their project development. Most students are assigned to work on individual projects. Through the 12-week stint, in addition to acquiring technical knowhow, hard and soft skills for project development, project work also instils life-long learning skills to prepare students adequately for their entry into the workforce. Students also develop their project report writing and presentation skills.

Students are assessed on their attitude, technical product, project management, report writing and presentation skills. To ensure fair assessment as well as to guide and motivate the students towards a successful project outcome, we have defined a clear assessment process and developed a set of assessment rubrics. As mentioned by Gray (2013), there are major challenges in such an endeavour.

Assessment Criteria

The criteria used by the School for the assessment of the capstone project are shown in Table 1. Each criterion has an accompanying description to illustrate the focus area(s) of the assessment.

Table 1. Assessment Criteria and Description

Criteria	Description
Attitude	Student should show interest and participate actively in the project. Student should show strong commitment and sense of responsibility.
Initiative	Student should look for means to solve problems diligently
Knowledge	Student should show that they understand the project well. Student should be able to apply relevant knowledge acquired in school and show competency in solving the problem.
Product	Student should design and implement a product/an application that meets specifications, is functional, reliable and practical
Documentation	Student's project report should express ideas and concepts orderly, comprehensively and logically. Student should explain technical specifications and achievements clearly and comprehensively.
Presentation	Student's presentation should have good flow, is relevant, comprehensive and clear. Student should use aids that are relevant and clear. Student should show a good command of language and manage his presentation time well.

The six criteria are assessed through three overarching components: product, presentation and report. Each assessment component covers two or more criteria.

A panel of assessors conducts presentation assessments for the students at week 6 and 12 of the project schedule. Project supervisors are responsible for assessing the product/application and project documentation of their own students.

Other than the descriptions given in Table 1, there were no further grading guidelines on the differentiation between an average, good or excellent project. While the existing guidelines do enable projects to be graded in a comprehensive manner, it does not adequately aid faculty and students in having a common and specific understanding of its requirement.

The team thus set out to develop a set of rubrics, for the three assessment components, that is used to assess the students throughout the project duration. In this paper, we would be sharing on the rubrics that are used, namely, the presentation, the report and the technical assessment components.

Rubrics

The objectives for the design and usage of the rubrics are firstly to ensure fair assessment across projects, students and faculty. In this respect, it would be desirable for students and faculty to share a common and clear understanding of a detailed set of scoring guidelines. Secondly, students' attitude and motivation towards a better project outcome could be improved by a heightened awareness of their mid-project performance through a scoring sheet and faculty's feedback.

Presentation Assessment

A clear outcome of the project module is to develop students to become confident presenters. During the course of the capstone project, students will have at least three opportunities to present their projects to an audience. They are required to do two formal presentations to a panel of assessors. The presentation assessment rubrics were developed to enable the faculty to achieve a fair and consistent assessment. The rubrics assess the students on their presentation skills as well as four other criteria: attitude, initiative, knowledge and product. This is achieved by assessing the students' ability to articulate their achievements and technicality of their projects.

The result is a rubric comprising five categories. Figure 1 shows the actual form used by students and the faculty, containing the presentation assessment rubrics.

Report Assessment

The report assessment component allows us to directly assess students on their project documentation, knowledge and attitude. Some level of initiative and product quality can also be assessed through the report assessment component.

The resulting rubric, through developing the report assessment criteria, is a rubric that assesses students based on the three major categories as shown in Figure 2 and three minor categories as listed in List 1. A key feature of this rubric is the inclusion of timeliness, to factor responsibility (attitude) as part of the assessment component.

List 1. Three Minor Categories of the Report Assessment

- Neatness and Formatting
- Timeliness
- Plagiarism

Technical Assessment

The technical assessment component allows us to assess students on their technical knowledge and their ability to apply skills that they have learnt in previous semesters.

A non-negotiable outcome for the capstone project module was for students to stretch themselves and complete at least an implementation of a single module of a large system or concept demonstrator within the 12-week timeframe that was given. We also recognised that students are at different technical skill levels. As such, the complexity of the projects are tailored to the students and taken into consideration for the assessment. This results in a rubric as shown in Figure 3, with a complexity multiplier factor that is applied to the technical competency, project implementation and scope fulfilment categories designed to reward efforts put in by academically stronger students attempting projects that has high level of difficulty and the rest of the students for doing well in a simpler project.

Applying Rubrics

We emphasise on awareness and understanding of the rubric for both faculty and students as an important part of the process in the application of the rubric. As mentioned in Boden (2007), awareness and understanding can better equip the faculty with knowledge on where to focus their training effort for their students. Students too will have a better knowledge on the areas they should improve on. Finally, we also emphasise a consistent set of operating procedures to ensure all students are assessed as fairly as possible.

Raising Awareness and Understanding of Assessment Criteria

Before mandating the use of the assessment rubrics, the team conducts briefings for all assessors. The assessors were brief on how to conduct the assessments and apply the rubrics to the assessment components. The team also provided samples to aid the assessors in scoring the rubrics.

The team also conducted briefings for the students on the assessment criteria set out in the rubrics. The briefings are usually conducted one to two weeks before their assessment. The students are provided with samples that represent 'good'/'excellent' standard in their assessment component. In fact, the school houses 'excellent' standard projects in an exhibition room, accessible by both faculty and students.

Continuous Feedback Process

The students are provided continuous feedback on their progress from various channels. Aside from their supervisors, students are provided constant feedback by the panel of assessors. The main feedback and assessment schedule can be found in Table 2.

Table 2. Major Assessment and Feedback

Week	**Milestone**	**Feedback Method / Assessment**
2	Project Proposal Pitch	Immediate feedback on the project objectives, scope and schedule
6	Progress Update Presentation	Immediate feedback on the students' progress and application Feedback & Assessment through Report Assessment Rubrics
	Project Documentation	Feedback through Report Assessment Rubrics
12	Final Presentation	Immediate feedback on the students' performance and quality of work Feedback & Assessment through Report Assessment Rubrics
	Technical Documentation	Report Assessment Rubrics
	End-Project Application/Pro-duct Delivery	Technical Assessment Rubrics

In Week 6, the presentation assessment rubrics are used to assess their progress update presentation. Within a week after their assessment, a copy of the rubric with the panel's evaluation on their presentation is returned to the students and their supervisors. The scored rubrics, used as a form of feedback, aim to allow students to know where their strengths and areas for improvement are so that they may work on their presentation skills with their supervisors for the final presentation assessment held in Week 12.

This feedback process has also improved the quality of the students' presentations regardless of the projects they were working on. This can be seen in the improvement of average scores that students attained between their mid-term and final-term presentations as shown in Chart 1.

Students are required to submit a mid-semester project report during their presentation assessment. This report serves to enable them to consolidate and document their project specifications, initial design and progress thus far. In doing so, it also helps them to start their project documentation process and lessen the amount of effort to be expended at the end of the project. Additionally, the report rubrics are also used to give them an assessment on their project documentation. This mid-semester project report has proven to be useful and beneficial in practice.

NANYANG THE INNOVATIVE POLYTECHNIC

Admin Number: [redacted]
Student Name: [redacted]

	Level of Acheivement				
	Below Expectation	Approaching Expectation	Satisfactory	Good	Excellent
Presentation Mechanics - Delivery - Q&A	Presentation is not comprehensible by audience and/or does not match slides	Audience has difficulty following presentation and flow of information can be improved	Audience is able to follow presentation which is delivered well but too heavily scripted	**Audience is able to follow presentation which is delivered well and smoothly**	Presentation is interesting, eloquently delivered and with enthusiasm
	Unable to handle most Q&A	Able to handle some Q&A	Able to handle most Q&A	**Able to handle all Q&A well**	Able to handle all Q&A well and able to anticipate questions
Presentation Content - Organisation - Supporting Materials	Illogical sequence without agenda	Agenda exists, but major disconnects in organisation / sequence	Agenda exists, but only minor disconnects in organisation / sequence	**Agenda exists and coherent organisation / sequence**	Agenda exists, coherent & interesting organisation / sequence
	Little or no supporting materials, eg. visuals	Supporting materials are used but not explained or put in context	Supporting materials are used and explained in context	**Supporting materials are effectively used and explained in context**	Supporting materials are effectively & innovatively used and explained in context
Technical Competency - Level of technical understanding - Soundness of Design	Does not comprehend project's technicalities	Able to explain some project's technicalities	**Able to explain most project's technicalities**	Able to explain most project's technicalities and understands associated technical limitations	Able to explain all project's technicalities and overcome associated technical limitations
	Design is not able to achieve project objectives	Design is able to achieve some project objectives	Design is able to achieve most project objectives	**Design is able to achieve all project objectives**	Design exceeds all project objectives, takes into account future
Initiative - Drive, originality & independence in problem solving	No observable interest and effort shown in project	Make some attempts according to supervisor's recommendations	Persisted in making repeated attempts as recommended by supervisor	**Experiments on his own with reliance on supervisor for guidance**	Experiments on his own exhibits independence and drive, and shows originality in his solution
Scope Fulfillment - Scope Fulfilment	Barely fulfilled the project scope	Fulfilled some of the project scope but with significant portions missing	Fulfilled some significant portions of the project scope	**Fulfilled most of the project scope**	Completely fulfilled or exceed the project scope

Comments from Assessors
[redacted]: Good presentation, clear, good voice and pace. Push harder on developing new features for a better grade. You can stretch a bit more.
[redacted]: Good presentation skills. Excellent command of English. Each assessor should get a copy of the survey form.
[redacted] Good Presentation. You report is mainly on correlation between 2 attributes. How about finding relationship among 3 or 4 attributes? You may also want to think about how the findings can be used by the poly in recruiting students

Figure 1. Assessment Result Sheet for Student

Final Year Project – Report Assessment Rubrics

	Level of Achievements				
	Below Expectation (1)	Approaching Expectation (2)	Satisfactory (3)	Good (4)	Excellent (5)
Technical Writing • Level of technical understanding • Correctness in technical explanation	• Technical coverage indicates lack of understanding of technical concepts • Incorrect usage of technical terms indicating lack of understanding	• Technical coverage indicates basic understanding of technical concepts • Some inaccuracies in usage of technical terms that results in poor explanation	• Technical coverage indicates good understanding of some technical concepts • Technical terms used are mostly accurate and aids in explanation	• Technical coverage indicates good understanding of many of the technical concepts • Technical terms are used appropriately & accurately and helps to explain technical details	• Technical coverage indicates good understanding of all of the technical concepts • Writing indicates a strong grasp of technical concepts (Eg. Technically accurate and with explanations that simplify difficult concepts)
Writing Mechanics • Content • Conciseness • Coherence	• Insufficient content to show that required topics are met • Plain listing of information without regards to structure and/or flow • Structure is missing or attempted but not obvious to the reader	• Some gaps in coverage of required topics • Contains repetitions and redundancies; • Structure is evident, but inappropriate transitions disrupt the progression of ideas	• Covers most required topics • Contains minor repetitions & redundancies; • Structure is evident, with some effort made in using transitions to link ideas together	• Covers all required topics • Clear and concise • Structure is clear and appropriate to the purpose; Appropriate transitions help to link ideas together	• Covers all required topics well and maintains reader interest with a logical coherent flow • Clear and concise • Structure is clear, appropriate and effective to the purpose. Transitions are effective, allowing ideas to flow
Spelling, Grammar and Punctuation	• Major lapses in grammar, spelling and punctuations that reduces the clarity of the report	• Some major lapses in grammar, spelling and punctuations that distracts the reader from the report	• Some minor lapses in grammar, spelling and punctuations	• Few lapses in grammar, spelling and punctuations	• Minimal or no lapses in grammar, spelling and punctuations

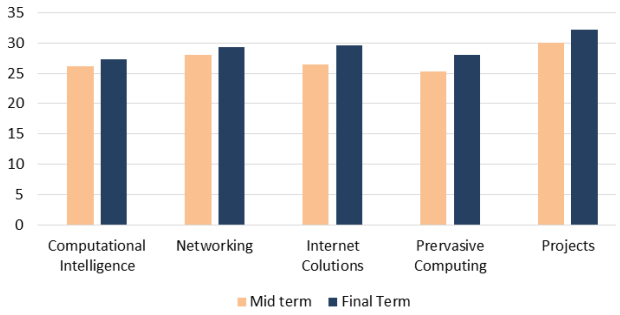
Figure 2. Major Categories of Report Assessment Rubrics

Final Year Project – Technical Assessment Rubrics

	Level of Achievement				Scores
	Below Expectations (1)	**Satisfactory (2)**	**Good (3)**	**Excellent (4)**	
Technical Competency • **Level of Technical Understanding** • **Aesthetic and Design**	• Does not understand project's technicalities and associated technical limitations	• Able to understand some of project's technicalities and associated technical limitations	• **Able to understand most of project's technicalities and work around associated technical limitations**	• Able to understand all of project's technicalities and workaround associated technical limitations	3
	• Design is able to achieve some project objectives	• Design is able to achieve most project objectives	• **Design is able to achieve all project objectives**	• Design exceeds all project objectives, takes into account future enhancements to the project	2.5
Project Implementation • **Approach** • **Implementation Specification**	• Approach to the problem statement chosen misses the objectives of the project	• Approach to the problem statement chosen meets the objectives of the project generally	• Approach to the problem statement chosen meets the objectives of the project effectively	• **Approach to the problem statement chosen is innovative and meets the objectives of the project effectively**	3.5
	• Implementation does not meet the needs of the projects	• **Implementation is largely specific to the needs of the projects but caters little for possible future enhancements**	• Implementation is specific to the needs of the projects and caters for some possibility for future enhancements	• Implementation is specific to the needs of the projects and robust to cater for future enhancements	2.5
Scope Fulfilment	• Fulfilled some of the project scope but with significant portions missing	• Fulfilled some significant portions of the project scope	• **Fulfilled most of the project scope**	• Completely fulfilled or exceed the project scope	3
Initiative • **Drive, originality & independence in problem solving**	• No observable interest and effort shown in project	• Persisted in making repeated attempts as recommended by supervisor	• **Experiments on his own with reliance on supervisor for guidance**	• Experiments on his own exhibits independence and drive, and shows originality in his solution	3
Complexity of Project (Multiplier to yellow highlighted boxes)	**Simple (0.9)**	**Average (1)**	**Difficult (1.2)**	**Complex (1.3)**	1.2
Complexity of Project • **System Components Integration** • **Complexity & Adaptation of Algorithms** • **Involves working with multiple stakeholders**	• Number of components / design elements to be integrated • Nature of APIs / design tools & techniques (Complexity in understanding and usage) • Does this involve adaption and/or modification of published algorithms? • Does the project involve working with multiple stakeholders and needing to meet differing requirements from the stakeholders?			**Total Score** (Base Score is 30)	**20.4**

Figure 3. Technical Assessment Rubrics

Chart 1. Average Presentation Scores attained by Students Categorised by Technology Group of their Projects



Observations

To ascertain the effectiveness of the presentation rubrics from both the students and faculty's perspectives, we conducted surveys immediately after the release of the mid-term presentation assessment results.

Student Survey Results

Table 3 shows the tabulated results of a survey on the usage of the presentation rubrics. The rating includes that of "Disagree" and "Strongly Disagree" but this is not shown in the table as there were no students with those feedbacks. The survey result generally shows that the rubrics do help the students to understand the assessment criteria and focus. Additionally, students generally agree that the rubrics help them to obtain specific feedback on their performance and progress.

Table 3. Survey Results on Presentation Rubrics

Questions \ Ratings	**SA***	**A***	**N***
The rubric helped me to understand what I am assessed on for my project	13%	72%	15%
The rubric gave me guidelines on what/how I should focus on for my project	15%	72%	13%
The mid-term feedback based on the rubrics helped me to identify my strengths and weaknesses	20%	70%	10%
I was able to better prepare myself for the final presentation based on the assessment rubrics scoring	22%	43%	35%
I feel that this set of rubrics is also applicable whenever I do a presentation on a project in the future	20%	63%	17%

*SA: Strongly Agree, A: Agree, N: Neither Agree Nor Disagree. Results for Disagree and Strongly Disagree is not shown in the table as no student selected those options

In the same survey, students also responded with encouraging comments towards how the rubrics have helped them as well as sharing on areas for improvement. These comments were shared with all faculty, to motivate them as well as to encourage them to spend time with their project students to debrief them on their performance through the rubrics. At the same time, it was also impressed upon assessors that students do appreciate and value their written comments. Representative comments are documented in List 2.

List 2: Comments given by Students in the Survey on Presentation Rubrics

Question 1: Share with us the one thing that you felt most strongly that the rubric has helped you with

- Helps me to identify what I should focus on when presenting and areas that I need to improve on.
- It encourages me to be better prepared for the final presentation.
- Let me know where my weakness is so that I can improve on it :)
- Enable us to set achievable goals
- Give me more confidence in my project after knowing my performance
- Helps me to enhance my project in the different ways that a project is assessed.
- We can use it as a guide to understand what the assessors are looking for.

Question 2: Share with us one item you felt that the rubric was lacking in

- More comments from the assessors
- The rubric would not be good enough, lecturers should spend slightly more time to guide and explain more about it to the students.
- Further details in the results
- Comments on where and how we can do better.

Faculty Survey Results

Faculty raised concerns about the assessment of projects with differing technical complexity with respect to the criteria on initiative and scope fulfilment. However, they also noted that when their students are acutely aware that they are being assessed on these criteria, their sense of innovation and work rate seems to improve.

Another concern relates to the time spent in paper administration relating to the scoring results. This feedback is addressed through the development and usage of an assessment web application, which is described in the next section.

IT Support

A web-based assessment application for the scoring of the capstone project via rubrics was designed and developed to support faculty, both in the mid and final project presentations. The faculty is able to input scores for students under their charge directly during presentation. The application also provides the auto-generation of scores for the compilation of results as well as indicative assessment results for the students. The timely introduction of this application helped to enable the acceptance and implementation of the rubrics-based project assessment.

Conclusion

The rubrics and its development and application process work together hand in hand for fair assessment of students in their capstone project. Additionally, it is also a tool for training and channelling feedback to students, enabling them to use their knowledge and skills from design to implementation of their capstone project. Judicious usage of the assessment result via the rubrics' scoring sheet facilitates the faculty to impart and inculcate positive learning attitudes more effectively.

The rubrics have served to highlight the capstone project's assessment criteria and enable them to be the guiding posts for students to strive towards not just achieving good results but more importantly, to train them to acquire the course learning outcomes in the process.

Over the next semester, the rubrics will be refined further to take into account feedback from the students and faculty.

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AUTHENTIC LEARNING EXPERIENCES IN ENGINEERING BASED ON THE ADOPTION OF INDUSTRY-STANDARD NATIONAL INSTRUMENTS LABVIEW ACADEMY PROGRAM

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Abstract

This paper seeks to explore authentic learning experiences that will develop students' interest in engineering imbued with an enthusiastic curiosity that enjoy challenges when solving complex real-world problems. Most Engineering courses have already come to the realisation that the transfer of knowledge is intrinsically linked to the activities conducted in the lessons as well as the context in which true learning can take place.

At NYP's School of Engineering (SEG), we strongly embraced the learning-by-doing approach. The internet coupled with a variety of emerging technologies has made it possible to offer students authentic learning experiences ranging from experimentation to real-world problem solving. "Authentic learning situates students in learning contexts where they encounter activities that involve problems and investigations reflective of those they are likely to face in their real world professional contexts" (Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991 and Herrington and Oliver (2000). In our efforts to give our students an authentic learning experience, we seek out suitable industry partners for real-life educational cooperation in order to engage the students to see the types of things that can bring the theory into "instant relevance". This paper describes how SEG has taken this authentic learning approach further by adopting the National Instruments (NI) LabVIEW (Laboratory Virtual Instrumentation Engineering Workbench) Academy Program which uses a blended learning model that combines face-to-face teaching with engaging content and hands-on laboratory exercises.

The paper covers the implementation of this curriculum in a 3rd year module, 'Instrumentation and Test Engineering (ITE)' and the preparation of the students to take the NI-CLAD certification examinations which gives the students a certain level of accreditation that is above and beyond what they might get by just passing the course. The paper also covers how authentic learning can be made possible by NI-ELVIS, NI-myDAQ hardware and NI-LabVIEW which is a Graphical System Design environment.

The results obtained from the implementation of the LabVIEW Academy curriculum, the key learning points and suggestions for future work are also covered in this paper.

Keywords: *hands-on learning, authentic learning, learning-by-doing, do engineering, instant relevance, engineering education, contextualised learning.*

Introduction

A key challenge faced by SEG is to design and deliver learning experiences suitable to our engineering students who are classified as the Net Gen (Generation) whose style of learning reflects their experiences with the rapidly evolving technology in consumer electronic devices. In this continuing endeavour to enhance the quality of engineering education, SEG, Nanyang Polytechnic has partnered with National Instruments (NI) Singapore Pte Ltd to set up the 1st LabVIEW Academy in Singapore by signing a MOU with the same on 17 February 2012.

LabVIEW Academy Curriculum

The LabVIEW Academy curriculum gives students the opportunity to validate their knowledge and skills at a professional level with certification. The Academy curriculum consists of National Instruments hardware (NI ELVIS II+) and includes the latest versions of NI LabVIEW Developer Suite, TestStand, Vision Development Module, FPGA Design Toolkit, Veristand, Circuit Design tools like Multisim and Utiboard, etc. After completion of the LabVIEW Academy program, students have the knowledge and tools to attempt the Certified LabVIEW Associate Developer (CLAD) certification examinations with confidence. Experience and certification in LabVIEW can improve students' career opportunities around the world – providing graduates and potential employers with benefits such as:

(a) Reliable validation and demonstration of skills and knowledge,

(b) Accelerated professional development, improved productivity and credibility in system designs, and
(c) Listing in the NI Certified Professionals database to demonstrate certification status.

National Instruments has been a premier virtual instrumentation hardware and software developer for more than 25 years. It is well recognised in the industry across diverse industry sectors. Coupled with an extensive R&D team, alliances with leading technology partners, we felt safe knowing that we are training our students on a platform with the aim to make the work force future ready.

Herrington and Oliver (2000) has pointed out that "the instructional technology community is in the midst of a philosophical shift from a behaviourist to a constructivist framework, a move that may begin to address the growing rift between formal school learning and real-life learning."

This paper will summarize what constitutes authentic learning and how LabVIEW Academy program supports it.

The implementation of LabVIEW Academy Programme as an authentic learning environment

This section sought to investigate the nature of a purposely-designed learning environment based on some of the attributes of authentic learning, to explore students' perceptions to this revised environment and the incorporation of this environment with the LabVIEW Academy program.

Authentic Learning

Lombardi (May 2007) highlighted that authentic learning generally focuses on real-world complex issues, and their solutions, using role-playing activities, problem-based activities, case studies, and participation in virtual communities of practice.

Lombardi (July 2007) also mentioned that authentic learning aligns well with the needs of today's participatory Net Gen learners. In order to engage them, we have to channel their online and collaborative abilities and interests into academic pursuits.

Herrington and Oliver (2000) have identified nine characteristics of authentic learning:

(a) Authentic contexts that reflect the way the knowledge will be used in real life
(b) Authentic activities that involve complex, ill-defined problems and investigations
(c) Access to expert performances enabling modelling of processes
(d) Multiple roles and perspectives providing alternative solution pathways
(e) Collaboration allowing for the social construction of knowledge
(f) Opportunities for reflection to enable abstractions to be formed
(g) Opportunities for articulation to enable tacit knowledge to be made explicit
(h) Provide coaching and scaffolding and fading of teacher support
(i) Authentic assessment that reflects the way knowledge is assessed in real life.

How LabVIEW Academy program Supports Authentic Learning?

Herrington (2000) highlighted that educational researchers are significantly coming to the conclusion that the value of authentic activity is not constrained to learning in real-life locations and practice, but that the benefits of authentic activity can be realized through careful design of learning environments.

With that in mind and coupled with some of the suggested lesson plans that NI provides through their Academy, the laboratory activities were enhanced from the procedural format whereby detailed instructions were given to one that includes as many of the critical characteristics of authentic learning as stated by Herrington and Oliver (2000) above.

The core the LabVIEW Academy Program is the Graphical System Design (GSD) LabVIEW platform and with its powerful set of NI tools, provides an easy means for abstraction of knowledge and concepts. Theorems and concepts can be easily encapsulated into "black boxes" in LabVIEW. These building blocks can then be used to create system designs easily. The physical world is made up of many of these "black boxes". The students can open and understand what's inside these "black boxes" as they progressively learnt deeper and more complex relationships. As students see similar tools used from tertiary, through university and even in the industry, they are able to relate and use the repeated skills which they acquired earlier. LabVIEW is a user-friendly graphical system design platform which allows students to see how they can put their own ideas into something and when they do that, they can realize their own capability. Students can quickly organise their observations and build their intuition as they tinker and make design changes.

The participants for the pilot run were 77 third year DECC students studying the Instrumentation and Test Engineering module (ITE). The choice of this group of students is because they have the opportunity to learn instrumentation and testing concepts through LabVIEW Academy programme. Based on their own preferences, students in this module formed into teams of 3 to 4 students to maximise collaborative interactions. The lecturer who incorporates the elements of authentic learning and uses the LabVIEW Academy program with the groups is the content expert. The study was conducted during the 2nd term of the semester. This was done so that the students can compare the traditional approach that they experienced in the 1st term versus the revised laboratory activities in the 2nd term and subsequently gave their feedback at the end of the semester.

The study was conducted within a normal term of instruction of 16 weeks. The lecturer introduced the authentic learning revised program to the class. All

students in the class used the revised program to complete their activity over a period of 5 weeks (3 hours per week). The activity required the teams of students to apply what they have learnt about the LabVIEW GSD platform during the 1st term and used it to explore instrumentation concepts, designed and developed a prototype project in the 2nd term. The teams worked on the revised learning program with their lecturer available for the entire period, providing assistance as required via face-to-face in the classroom as well as via the social media. At the end of the 2nd term, the lecturer invited the students to present their prototype projects to the class. Table 1 shows a sample of the revised study unit which incorporates some of the elements of authentic learning which LabVIEW GSD augmented well into this revised learning environment. For each study unit to be learnt, the activity lessons are structured into 3 phases, namely, exploration phase, design application phase, and take action project phase. Table 1 illustrates an example of a study unit taken from the module on Instrumentation & Test Engineering (ITE).

Table 1: Sample of a study unit

Exploration 1 (45 mins)	**Exploration 2 (45 mins)**	**Design Application (90 mins)**	**Take Action Project (3 hrs)**
How to acquire real world signals? *Exploration* : Students explore transducers and signal acquisition. *Discussion* : Students discuss selection of suitable transducers and components that make up a signal acquisition system.	How to record the smallest possible change in a signal? Exploration : Students explore factors that affect the amount of detectable change in a voltage signal. Discussion : Students discuss factors to improve measurement quality. Students build their intuition.	Design an Efficient Temperature Control System. Students apply their exploration and learning to design a new product.	Create an Efficient Temperature Control System. (Approx. 3 hrs, or complete outside of class) Students create a working solution of their design proposal from the *Design Application*.

In the Exploration phases, the concept that is intended to be taught is first introduced. The explorations in these phases are meant to get the students to work in teams to start thinking about the concepts and answer the provided questions. In this phase, simulated scenarios were created through the LabVIEW GSD platform to enhance students' understanding of the concepts. The students were guided to think about and look for answers to the essential questions.

After students have experience the concepts through exploration, the Discussion section were used to connect and apply the theory to the concepts students have just explored.

The Design Application Phase presents students with a real-world problem to which they can apply their knowledge of the concept to brainstorm and design a real-world solution.

In the Take Action Phase, students complete the Engineering Design Process by creating a prototype of their proposed designs from the Design Application Phase. With LabVIEW Academy platform, students were able to easily create their prototypes that help them implement their solutions.

In order to expand on the information gained from observing the students using the program, a feedback session through a survey was conducted individually with the students. Questions were designed to elicit students' perceptions of the learning environment as a whole, with particular reference to the nine situated learning design elements.

Discussion

This section shows how some elements that contribute to the success of authentic learning environments are operationalised through the LabVIEW Academy programme.

A well-designed activity must be more than an opportunity for students to practice and apply their learning. In this paper, it is proposed that the activity students perform as they complete related concepts is a very important element in the design of the learning environment. A complex and sustained activity can motivate students to learn. The LabVIEW Academy programme allows the students to work in teams to quickly design and prototype a solution to solve a real-world problem. And because real-world challenges are ill-defined, students need to have opportunities to explore it and determine how the task might be broken up into smaller tasks, select relevant information, and find solutions that suit their needs. In this aspect, LabVIEW with its built-in I/O integration and instrument control, thousands of functions for math and signal processing, user interfaces to visualise and explore data, students can access the power of graphical system design to go from concept to prototype in one semester. LabVIEW GSD platform also allows the teachers to quickly come up with simulation systems to illustrate the concepts to be taught.

To provide authentic context that reflect the way the knowledge will be used in real-life, teams of 3-4 students will assign projects which requires them to design systems which reflect the way the knowledge will ultimately be used. These are implemented efficiently through the LabVIEW graphical system design platform.

In the exploration phases of the lab activity, questions were set to promote reflection to enable abstractions to be formed.

At the completion of their group projects, each team member was asked to make a presentation which

provides them the opportunity to articulate what they have learnt.

Based on the assessment of learning throughout the module, the well prepared students are challenged further to attempt the industry standard Certified LabVIEW Associate Developer examinations (CLAD).

Module Evaluation Results

To determine whether the students have benefitted from the LabVIEW Academy Program and the revised learning environment in the ITE module, a survey was conducted with 53 students from the pilot group towards the end of the semester. The survey was designed to ask the students regarding how the revised learning environment using LabVIEW and the elements of authentic learning has helped to enhance their learning of this module. Sample results of the survey are shown in Figures 1 (a) – (d).

The survey results obtained generally highlighted that students' perception of effective delivery of practical lessons can be achieved in the following areas:

(a) using real-world situations and scenarios that reflect how knowledge is being used in real life versus the procedural format of showing how problems can be solved or theorems were verified,
(b) Providing opportunities for exploration, discussion and presentation of their tasks, and
(c) Performing the tasks in teams.

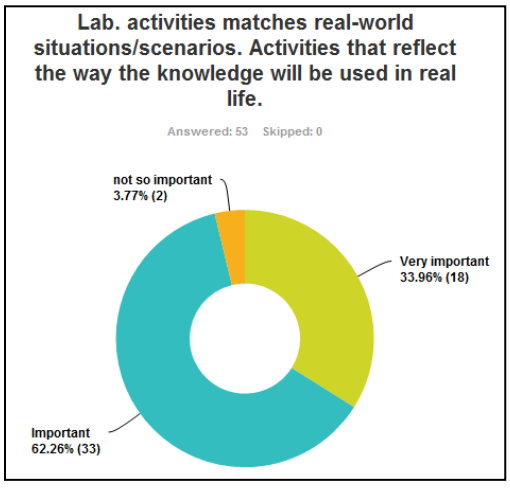

Figure 1(a): Students' Perception of the importance of real-world laboratory activities.

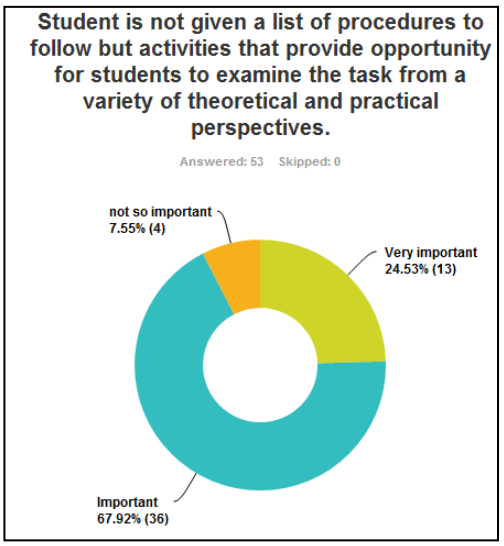

Figure 1(b): Students' Perception of the importance of open-ended laboratory activities.

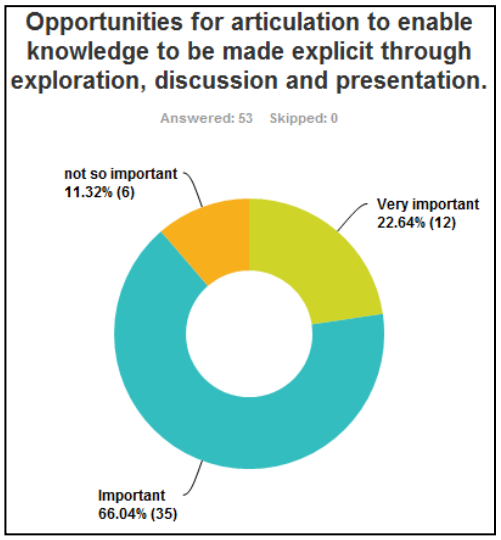

Figure 1(c): Students' Perception of the importance of providing activities to perform exploration, discussion and presentation of the task.

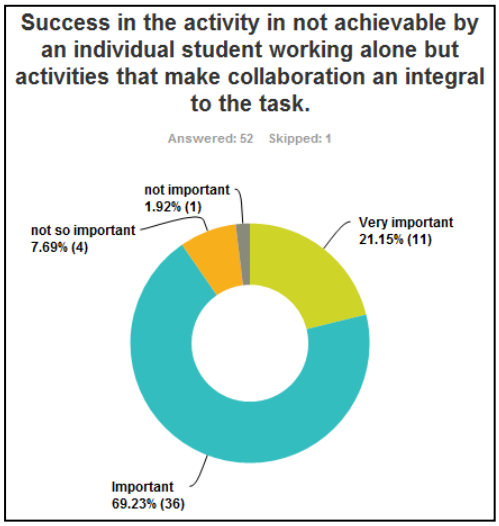

Figure 1(d) : Students' Perception of the importance of teamwork versus working individually on a task.

The results obtained from the ITE module's practical lessons have suggested that with authentic learning adopted through the LabVIEW Academy Program, students' performance in their practical works have been improved.

The module team received positive feedback, which confirms that through the adoption of LabVIEW GSD platform in the ITE module, authentic teaching approach was effectively incorporated, created team building in the learning process, enhanced students' engagement in the module and improvement in their design and problem-solving skills.

Challenges

Through a focus group sharing on the students' perception with regards to effective teaching and learning in practical lessons, lecturers generally recognized the benefits of moving from the more traditional procedural approach to the use of authentic learning strategies outlined above. However, they also highlighted the following areas that require follow up in order to be effective in the re-designed of the laboratory activities. The key recommendations are:

(a) Facilitation skills are needed so that they can effectively manage the class in this revised teaching and learning environment, and
(b) The creation of a sharing platform whereby staff can mutually support one another in the generation of real-world case studies for incorporation into the laboratory activities across the related modules in the course.

While analysis is preliminary at this stage, in the development of modules featuring complex, authentic activities, teachers interviewed have mentioned that they is an increase amount of time involved in both the preparation of the authentic tasks and environments. Teachers also reported that students were likely to spend much more time on the tasks. Feedback from teachers also revealed about the nature of authenticity and its subjectivity.

Further research may help to understand how authentic learning environments can be sustained with standard resources, sharing platforms and faculty allocations. It is hoped that those characteristics of authentic activity through the LabVIEW Academy programme could be infused into the various modules of the other engineering courses.

Conclusions

This paper has described one study related to the investigation of the use of NI-LabVIEW Academy as a tool for developing authentic learning environments.

In this study, the authentic learning framework appeared to be a successful, alternative framework and coupled with the LabVIEW Academy platform, the characteristics of authentic context, authentic activities, and collaboration can be effectively operationalised. With this, the study provides another step in our pursuit of excellence in teaching and learning that are truly critical in engaging our students and equipping them for work and life.

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FROM IDEA TO INNOVATION: AN INTEGRATED PROJECT-BASED LEARNING METHODOLOGY FOR SCHOOL OF ENGINEERING STUDENTS

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Abstract

This paper describes an integrated project-based training approach to provide students with the knowledge to translate an idea into an innovation. It integrates creative thinking, problem solving and engineering application skills coupled with a sound marketing strategy to transform the innovation into a realistic product. This systematic approach will be delivered in five academic modules which span over a three years period to the completion of the Mechatronics Engineering diploma course.

The Semestral Project 1 & 2 in Year 1 aim to promote students' creative thinking and problem solving skills. These modules equip students with the knowledge to apply ideas, techniques, manufacturing processes and skills learnt into actual applications. The Semestral Project 3 & 4 in Year 2 enable students to develop mechanical design, programming as well as device interfacing skills through a series of practical exercises. The Semestral Project 5 in Year 3 aims to explore and develop students' abilities in applying techniques, skills and knowledge learnt on new product design, development and product marketing. Students are expected to complete and present their project with a full product and marketing plan, which includes product's information, product life-cycle analysis, manufacturing processes, break-even analysis, and marketing strategy.

The Semestral Project series inspire students to think creatively, promote innovative product development and technopreneur skills. This indispensable knowledge enables students to translate creative idea into real product development. (John W. Thomas, 2000). In addition, it provides a borderless platform for students from different schools and of different academic levels to work together on a designated project. It is also an excellent platform to promote teamwork and offer students an opportunity to participate in various creative product competitions.

Keywords: *Semestral Project, integrated project-based training, creativity, creative thinking, teamwork, innovation, Innovation and enterprise*

Introduction

The Semestral Project modules are in line with the Diploma in Mechatronics Engineering from Nanyang Polytechnic (NYP), which provides students with the knowledge of Mechanical design, electronic control, software programming, product development, presentation skill as well as marketing skill.

Mechatronics Engineering

A Fusion of Mechanical, Electronic and Software Engineering

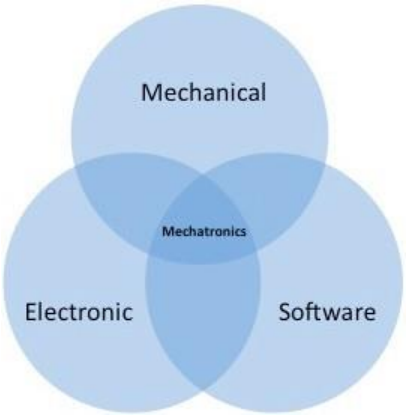

Figure 1: Mechatronics Engineering

The multidiscipline teaching approach offers a vibrant learning environment for students. The nature of this diploma will add versatility to the graduates' capabilities. Graduates will be able to adapt to various kind of project work and working environment, which increases their employability.

Figure 2: Multidiscipline approach – A vibrant learning environment

Pedagogy

The Semestral Project Modules are the core modules of the Diploma in Mechatronics Engineering. All students will have the opportunity to learn the skills and knowledge from these modules during the three years course in Nanyang Polytechnic.

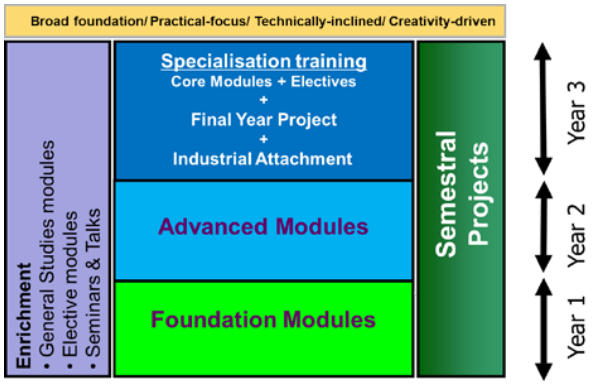

Figure 3: The Semestral Project modules span over the three year mechatronics diploma course

Every semester, there are more than 80 students taking the Semestral Project Modules at different stages.

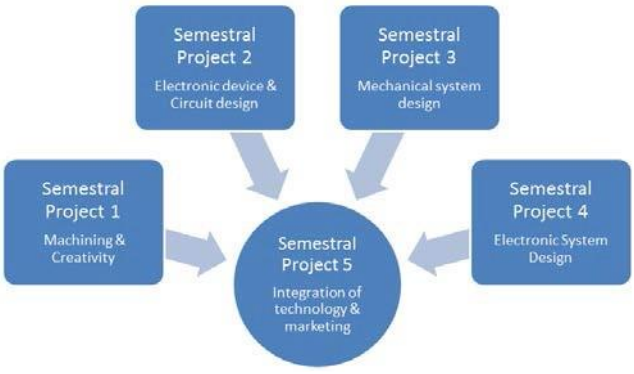

Figure 4: Integrated Project-based Learning Approach

Semestral Project 1 is designed to provide students with the hard skill learning experience where students will acquire technical knowledge in the engineering workshop coupled with the soft skill of developing creative thinking ability. The students will have a clear understanding of material properties, essential machining tools operation, and the procedure to shape raw materials with proper machining equipment. Other than workshop practice, students will also be involved in creative project development. Students will work in teams to create and develop new projects. A project report and presentation are required at the end of the module. This learning program provides a highly liberated experience which main objective is to nurture and promote innovation.

Semestral Project 2 aims to explore and develop students' electronic circuit development skill and troubleshooting skill. Students will be exposed to the different types of project development, building prototypes, as well as studying the basic working principle of electronic component and circuit analysis. At the end of this module, students will be able to identify various types of electronic components, understand the circuit operation as well as to carry out an oral presentation to the class as a team.

Semestral Project 3 aims to provide students with opportunities to develop their skills in mechanical system design using computer aided software, component selection, and system analysis. Students will learn how to source for proper materials and components to build and size a mechanical system according to specifications. At the end of this module, students will be able to identify the system requirements and select the proper materials and components to build the system. In addition, students are able to carry out system analysis, dynamic load calculation as well as generate a Bill of Material and part drawings for the system. The use of case studies to reinforce key design concepts will be emphasized and this will be an important part of the learning experience in this module (David Ullman 2009).

Semestral Project 4 aims to enable students to develop their skills in digital and analogue circuits design, micro-controller programming and its applications. Students will learn to interface various types of input and output devices to the micro-controller through a series of practical exercises. Upon completion of the module, students will be able to write programs to drive external devices such as motors, LEDs and sensors. Effective use of technology to invent and innovate will be emphasized throughout this module. Close supervision and teamwork among peers reinforce students' learning and encourage creativity. With these skill-sets, students are able to develop mechatronics products or build robots to participate in either local competitions such as the Singapore Robotics Game Competition or other competitions in the international arena.

Semestral Project 5 is the final module of the Semestral Project Series. This module integrates all the acquired knowledge from the four prior modules and enables students to apply the techniques and knowledge learnt to create, to develop and to market the product. It provides an excellent platform for students to present their solution using the essential marketing tools with a complete financial and business report. This report consists of cost analysis, financial statement and break-even calculation together with a product life cycle analysis. At the end of the module, students will be able to identify the proper manufacturing processes; types of materials used for product development and to market and create new ventures for the product (Cynthia L. Greene 2009).

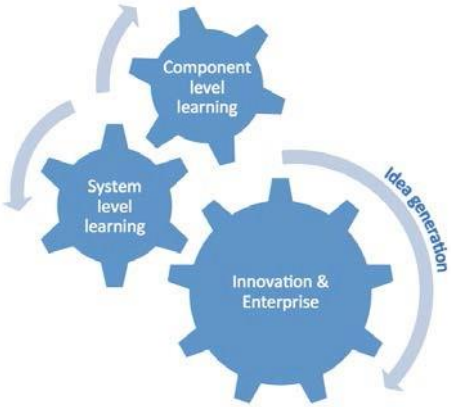

Figure 5: Progressive and integrated leaning approach

Results and Discussion

The Semestral Project Modules provide an excellent platform to nurture and inspire students in project development, creative thinking and entrepreneurship. Peroidical assessment is carried out to evaluate the learning outcome of this module. The assessment is based on the quality of the project work, prototype built, presentation and project report.

At the end the of the module, a survey will be conducted to obtain feedback from students on the effectiveness of the subject delivery and the teaching methods as well as to understand the students' learning experiences. Based on past survey results, more than 90% of the students feedback that these modules were relevant, practical and the skills and knowledge gained have enhanced their design and project development capabilities. They were able to apply and demonstrate their creativity, innovativeness and entrepreneurial spirit in their respective fields.

Regular curriculum review by the teaching staff is also undertaken to study areas of improvement and ensure the quality of the program.

With this skill set learnt, other than promoting creativity and entrepreneurship, students will have the opportunity to participate and achieve outstanding results in various technology and creativity competitions, such as the Singapore Robotics Game, Tan Kah Kee Young Inventors' Award, i-CREATe (International Convention on Rehabilitation Engineering and Assistive Technology), A&RT Student Design Challenge (Assistive & Rehabilitation Technologies Student Design Challenge), World Skill Competition, etc. In addition, students will be able to work with students from different academic years and across different schools through a borderless project work environment.

Figure 6: NYP won the most Gold medals and the most number of medals, amongst other institutes, at the 20th Singapore Robotic Games 2013

Figure 7: Students received award from the Guest of Honour at Tan Kah Kee Young Inventors' Award Ceremony

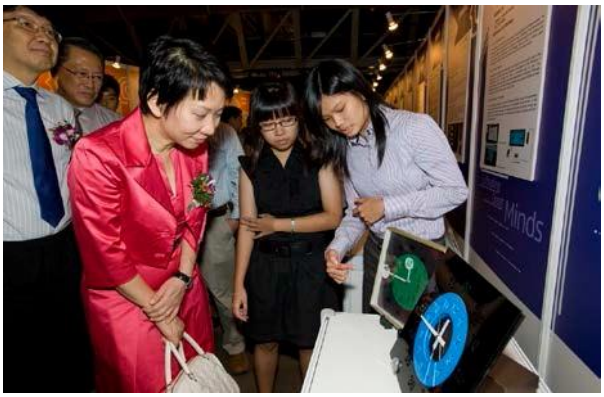

Figure 8: Students demonstrate the winning project to the Minister

TODAY news Paper featured NYP's winning project of i-CREATe competition (Today 16 Sept 2013):

Figure 9: X-RIGHT, won the top prize in a global student design competition at i-CREATe competition held at South Korea, emerged champions from among 51 teams.

Figure 10: Students participated in the World Skill Competition.

Furthermore, students are able to participate in the IE-Portal's (Innovation & Enterprise Portal) Idea Campaign to share and protect their idea. This portal is a one-stop facility for students to submit their innovative ideas as well as to share, view, vote and rank their peers' submissions.

Figure 11: NYP IE-Portal for idea submission and share

Conclusions

Semestral Project series is a holistic learning experience for engineering diploma students in Nanyang Polytechnic. This program inspires engineering students to create, innovate and translate their ideas into real product development. The project-based learning approach is designed to allow students to expand their applied knowledge and develop essential analytical skills to create real-world applications. Learning mainly takes place through a series of individual and group projects in different discipline which intended to enable students to apply their academic knowledge as well as creative thinking skill in new products or systems development. The robust training program exposes students to a multi-discipline learning environment and enables them to participate in various competitions or projects as well as able to adapt to various kind of working environment.

The Semestral Project module is in line with NYP's key goal of 'innovation and enterprise' and meets NYP's brand promise as an 'Innovation Polytechnic' to provide quality education & training as well as nurture students to become innovative and enterprising graduates.

Acknowledgements

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CONNECTING EVERY DOTS – MEETING ORGANISATION NEEDS AND INDIVIDUAL EXPECTATIONS IN TEACHING ADULT LEARNERS

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Abstract

Curriculum design is paramount in meeting course objectives and learning outcomes before any courses are being proposed and delivered, be it for Continuing Education and Training (CET) or Pre-Employment Training (PET) courses. For CET courses, there are many important elements as well as challenges affecting the design and teaching strategy chosen in adult teaching and learning. One of the key challenges that faced by many human resource or talent development teams, curriculum developers and instructors is to have customised curriculum and strategic lesson plans for Continuing & Education Training (CET) courses that not only able to meet organisation manpower development needs, but at the same time satisfying learners' expectations who are from diverse backgrounds and experiences during lessons delivery. During the curriculum design and planning stage for CET courses, there is a need to fully understand the organization's training needs; the expectations, backgrounds and experiences of the adult learners; and also decide which teaching methods are effective and feasible. In this paper, we propose a methodology that connects and engages all stakeholders or dots for effective and strategic course design and lesson plan, which takes care of the balance between the organization's training needs and its participants' expectations. Our proposed methodology, Connecting Every Dots (CED) was implemented and fined tuned over a period of 15 years for various programmes and courses for our two key training partners, Ministry of Defence (MINDEF) and Singapore Telecom (SingTel). We will share the details concept of our methodology, the implementation details, the results, outcomes and conclusion of our work in applying the CED methodology on these customised programmes and courses, which had benefited more than 10,500 professionals.

Keywords: *Continuing Education and Training (CET), training needs, expectations, customised curriculum, lessons plans*

Introduction

The need to continually upgrade our knowledge and skills remains critical when one completes formal education and enters into the workforce. These new skills and knowledge acquired to stay relevant in the job market will evolve when economic is restructuring in the current era of growing speed of technological changes and globalisation. Recognising the importance of lifelong learning and to better meet the upgrading needs of professionals, managers, executives and technicians (PMETs), the Ministry of Education (MOE) of Singapore announced in MOE Press Release (2011) several initiatives to enhance access to Continuing Education and Training (CET) for adult learners. These initiatives include the expansion of CET capacity, modular CET framework, recognition of alternative qualifications, *etc*. Marjan Laal and Peyman Salamati's paper on *Lifelong Learning: Why Do We Need It,* Hildebrand D.S. (2008) and Mascle, D. (2007) provides overviews of many key benefits of lifelong learning.

Curriculum design and strategic lesson plans are paramount in meeting course objectives and learning outcomes before any courses are being proposed and delivered, be it for CET or Pre-Employment Training (PET) courses. One of the key challenges that faced by many human resource or talent development teams, curriculum developers and instructors is to have customised curriculum and strategic lesson plans for CET courses that not only able to meet organisation manpower development needs, but at the same time satisfying learners' expectations who are from diverse backgrounds and experiences during lessons delivery. During the course design and lesson planning stage for CET courses, there is a need to fully understand the organization's training needs; the expectations, backgrounds and experiences of the adult learners; and also decide which teaching methods are effective and feasible.

Numerous models of planning education training programmes for adult learners exist, ranging from conceptual on programme planning to how-to handbooks and guides. Some of these models are considered seminal works, such as Cyril Houle's *The Design of Education* (1996), Malcolm Knowles's *The Modern Practice of Adult Education* (1980), and Ron

Cervero and Arthur Wilson's *Planning Responsibly for Adult Education: A Guide to Negotiating Power and Interests* (1994). Other authors have provided very useful, but limited application as they are targeted at programme planners only, and not for curriculum designers and instructors.

Much work has also been done on motivation and expectation of adult learners. Raymond J. Wlodkowski (2011) touched on the understanding of the motivation of adult learners and what motivates them to learn. Similarly, Christopher K Knapper et (2000) provided good insights into the characteristics and motivation of adult learners in the chapter '*lifelong learner*', and in the chapter "*Adult learners: What you need to know about"*, Jenny Rogers (2007) touched on the differences between the learners expectations of a course and what teachers expect them to learn from the course. Many of the characteristics cited in the books are similar to what we have experienced. However, there are also distinct differences. One of the two key reasons is that the customised courses that were designed and delivered by us were to meet organisation training needs while the courses cited by the authors are based on individual learning needs. The other reason is that most examples cited are based on cases in US or European countries, which are not the same as those in Singapore.

In year 2000, well before the introduction of modular CET framework by Singapore MOE, we had the opportunity to collaborate with two of our key training partners, Ministry of Defence (MINDEF) and Singapore Telecom (SingTel) in customising various CET programmes and courses for their officers and professionals. The practical experience as course designer, planner, coordinator, domain experts and instructors for these customised courses over the years has given us the opportunity to create, formulate, develop, implement and refine our propose methodology, Connecting Every Dots (CED), an adaptive modular framework that connects and engages all stakeholders or dots for effective and strategic curriculum design and lesson plans with aims to achieve a right balance between the organization's training needs and its participants' expectations. Our proposed CED methodology is suitable for both novice and experienced people who plan and manage customised courses for adult learners.

In this paper, we will share the details concept of our methodology, the implementation details, challenges faced, the results, outcomes and conclusion of our work in applying the CED methodology on these customised programmes and courses, which had benefited more than 10,500 professionals.

The CED Methodology

Our proposed Connecting Every Dots (CED) methodology started with the definition of people being defined as dots. In fact, we place emphasis on people being the heart of the CED methodology. The people or stakeholders of customised CET courses include organisations' talent development and human resource team, learners, programme or course planner, course coordinator, domain experts, instructors, technical support staff, administrative, *etc.*

We define 5 stages of cycle for each of the CET programmes or courses as follows.

Stage 1: Establishment of organisation manpower development needs and individuals learning expectations

Stage 2: Curriculum design and development

Stage 3: Development of lessons plans, course materials and execution plan

Stage 4: Course delivery and assessments

Stage 5: Course feedback and review

In each stage, we identify relevant stakeholders or dots and connect these dots together. Subsequent section shows the concepts of our methodology through various stages.

Figure 1 shows the way we connect, engage and expand the dots from a training provider and an organisation that has manpower development needs in stage 1.

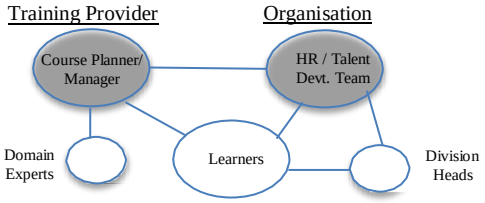

Figure 1: CED in Identifying Needs & Expectations

With reference to Figure 1, there are 3 big dots – course manager from training provider, human resource (HR) personnel or talent development team from the organisation, and the learners (or learners representative) in a discussion to define clearly the organisation training needs and individual learning expectation, if course manager understand well the expertise his organisation can provide and HR personnel understand what are his organisation needs. Our dots approach, which uses big dots to represent those stakeholders who must be present in engagement and discussion process, will ensure effective and fruitful discussion together. In this stage, the learners as a big dot show a must for learners to be present in the discussion, which most organisations do not involve learners in this stage, to hear from them their learning expectations. The engagement of learners at this stage will ensure learners not just understand the learning outcomes of the courses, which often happen, but also to understand their organisation training needs, target deliverables or changes in their job functions expected of them after the completion of the course and participate in defining and aligning closely their individuals learning expectation to the organisation needs. The small dots represent a good to be present stakeholders to strengthen the identification and prioritization of needs, and make clear the defined outcomes from the stage 1, i.e. training needs and learning expectations. There are many methodologies such as the one defined by Rosemary S. Caffarella

(2013, pp 133-160), in identifying and prioritizing training needs that one can adapt. To keep it simple, we propose to focus on identifying just 3 primary key organisation training needs and 3 main consolidated individual expectations, along with measurable outcomes and profile of learners for each course. The individual expectations can often match the organisation training needs, when learners are involved in the stage 1. Table 1 shows a sample template that we created.

Table 1: Organisation Needs and Individual Expectations

Organisation: Proposed Course Title/Areas: Available Budget:			
Training Needs	Measurable Outcomes	Profile of Learners	Individual Expectations
1.			
2			
3.			

With the identified training needs, measurable outcomes (way to assess whether training needs met eventually), profile of learners, and individual expectations, *etc*., the training provider can now move on to stage 2 on designing and developing curriculum with clear outcome-based learning objectives. Figure 2 shows our CED dots concept in this phase where 3 big dots, namely course manager, domain experts and instructors have to be connected and engaged to ensure the curriculum design and course proposal put forward for organisation to consider and review has an aim to meet a balance of organisation needs and individual expectations, which not necessarily be 50-50, by design. The small dot, such as the technical support staff is required to be present if lab equipment and configuration need to be prepared for the support of practical sessions.

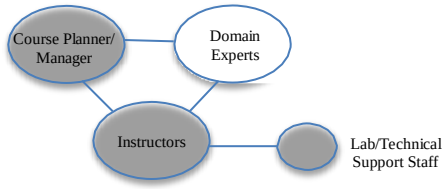

Figure 2: CED in Stage 2 - Curriculum Design

We use the template in Table 2 that captures again the training needs and individual expectations, to keep stakeholders in mind on these, and some guidelines to meeting organisation needs and individual expectations.

Table 2: Mapping in Course Proposal Development

Organisation Training Needs	O.1	O.2	O.3
Individual Expectations	I.1	I.2	I.3
Course Title & Objectives	Must align to the areas of technology & focus, *etc*. and reflect or match organisation training needs		
Syllabus & Learning Objectives	Use matrix to map and show which topics and sections and learning objectives match O.1-O.3 and I.1 – I.3		

With the information obtained from Table 2, training provider can follow Rosemary S. Caffarella (2013) model of designing course curriculum and learning objectives, or adapt from existing practices in preparing the course proposal with learning objectives to meet the organisation training needs, course objectives and individual expectations, *etc*. The course proposal will be presented and discussed further with the organisation, where CED shown in Figure 1 can be used. A hybrid of CED, created from Figure 1 and 2 by re-grouping the big dots, can also be adopted to confirm the course proposal speedily before moving to stage 3. An example is shown in Figure 3, where there is an advantage for instructors and learners to build connections before course commences.

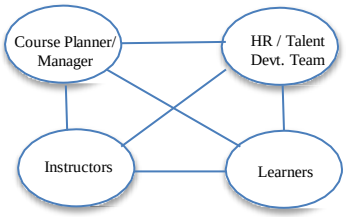

Figure 3: A Hybrid of CED – adapted from Stage 1 and 2

In stage 3, we propose the CED as in Figure 4 for training provider in the development of lessons plans and course materials. Domain experts are considered big dots though instructors are normally the domain experts themselves. The advantage to have other domain experts in our proposed CED, is to enable discussions among multiple experts and instructors to develop, check, vet and enhance strategic lesson plans and course materials for meeting the learning outcomes. Lab or technical support staff member is considered a big dot but with dotted line as it is only applies when the courses are technical and require lab training or practical demonstrations.

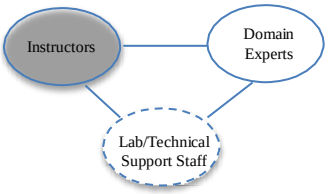

Figure 4: CED in Stage 3 – Lesson Plans

Table 3 shows the template that we propose to align and map the instructional objectives, learning outcomes, lesson plans and mode of delivery in stage 3.

Table 3: Mapping in Stage 3

Organisation Training Needs	O.1	O.2	O.3
Individual Expectations	I.1	I.2	I.3
Instructional Objectives & Learning Outcomes	Use matrix to map and show which instructional objectives, learning outcomes, and delivery mode match O.1-O.3 and I.1 – I.3		
Lesson Plan			
Mode of Delivery			

Stage 3 covers also the execution plan that pays attention to the many logistical details, which is equally important to ensure learners have a good total learning experience besides the course contents itself. Figure 5 shows our proposed CED and Table 4 shows a sample checklist (not a complete and exhaustive list) for this phase. A contingency plan for each key item has to be put in place, as there is nothing more frustrating to learners than discovering that some of the essential logistics have been overlooked and the course does not run smoothly.

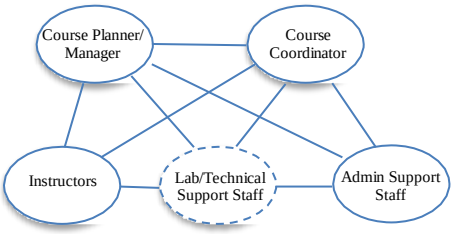

Figure 5: The CED for Execution of Plan

Table 4: Checklist

Organisation Training Needs	O.1	O.2	O.3
Individual Expectations	I.1	I.2	I.3
Item	Name	Ready by	Check
Before			
Approval of budget			
Scheduling, reservation of venues			
Printing of course & assessment materials, feedback form, *etc.*			
Venue, instructional equipment, demo set up			
Directional signage			
others			
During			
Registration			
Welcoming learners			
Instructors readiness			
Assessments			
Interaction with learners			
Contingency plan			
Formal & informal feedback gathering			
others			
After			
Assessment marking			
Learners and instructors feedback review			
Organisation Review & Recommendation			
others			

Stage 4 covers the actual course delivery and assessment. Obviously, the instructors and learners will be the 2 big dots in this stage as shown in Figure 6.

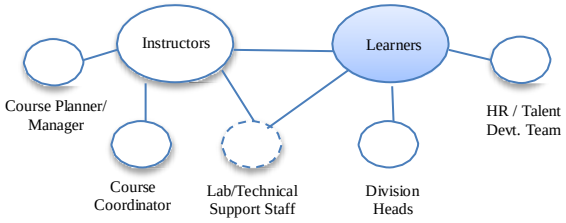

Figure 6: CED in Course Delivery & Assessments

The small dots such as course coordinator and technical support staff are there to provide assistance whenever the instructors or learners require them. Course planner, HR team and division heads can be there as observers to interact and engage with instructors and learners directly and eventually provide feedback for improvement. A simple evaluation form is used to gather all feedback remarks from learners and instructors every day. If a course spans more than a day, the remarks are shared with instructors on the next day.

In stage 5 where course feedback is done, our proposed CED is shown in Figure 7. The course coordinator will consolidate and analyse all feedback received together with course planner. As feedbacks and recommendations from all stakeholders are important for course improvement, we use all big dots.

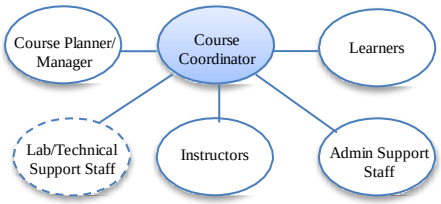

Figure 7: CED for Course Feedback

The course planner will then do a course review and recommendation with the organisation HR or talent development team as shown in Figure 8, similar to Figure 1 in stage 1. The team will deliberate and conclude not just only on whether the course meets the target organisation training needs and individual expectations, but continual actions to be taken for the next few months, to track the impacts of the course on learners in their jobs roles and performances.

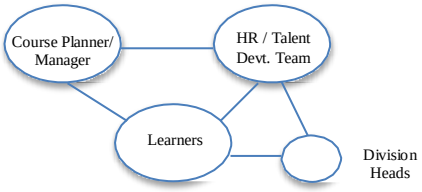

Figure 8: CED for Course Review

Implementation

We applied the CED methodology to all customised courses since year 2000, when the opportunities arised for us to collaborate with Ministry of Defence (MINDEF) of Singapore and Singapore Telecom (SingTel) on various manpower development programmes. Table 5 and 6 list these courses for MINDEF and SingTel respectively that we have applied the methodology. We categorise theses programmes and courses into 3 main categories, following the distinct organisation training needs, i.e. A: enhancement of technical knowledge, skills and knowhow; B: re-profiling of learners; C: leveling up all employees through updates of relevant technologies and applications.

Table 5: Customised MINDEF Courses

Category	Course / Programme Title	Yrs	No of Runs / Learners
A	Networking Certifications	2000 - 03	3/74
	Signal 21 Programme	2006 - 13	54/1162
B	Signal Re-profiling Programme	2003 - 04	20/562
	DSTA Re-profiling Programme	2007	1/63
C	Infocomm Technology (ICT) Programme for Army	2006 - 07	18/1974
	ICT Programme for Senior Officers	2006	2/164
	ICT Programme for All	2007 - 14	121/5001
		Total:	219/9000

Table 6: Customised SingTel Courses

Category	Title	Yrs	No of Runs / Learners
A	Next Generation Networks Technology Courses	2000 - 11	23/395
B	Infocomm Reprofiling Courses	2001-04	14/460
C	Next Generation Networks Technology Courses	2002 - 14	32/686
		Total:	69/1541

We present the results and findings with reference to each category A, B and C of the programmes and courses in the next section.

Results and Discussion

Application of the CED methodology over the past 15 years on all customised courses are banded into 3 categories based on distinct organisation training needs (i.e. A: enhancement of technical knowledge, skills and knowhow; B: re-profiling of learners; C: leveling up all employees through updates of relevant technologies and applications) for a total of 10,541 participants has consistently yielded an increasing positive trend of outcomes, supporting the effectiveness of the CED methodology in meeting both organisation manpower development needs and satisfying learners' expectations.

For customised MINDEF courses, with discussions and agreement with the organisation, various forms of in-course assessments (such as quizzes at the end of each topic, or at the end of whole course, practical assessments, group discussion and presentation, *etc.*) were used to measure the effectiveness of the CED methodology in meeting the organisation training needs, and learners' course feedback (such as my rating of the overall course) was used to measure the effectiveness of the methodology in meeting learners' expectations. The results over the years show a consistent increasing positive trend based on in-course assessments and course feedback as shown in Figures 9 - 11.

Besides the normal lecture, tutorial and practical sessions, we have implemented various curriculum designs, lessons plans and methods of teaching and learning to continuously meeting the changing and increasing demanding organisation needs and individuals' expectations. These methods include integrated lecture/tutorial/practical sessions, sharing as in industry seminar style setting, products and solutions demonstrations as part of teaching aids, sharing of experiences in project development and challenges faced through tour of various specialist centres and industry collaborative labs, break-out group discussion and sharing, application and continuous learning in real environments of MINDEF, *etc.*

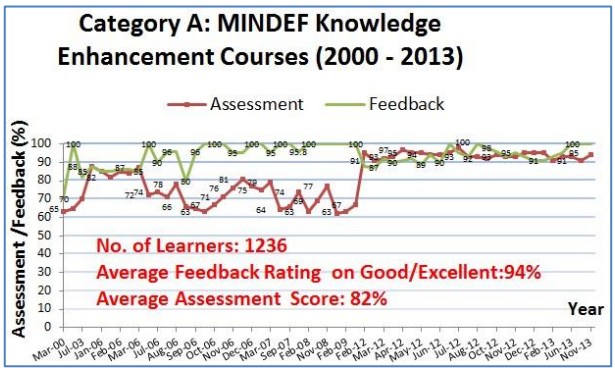

Figure 9: CED outcomes for MINDEF courses Category A

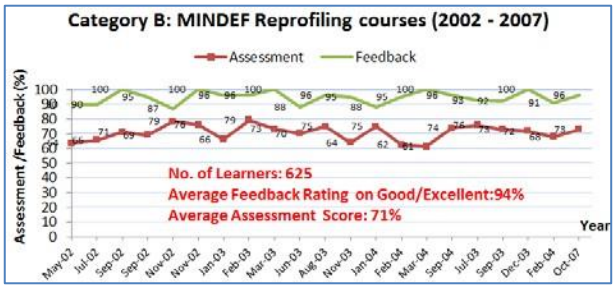

Figure 10: CED outcomes for MINDEF courses Category B

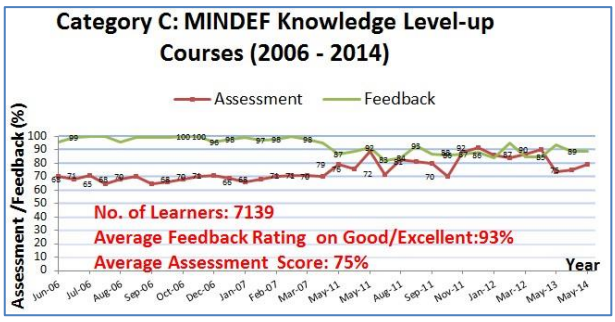

Figure 11: CED outcomes for MINDEF courses Category C

As there was no requirement of in-course assessments for SingTel customised courses, we used question such as 'the course has met its stated objectives or/and organisation needs' as a measure to the effectiveness of applying the CED methodology in meeting the organisation training needs, besides getting feedbacks from the manpower development division of SingTel and individuals after the conduct of courses. Learners' course feedbacks on rating of overall course, similar to those used for MINDEF courses, was used to measure the effectiveness of the CED methodology in meeting individual expectations. As shown in Figures 12–14 customised SingTel courses using CED methodology yields similar positive results for organisation training needs and learners' expectation.

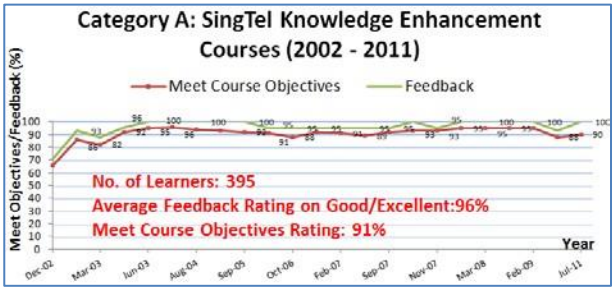

Figure 12: CED outcomes for SingTel courses Category A

Figure 13: CED outcomes for SingTel courses Category B

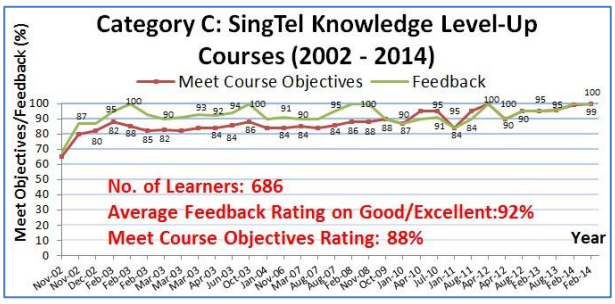

Figure 14: CED outcomes for SingTel courses Category C

The long standing training collaborations on customised courses between the School with MINDEF and SingTel over the 15 years period is another testimony on the effectiveness of the CED methodology in continuously meeting both organisations training needs and individual expectations.

Conclusions

We propose a methodology, Connecting Every Dots (CED) that connects and engages all stakeholders or dots for effective and strategic planning and management of CET courses, which takes care of the balance between the organization's training needs and its participants' expectations.

We applied the CED methodology on various courses for more than 10,500 professionals over a period of 15 years, for our two key training partners, Ministry of Defence (MINDEF) and Singapore Telecom (SingTel). We banded these courses into 3 categories based on distinct organisation training needs i.e. A: enhancement of technical knowledge, skills and knowhow; B: re-profiling of learners; C: leveling up all employees through updates of relevant technologies. The consistent positive results and outcomes gathered have validated the effectiveness of the CED methodology in meeting both organisation manpower development needs and satisfying learners' expectations. We believe our proposed CED methodology which focuses on people engagement, provides adaptive modular structure, and has processes and templates that can be automated through technology will be increasingly applicable and important in managing adult learning courses for organisations with diverse and increasing demanding needs and individual expectations.

Acknowledgements

We would like to thank the management of the Nanyang Polytechnic, MINDEF and SingTel, who have provided the opportunity of these many customised courses over the years where our CED methodology was implemented, as well as the many colleagues who have successfully delivered the many courses together.

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NYP EXPERIENCE IN IMPLEMENTING 'INTRODUCTION TO ENGINEERING' (CDIO STANDARD 4)

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Abstract

Nanyang Polytechnic, Singapore has been a collaborator of the Worldwide CDIO Initiative since 2011. A working committee has since been formed to strategize and steer the CDIO implementation in the School of Engineering (SEG). This paper shares our experiences in adopting CDIO standard 4 - "Introduction to Engineering"; from raising awareness of the CDIO initiative, benchmarking our existing practices with the CDIO standards, sharing of success stories through pilot studies, to full implementation in 2013. In the design of the "Introduction to Engineering" module, a general framework has been developed. This framework emphasizes on the relevance of knowledge covered in the first semester of study to the engineering disciplines, and the use of these integrated knowledge in engineering practices, as well as the essential personal and interpersonal skills. This framework can be adapted to various engineering disciplines and has been successfully implemented in all the 11 engineering courses offered in SEG. In particular, the use of such framework in two of the courses: Diploma in Aeronautical and Aerospace Technology and Diploma in Aerospace and System Management, and the challenges faced in the implementation are detailed in the paper. Finally, the paper highlights that organizational cultures and values, systems and processes are important enabling factors for the success of large-scale implementation in an institution.

Keywords: *introduction to engineering, course design, factors enabling success, large scale implementation, CDIO standard 4*

***Note* –** In the context of Nanyang Polytechnic, the term 'course' refers to a 'program' while the term 'module' refers to a 'course'. For example, Diploma in Aeronautical and Aerospace Technology is a course; Introduction to Engineering is a module.

Introduction

Nanyang Polytechnic (NYP) started its endeavour to implement CDIO in 2011. Naturally, School of Engineering (SEG) in the polytechnic has been identified to pioneer the adoption of this initiative. In order to strategize and steer the CDIO implementation in the school, a working committee has since been formed. As a start, the committee organized several sharing sessions to raise the awareness of CDIO initiative among the management staff and faculty members to solicit their support and buy-in for the implementation. Through these sharing sessions, the concepts and benefits of CDIO framework were shared, and the relevance and importance of its implementation to train students to be industry-ready graduates were highlighted to the staff.

Concurrently, the course managers led their course management teams to kick off self-assessments on their respective diploma courses, based on the twelve CDIO standards. One common gap identified from the self-assessment exercises was the absence of an introductory module that matches the requirements as specified in CDIO Standard 4. That is, an introductory module that provides the framework for engineering practice in product, process, and system building, and introduces essential personal and interpersonal skills. The course managers and their teams believed that the introduction of such module in the first semester of students' first year of study will further stimulate students' interest in, and strengthen their motivation for, the practice of engineering through problem solving and design.

To gain the know-how in designing and implementing this introductory module, key members in the working committee visited institutions which had experiences in designing and implementing the "Introduction to Engineering" modules, and learn from collaborators during the CDIO International conferences and meetings. Eventually, the new introductory module had its pilot runs in two SEG courses after redesigning two existing modules for year-one students in 2012. The pilot runs had been a success, complementing with positive and encouraging feedback from the students.

With the extension of this introductory module to all SEG courses in plan, the staff members who were involved in the pilot runs were invited to share their experiences and the challenges they had faced through

sharing sessions. Based on the feedback and evaluation of the pilot runs, the working committee has developed a general framework which emphasizes on the relevance of knowledge covered in the first semester of study to the engineering disciplines, and the use of these integrated knowledge in engineering practices, as well as the essential personal and interpersonal skills. This framework can be adapted to various engineering disciplines and has been successfully implemented in the "Introduction to Engineering" modules which were offered in all eleven SEG courses in April 2013.

General Framework for Implementing Introduction to Engineering Module

Module Design:

SEG aims to achieve five objectives through the implementation of these "Introduction to Engineering" modules in students' first year of study:

- Motivate and excite students;
- Demonstrate the relevance of disciplinary knowledge covered in Year 1 Semester 1, and show that it can be applied to real-world problems;
- Begin the process of developing professional skills: creative & critical thinking, problem solving, team working, report writing & presentation skills, etc.;
- Introduce students to relevant core engineering disciplines, and clarify their understanding of the nature of engineering and what engineers do;
- Raise students' awareness of CDIO program.

These objectives were shared with the staff responsible for the module development (module coordinator) in order to ensure alignment across various courses.

The introductory module is designed to be a 60-hour module that lasts for 15 weeks of instruction (i.e. four instructional hours every week). In order to provide year-one students with a clearer picture on engineering and prepare them to work on hands-on projects in team setting, the first part of the instruction is designed to include various learning activities (e.g. case studies, videos, games, etc.) to introduce the students to the concepts of CDIO program, roles and responsibilities of engineers, the impact of engineering on society and environment, teamwork, thinking and problem-solving skills. After which, the students would be assigned in groups to work on their first project that gets them familiarized with the necessary tooling and experimentation skills. They would then continue to work on a second group project that integrates the application of CDIO skills and all relevant disciplinary knowledge they have learnt from other modules in the semester. To motivate and excite the students, they would compete in groups to demonstrate their achievements in the second project.

The abovementioned module design (as summarized in Table 1) serves as a general guideline; however, the respective module coordinators have the flexibility to design and incorporate various learning activities and project assignments on their own based on the needs of the respective courses.

Table 1: Module Design

Introduction to Engineering (60hr – 4 hours per week)	
Week 1 to 2	Topics to be covered in the first 8 hours: • Introduction to CDIO and purpose of Introduction to Engineering (~¼ hour) • Roles and Responsibility of Engineers (~¾ hour) • Impact of Engineering on Society and the Environment (~1 hour) • Teamwork (~2 hours) • Creative & Critical Thinking (~2 hours) • Problem Solving Skills (~2 hours)
Week 3 to 7	Group Project One – Familiarisation with Tooling & Experimentation
Week 8	Presentation for Group Project One
Week 9 to 14	Group Project Two – Integration of CDIO Skills
Week 15	Presentation for Group Project Two & Competition

Resources:

To facilitate the instruction on introducing students to the concepts of roles and responsibilities of engineer, impact of engineering on society and the environment, teamwork, creative and critical thinking, and problem solving skills, a common pool of resources like training materials and ideas for designing learning activities on these areas were gathered, developed and shared among all module coordinators.

Regular meetings were also organized by the working committee to provide a platform for module coordinators to share, discuss and exchange ideas on best practices that were deployed in their classrooms. Peer observation of classes in action was also encouraged so that module coordinators could learn through collaboration, reflection and discussion.

Forming of such community of practice connected the module coordinators and allowed them to identify solutions to common problems, solve challenging problems, explore new possibilities, and create new, mutually beneficial opportunities.

Assessment:

Module coordinators were encouraged to use rubrics as a standardized way of assessment by stating clearly the criteria and weightage for the different components of assessment. Through the use of rubrics, students would be clear on the expectations of quality for assignments and they would understand the reasoning behind a grade. Standard rubrics were developed to assess students' performance in individual contribution, teamwork, and presentation. The assessment criteria

specified in these rubrics are listed in Table 2. The students are graded against the criteria on a scale of "Excellent", "Good", "Satisfactory" and "Need Improvement", which have marks assigned to them. However, module coordinators are allowed to assign different weightages for the criteria. They also have the option of not using all the assessment criteria but only choosing those appropriate for the delivery of their modules.

Table 2: Assessment Criteria for Students' Performance

Assessment Criteria for Individual Contribution	Assessment Criteria for Teamwork	Assessment Criteria for Presentation
Attendance/ promptness	Contribution to the team	Organization of information
Ability to describe a problem and develop a plan to solve the problem	Leadership	Delivery
Focus on tasks	Ability to work with others	Command of language
Critical thinking		Use of supporting materials/aids
Innovative thinking		Subject knowledge
Product and documentation		

To facilitate the use of rubrics in the Introduction to Engineering modules, a flow chart on how rubrics could be implemented in the module was developed (see Figure 1). Two forms were created for the rubrics: Form A and Form B. Form A is for faculty use and they can input the actual marks for each criteria of the rubric.

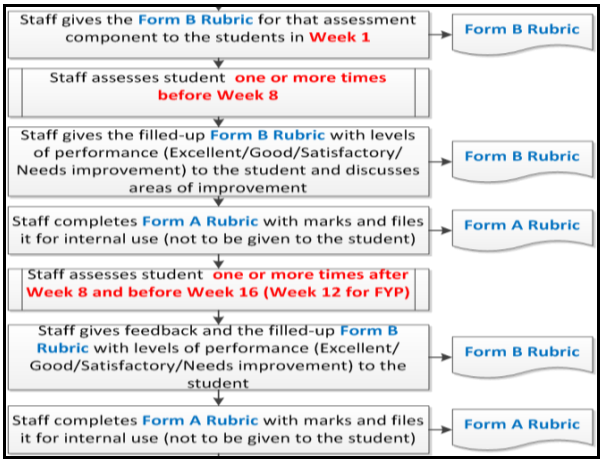

Figure 1: Flow chart for implementing rubrics in a module

Form B is for faculty to discuss with students on areas that students had done well and areas that needed improvement.

Adoption of the General Framework in SEG

The following sections showcase the implementations of "Introduction to Engineering" modules in two SEG courses: Diploma in Aerospace and System Management (DASM) and Diploma in Aeronautical and Aerospace Technology (DAAT).

Adoption of the framework in DASM

The introductory module in DASM course aimed to promote students' interest in engineering by providing a platform for students to build electronic engineering projects for aerospace application. The module has been designed to include the following projects.

Individual Project – My First Avionics:

This project was designed for the students to get familiar with electronic components (such as resistors, capacitors, light-emitting diodes, switches and 555-timers), circuit diagrams, tooling, and learn experimentation skills by building an electronic board that demonstrated the functions of aircraft navigation lights and anti-collision lights. Each student was required to connect the circuit on the breadboard to understand the circuit connection and verify the circuit functions. They were then guided to prepare component layout diagram, and soldered the components onto the strip-board. They were expected to perform functional test for their project board.

At the end of the project, each student shared their learning experiences with the class for enhancing peer-learning in the class. Through this project, the students built up their technical capabilities and gained confidence for the group project.

Group Project – Let's Make It Fly:

Groups of three to four students were formed by staff. Each group worked on a control board for the flying machine (Figure 2). The project integrated the application of CDIO skills and all relevant disciplinary knowledge they have learnt from other modules in the semester (e.g. Electrical Fundamentals and Computer Programming).

The project involved both hardware and software tasks. On one hand, the students were required to study and solder the circuit that controlled the rotor speed of the flying machine onto the strip-board. They were expected to verify the output waveform from the control board using oscilloscope. They were challenged to modify the given circuit to add new features such as ON/OFF control and indication lights. On the other hand, the students were required to develop the interface program (based on a sample C program code) that read and processed the sensor values (such as flying altitude and acceleration) from the flying machine, and output the relevant information to a display panel in their preferred format. The program was expected to control two indication light-emitting diodes on the flying

machine too. Finally, the students were required to connect the control board to the flying machine, and upload the interface program to the flying machine controller before they performed testing to verify the functions and made changes if necessary.

To motivate and excite the students, they would compete in groups to demonstrate their achievements and to share their group learning experience to a panel of judges. Through this project, the students learned teamwork, enhanced their communication skills and practiced problem-solving skills.

Most of the students commented that they enjoyed the learning activities and the module did stimulate their interest to learn more about Aerospace Systems.

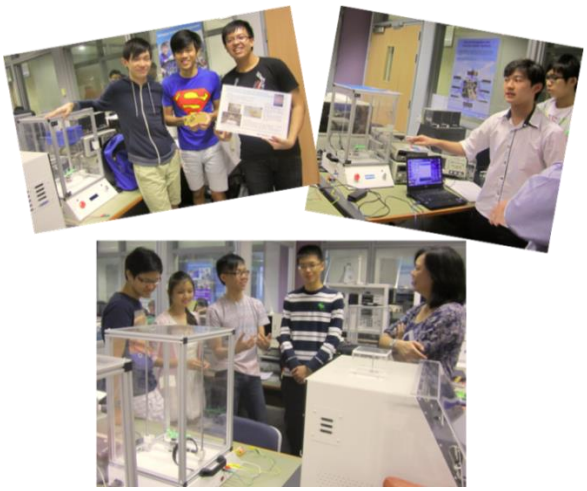

Figure 2: Flying Machine Project

Adoption of the framework in DAAT

DAAT students were assigned interesting projects in their "Introduction to Engineering" module, in order to capture their interest for subsequent aeronautical-related modules. In addition to hands-on practical skill of producing work pieces using various machining processes, each group of students was tasked to design and build a hand-launched glider using compressed foams (Figure 3). As a group project, members within a group were tasked with different responsibilities in conducting research, designing and building the prototype, and presenting their project. The use of rubrics to feedback to students in this phase proved to be useful as students were aware on areas that they had been done well and areas that needed further improvements. The nature of the project had motivated the students to undergo several iterations of design improvements after initial failures, before completing a successful glider prototype.

The project provided a platform for the students to demonstrate practical application of their basic knowledge on airplane structures and theory of flight. At the end of the project assignment, the students competed for the glider that could fly the furthest linear distance. The competition had successfully created a lot of fun and excitement among the students.

In addition to the competition, each group of students prepared an after-competition presentation, with every member sharing their roles, challenges faced and how their design was conceived and improved on. The learning experience through this glider project has enabled the students to learn through self-discoveries and failures in a safe environment.

Figure 3: Glider Project

Feedback from Students

At the end of the semester, surveys with a four-point scale (strongly agree, agree, disagree, strongly disagree) were conducted to gather feedback from 560 students on the "Introduction to Engineering" modules. The students were asked a series of questions that sought to validate the objectives and conduct of the introductory module, design-build experiences as well as the integrated curriculum. The results on the quantitative aspect of the surveys are as shown in Figure 4.

Do you agree?	Students' Response n = 560
1. The learning objectives of this module are clear.	96% agreed
2. The module is well organized.	95% agreed
3. The pace is just right.	94% agreed
4. The module stimulates my interest to learn more about Engineering.	90% agreed
5. The module is relevant to other modules in the same semester.	88% agreed
6. Feedback provided by lecturers is helpful and timely.	96% agreed
7. Grading criteria are clear and fair.	94% agreed
8. Overall, the module is worthwhile.	94% agreed

Figure 4: Student Survey Results

From the surveys, majority of the students agreed that the learning objectives were clear and found the

module to be well organized and conducted with the right pace. This indicated that they understood and knew the deliverables that were expected of them. Most students also found the module to be stimulating their interest to learn more about their respective engineering discipline. The results also indicated that majority of the students were able to apply knowledge learnt from different modules in the same semester. When it came to assessment, grading criteria were deemed clear and fair. Overall feedback from the students was positive.

On the qualitative aspect of the survey, comments from students were encouraging. In response to the question about the "best" part of the introductory module, the students reflected they liked the hands-on experience of developing projects in teams, which allowed them to learn more effectively through self-discoveries and to persevere through their failures.

Faculty Learning Experiences

Module coordinators observed that students were much more engaged and motivated to learn more about engineering during the lessons. Students were enthusiastic in completing their projects and were excited in participating in the competitions. On the other hand, the module coordinators also face some challenges in the process of implementation which include: managing students with different capabilities in team setting (e.g. advising the students on proper problem-solving approaches, monitoring and ensuring the students were working as a team in carrying out the project works), synchronizing the delivery of related topics in various modules with that of the Introduction to Engineering module for better integration, etc. They also identified the need for more free-access workspace for students especially during the trouble-shooting phase of project development.

Going forward, the working committee will be working with the module coordinators to incorporate more activities within the introductory modules to enhance students' creative and problem-solving skills. One way is to inject more flexibilities and options into the project assignments for students to explore further on their own. The module coordinators will also look into how they can integrate with more modules that the students study in the same semester, so that the students apply the knowledge learnt in real-world problems. The school will be looking into designing and providing free-access workspace specifically for students to work on the Introduction to Engineering projects.

Lessons Learnt for Large Scale Implementation

The "Introduction to Engineering" modules have been implemented in all the eleven SEG courses concurrently in the first semester of the academic year 2013. For such large-scale implementation to succeed, the working committee first had to obtain support from the course managers and department heads that were in positions of influence over the course and module curricula and the allocation of resources. The successful pilot runs in two SEG courses had convinced the faculty that the introductory module has been well-accepted by the students, and provided them with a positive learning experience.

NYP has long established a culture in which the staff shares a set of common organizational values, which include "the can-do spirit" and "borderless teamwork". This has facilitated the smooth implementation of this large-scale curriculum redesign, besides capabilities and efforts by individual staff member. The general framework for implementing "Introduction to Engineering" module and the various systems and processes that have been established have also enabled the staff to deliver the desired outcomes. The framework proves to be useful and flexible that allows the module coordinators to easily adapt and design various learning activities and project assignments for their respective engineering disciplines.

Conclusions

In summary, the curriculum redesign to implement "Introduction to Engineering" module in all eleven SEG courses has been a successful exercise. The organizational cultures and systems, as well as the individual efforts by the staff members, are crucial to the success. The learning objectives of this introductory module have been achieved in various courses of different engineering disciplines through adopting and adapting the general framework. Positive feedback from the students encouraged the faculty to fine-tune the processes and learning activities further to ensure that the implementation is sustainable, and the students will gain fruitful learning experience through the "Introduction to Engineering" modules. The CDIO approach of having practical introductory exposure to engineering activities coupled with built-in exercising of communication skills and teamwork was shown to be not only achievable but also rewarding.

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VIRTUAL DEMENTIA HOME SERIES: BATHROOM-TOILET

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Abstract

The Virtual Dementia Home Series (VDHS): Bathroom-Toilet is a locally customized e-learning package developed in four languages – English, Chinese, Malay and Tamil – and made available via the internet (www.dementiahomeseries.com.sg) and android apps. It aims to provide an e-resource to caregivers on how to modify the home bathroom and toilet, making them more dementia- and wheelchair-friendly. A descriptive survey of a convenience sample of 151 online participants was conducted. Prior to the recruitment, road shows were organized at conferences and various caregivers' support sessions to inform potential participants of the e-resource. Participants were recruited when they consented and registered for the VDHS's online package from February 2013 to February 2014. Potential participants were informed that the apps version would be available to them should they choose not to participate in the survey. The data collection tool was a 15-item online survey questionnaire of participants' demographic profile and a 10-item pre- and post-test questionnaire to evaluate their knowledge on home modification. Most of the participants are Chinese, female between 31 to 60 years old, spouses or children, healthcare professionals, working full-time, and well- educated. The pre-test and post-test results indicated a 100% improvement in knowledge related to a dementia home environment and modification. Findings indicate a consistent demographic profile of family caregivers which is similar to that of other studies. Internet research is a new approach with its fair share of strengths and weaknesses. Strengths include speed, immediate retrieval of information and cost reduction related to travel expenses and printing of survey questionnaire. A key weakness may be selection bias due to the non-representative nature of the internet population, and self-selection of participants, also called the `volunteer effect'. However, in the case of this study, it may not be entirely so as the participants could be end-users who were exposed to the website during the road shows.

Keywords: *Android apps, caregivers, dementia, e-learning, environment, home, non-pharmacological intervention, modification, mobile learning, on-line, web-based*

Introduction

The Virtual Dementia Home Series (VDHS): Bathroom-Toilet is a locally customized e-learning package developed in four languages (Figure 1) – English, Chinese, Malay and Tamil – and made available via the internet (www.dementiahomeseries.com.sg) and android apps. It aims to provide an e-resource to caregivers on how to modify the home bathroom and toilet, making them more dementia- and wheelchair-friendly (Figure 2).

Figure 1

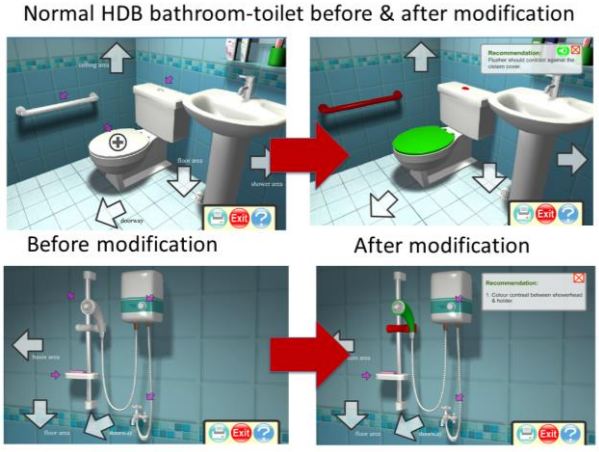
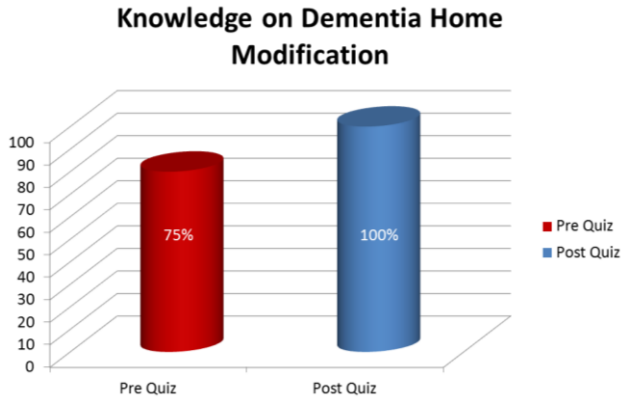


Figure 2

Four language options; Clockwise from the left – English, Chinese, Malay, Tamil

Figure 3 Pre & Post Test Results



Materials and Methods

This was a descriptive survey of a convenience sample of 151 online participants. Prior to the recruitment, road shows were conducted at a conference and various caregivers' support sessions to inform potential participants of the e-resource. Participants were recruited when they consented and registered for the VDHS's online package from February 2013 to February 2014. Potential participants were informed that the apps version would be available to them should they choose not to participate in the survey. The data collection tool was a 15-item online survey questionnaire of participants' demographic profile (Appendix 1) and a 10-item pre- and post-test questionnaire (Appendix 2) to evaluate their knowledge on home modification.

Results and Discussion

Most of the participants are Chinese, female between 31 to 60 years old, spouses or children, healthcare professionals, working full-time, and well educated. The pre- and post-test results (Figure 3) indicated a 100% improvement in knowledge related to a dementia home environment and modification.

Conclusions

Findings indicate a consistent demographic profile of family caregivers which is similar to that of other studies. Internet research is a new approach with its fair share of strengths and weaknesses. Strengths include speed, immediate retrieval of information and cost reduction related to travel expenses and printing of survey questionnaire. A key weakness may be selection bias due to the non-representative nature of the internet population, and self-selection of participants, also called the `volunteer effect'. However, in the case of this study, it may not be entirely so as the participants could be end-users who were exposed to the website during the roadshow.

Figure 4 Rehab Tech Asia 2013 Conference

The Virtual Dementia Home Series (VDHS): Bathroom-Toilet was presented and showcased at i-CREATE 2012, AWWA Caregivers Event 2012, Rehab Tech Asia 2013 Conference, Education Symposium 2013 and talks at ADA's caregivers' support group. During the Rehab Tech Asia 2013 Conference (Figure 4), Dr Amy Khor Lean Suan (Minister of State, Ministry of Health and Ministry of Manpower, Mayor, South West District and Deputy Government Whip) visited the booth then, and complimented on the usefulness of the project for caregivers and people living with dementia. She mentioned that this was a "very good" project. The other virtual rooms (bedroom, living room and kitchen) of the HDB flat are currently being developed through the TOTE SIR Fund.

Recommendations

- To further expand the current online resource to include the other rooms of the HDB flat – bedroom, living room and kitchen.
- To further enhance the current online portal with supportive features for family caregivers such as discussion forum, blogs.
- To provide caregivers with information on where to purchase or obtain items which are reasonably priced when considering home modification.

Acknowledgements

The authors would like to acknowledge the Alzheimer's Disease Association (Singapore) for their collaboration in the Virtual Dementia Home Series (VDHS): Bathroom-Toilet project, and the Centre for Enabled Living for funding this project through the Sustainable Enhancements for Eldercare and Disability Services (S.E.E.D.) Fund.

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Appendix 1: 15-item online survey questionnaire of participants' demographic profile

1) Nationality_____

2) Race
- ☐ Chinese
- ☐ Malay
- ☐ Indian
- ☐ Others. Please specify.

3) What is your age?
- ☐ Under 21 years. Please specify your exact age.
- ☐ 21 to 30 years.
- ☐ 31 to 40 years
- ☐ 41 to 50 years.
- ☐ 51 to 60 years.
- ☐ 61 to 70 years.
- ☐ 71 to 80 years.
- ☐ 81 to 90 years.
- ☐ 91 years and above.

4) What is your gender?
- ☐ Male
- ☐ Female

5) What is your highest educational level?
- ☐ Primary
- ☐ Secondary
- ☐ Certificate
- ☐ Diploma
- ☐ Advanced Diploma
- ☐ Degree
- ☐ Masters
- ☐ PhD
- ☐ Others. Please specify _____

6) Are you working?
- ☐ Full time
- ☐ Part-time
- ☐ Unemployed

7) What is your occupation?
- ☐ Professional. Please specify _____
- ☐ Skilled worker. Please specify _____
- ☐ Retired
- ☐ Student
- ☐ Foreign Domestic Worker (Maid)
- ☐ Others. Please specify _____

8) What is your monthly income?
- ☐ Less than S$1000
- ☐ Between S$1001 to S$2000
- ☐ Between S$2001 to S$3000
- ☐ Between S$3001 to S$4000
- ☐ Between S$4001 to S$5000
- ☐ Between S$5001 to S$6000
- ☐ Between S$6001 to S$7000
- ☐ Between S$7001 to S$8000
- ☐ Between S$8001 to S$9000
- ☐ Between S$9001 to S$10000
- ☐ Above S$10000.

9) What type of housing do you currently reside in?
- ☐ 1-room housing development board flat
- ☐ 2-room housing development board flat
- ☐ 3-room housing development board flat
- ☐ 4-room housing development board flat
- ☐ 5-room housing development board flat
- ☐ Executive maisonette
- ☐ Condominium
- ☐ Landed property

10) How many people are staying in the same household as you? _____

11) Are you staying with a person with dementia?
- ☐ Yes
- ☐ No

12) What is your role in the care of a person with dementia?
- ☐ Main carer
- ☐ Secondary carer
- ☐ Not involved with any care
- ☐ Professional trainer
- ☐ Others. Please specify

13) How are you related to the care recipient (person with dementia)?
- ☐ Spouse
- ☐ Brother
- ☐ Sister
- ☐ Son
- ☐ Daughter
- ☐ In-law
- ☐ Grandchild
- ☐ Others. Please specify.

14) How many hours a day do you spend looking after the person with dementia?
Please indicate the number of hours _____

15) Which support group or organization are you registered with?
- ☐ Alzheimer's Disease Association (ADA)
- ☐ Asian Women's Welfare Association (AWWA)
- ☐ Others. Please specify.

Appendix 2: Online Pre / Post Test

1. Which type of switch is easier to notice?

Light switch with a 2 x 1 (in cm) measurement

Light switch with a 4 x 4 (in cm) measurement

2. Which lighting option is better?

Light which casts shadows

Light without glare

3. Is a curb at the entrance of the bathroom / toilet wheelchair friendly?

- Yes
- No

4. Should mirrors be placed in the bathroom / toilet for elderly with end stage dementia?

- Yes, to help them recognize themselves
- No, they cannot remember who they are and it will cause fear

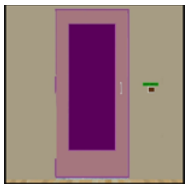
5. Which type of sink is wheelchair friendly?

Sink with cabinet below

Sink without cabinet below

6. Which door is wheelchair friendly?

Sliding door



Swinging door

7. Do contrasting colours in the bathroom (walls, floors, toilet seat, sink) assist a person with dementia to bathroom facilities?

Yes, because it will help them to see better

No, as it will cause confusion

8. Is having a non-slip mat necessary to ensure safety?

Yes, it will reduce the risk of slipping in a wet area

No, it is not necessary as the person can balance

9. Is a signage in and outside the bathroom / toilet useful?

Yes, because it will guide the person with dementia

No, as it will cause confusion

10. Should the temperature of the water heater be set to a fixed level?

Yes, to prevent scalding from hot water

No, it is up to the person to change the temperature

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THE ILIT-PLATFORM (I LEARN, I TEACH PLATFORM): A GRAPH-BASED MODEL FOR E-LEARNING

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Abstract

It was highlighted in (Plotkin, 2010) that one of OER [1] movement's first major problems is the inability of many potential users to easily and quickly determine which resources best fit their needs. While there is a vast amount of learning materials generously made available by various institutions of higher learning for free public use and repurposing, users often faced difficulties navigating the vast space of digital contents while deciding which are the ones that are useful for their needs. Contents are readily available, but users will most likely need some form of external guidance before they can embark on their e-learning process. A learner with little background in a topic which he/she desires to learn will have trouble sifting through vast amount of contents deposited in the existing e-learning platforms. Without any "roadmaps", an uninformed learner will not have a clue on where one should start and what are the important pre-requisites to acquire. Neither will the learner be directed to more advanced topics upon completion of the current topic. Herein lies the main motivation behind the development of the iLiT-Platform (I Learn, I Teach Platform) which is to create a platform where digital contents can be easily stringed into logically related components and in doing so, provide learners with the much needed "roadmaps". In particular, we will discuss the use of graph database for our platform and the development of a recommender system such that a learner, upon selecting a set of contents, would be provided with a series of learning paths based on his/her profile and other relevant criteria.

Keywords: *graph database, recommender system, learning paths generation, personalised learning, e-learning.*

Introduction and Motivation

With the advent of the internet, we have seen an explosion of knowledge and information made available online. Many e-learning platforms, corporate intranets and other online media [2] have attempted to present content in various digital modes (such as videos, slides, and pdf notes) and arrange them, often in a static format listed according to topics or relevance. Such attempts aim to facilitate self-directed learning amongst individuals.

However such proliferation of digital learning resources comes with its unique set of problems and issues. As highlighted in (Plotkin, 2010), one major problem is the inability of many potential users (learners and instructors alike) to easily and quickly determine which resources best fit their needs. Due to the vast amount of free learning materials generously released by various institutions of higher learning (such as MIT, Yale, Rice University, Tufts University, etc.) for free public use and repurposing, users faced difficulties navigating the vast space of digital contents while deciding which are the ones that are useful for their needs. In other words, many users are experiencing what is commonly known as "information overload".

While contents are readily available, learners will most likely need some external guidance before they can embark on their e-learning process. A learner who have no background in a topic which he/she desired to learn will have trouble sifting through vast amount of contents deposited in the existing e-learning platforms. Without any "roadmaps", an uninformed learner will not have a clue on where he or she should start and what are the important pre-requisites to acquire before embarking on the learning process. Neither will the learner be directed to more advanced topics upon

[1] OER or Open Educational Resources are teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits sharing, accessing, repurposing (including for commercial purposes) and collaborating with others. The OER movement started in 2001 with MIT's initiative to make all of the learning materials used by its faculty in its 1,800 courses available via the Internet where it could be used and repurposed as desired by others without charge. Since then, the movement has gained tremendous tractions, with over 250 institutions and universities worldwide participating in it in some manner.

[2] Some examples: Khan Academy (www.khanacademy.org); MIT Open Courseware (http://ocw.mit.edu/index.htm); Saylor.org (www.saylor.org).

completion of the current topic. Similarly, instructors may prefer to know how others are making use of these digitised contents for their teaching. The massive quantity of digital resources may be made available to an instructor who is teaching on a new topic. Yet, the same instructor may be clueless on the how these resources can be stringed together to form an interesting teaching curriculum.

As pointed out in (Dalziel, 2005), most of the e-learning technologies and platforms have done well in emulating the library (with many taking the form of online repositories), but are somewhat lacking in reproducing the training environment where guidance is readily available. The development of the iLiT-Platform (I Learn, I Teach Platform) aims, to some extent, address some of the problems or issues faced by users when they navigate the vast digital contents deposited in a learning platform. Our approach here is to create a platform where digital contents can be easily stringed into logically related components and where users, upon selecting the desired contents within the platform, will be presented with a series of relevant learning paths that suit their profiles[3] to guide them in their learning.

Proposed Approach

The iLiT-platform is designed based on a (directed) graph model. In a graph model, the contents or digital learning objects are represented by vertices or nodes; linkages between vertices are represented by the directed edges or arcs between them. Below we give a formal definition of a directed graph (see Bang-Jensen and Gutin, 2009).

Directed Graph: A directed graph $G = (V, A)$ consists of a non-empty finite set V of elements called vertices (or nodes) and a finite set A of ordered pairs of distinct vertices called arcs. We call V the vertex set and A the arc set of the directed graph G. (When A is a set of unordered pairs of distinct nodes, the graph G becomes an undirected graph and we usually call the set A the edge set of the graph and denote it by E, i.e., $G = (V, E)$.)

One of the main features of the iLiT-platform is the ability for instructors to define relationships between digital contents and to provide a visual representation of these connections (between contents). As such, modelling of digital contents and the relationship between them becomes important and this leads to the eventual adoption of graph database technology, Neo4j[4], for the iLiT-platform.

Graph Database: A graph database uses graph structures with nodes, arcs and properties for data storage. It provides an index-free adjacency, meaning that every element (vertex and arc) in the graph (database) has a direct link to its adjacent element. There is no need for indexes and index lookups; every node in the graph database knows what node or nodes it is linked with through connections called arcs. This feature has allows graph database systems to utilise tools in graph theory to very rapidly examine the connections and interconnectedness of nodes.

Figure 1 below provides a visual example on how a graph database system stores and represents relationships among a group of people.

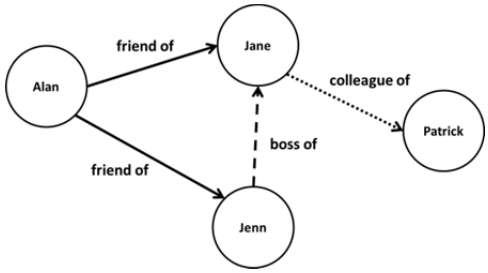

Figure 1: A graph model describing relationships between individuals.

A graph database is unlike the relational databases which are commonly used in many database systems. The relational database model has been around since the late 1960s (Codd, 1970) and has been today's most prevailing data management tool. A typical relational database consists of distinct tables which are defined by sets of rows and columns. A row can be seen as an object (or data) while the columns would be the properties or attributes of the object. One of the weaknesses of relational database system is its limited ability to capture, retrieve and manipulate complex relationships between datasets (Miller, 2013). As mentioned in (Robinson *et al*, 2013; pp11-14), relational database struggled with highly connected domain, especially when performing connected queries.

Graph database on the other hand embraces relationships. In a graph database system, connected data is stored as connected entities. In other words, connected data is stored in its natural form and not in an implicit form as in the case of relational database. A graph model is also flexible, allowing addition of nodes and relationships without compromising existing

[3] The profile of users (as learners) can be as simple as the grade point average of students in an educational institution, a position of an employee in a company, or the level of competence as determined by the how much an user have learned (through some form of testing). The idea here is that we want the platform to be more adaptive to the profile of the users – the platform would recommend different learning paths for a weaker learner as compared to a fast learner.

[4] We use Neo4j v.1.9.3 (http://www.neo4j.org/) for the iLiT-platform's database. Neo4j is the world's leading open-source graph database supported by Neo technology. Neo4j stores data in nodes (or vertices) connected by directed labelled relationships (or arcs) with properties on both. See also http://neo4j.com/docs/1.9.3/ for the Neo4j Manual v1.9.3.

connected data (Robinson *et al*, 2013; pp19). Further, when compared with connected data stored in a relational database, queries performed on connected data in a graph database are much efficient (or faster) (see (Robinson *et al*, 2013; pp17-18) and (Partner *et al*, 2014; Chapter 1)).

As mentioned earlier, the iLiT-platform is based on a graph model where we envisage digital contents as nodes while the connections between nodes (which give the logical sequence of how a digital content is linked to others) are represented by arcs or directed edges. The use of a graph model has many advantages. It provides a highly intuitive and visual representation of connections between various digital contents. In particular, graph model allows a clear portrayal of the sequence in which contents are ordered and linked (see Figure 2 below). As a result of this clear depiction of sequences, learning paths showing how contents "flow" among themselves and algorithms to generate them can be developed more intuitively.

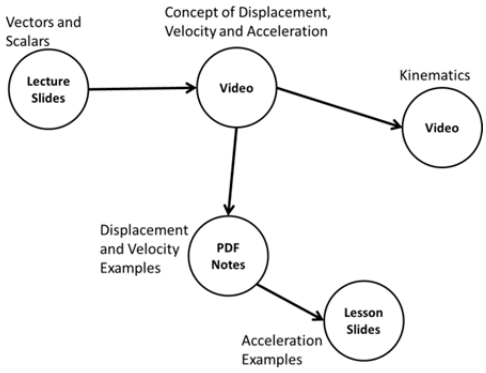

Figure 2: Example of a graph model of digital contents and their linkages.

Platform's Software Architecture and Database

This section describes iLiT-platform's software architecture, components and database setup. We will also describe features of the platform's path-generating/recommender system where users, upon selecting the desired digital contents, will be presented with learning paths that suit their profiles and needs.

(A) Software Architecture: This is based on a three-tiered web architecture which consists of the following three layers:

(i) *Presentation Layer*: This layer consists of the Graphical User Interface ("GUI") which provides a simple interface for user to interact with the backend system. The GUI is programmed using HTML5 and Javascript. Any user request via the GUI will be sent to the corresponding servlet using HTTP request. The results will then be received via HTTP response from the servlet and be displayed graphically to the user.

(ii) *Business Layer*: The business layer processes the business logics of all incoming HTTP requests from the GUI. It contains two modules, namely the Servlets and the Recommender module. All requests received from the presentation layer are received by the corresponding Servlets. The incoming request can be broadly classified into 2 different categories, namely the CRUD (create, read, update, delete) request or the recommendation request.

For a CRUD request, the servlet will interact with the database for the CRUD operations via Cypher commands[5]. The results retrieved from the database will be packed in JSON format and then returned to the GUI.

On the other hand, if the incoming request is a recommendation request, the Servlet will redirect it to the Recommender module (which essentially generates learning paths for users based on certain input parameters; see also the section in this paper on Learning Paths Generation and Recommender System). The Recommender module contains the business logic to query the database via Cypher commands. The results are returned from the database will be packed in JSON format and subsequently sent to the servlet. The servlet will then send the results back to the GUI.

(iii) *Database Layer*: The database layer contains the data persistence mechanism, which is the graph database built using Neo4j. Cypher commands received from the business layer will either modify the data in the database, or perform queries on the database. Modifications can be performed to the data (stored as nodes) of instructors, students, contents and also the interconnected paths among the different nodes. Results (of the modifications or queries) are then returned to the requesting servlet or Recommender module.

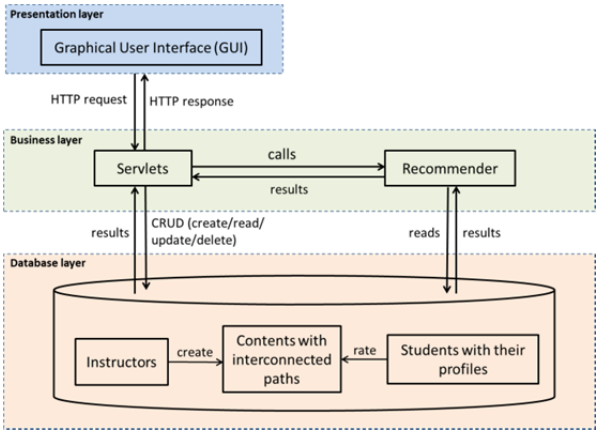

Figure 3: Software architecture of iLiT-platform.

(B) Contents Database Structure: Digital contents (videos, slides, lecture notes, etc.) are stored in the form of Content Nodes ("CN") in the iLiT-platform. These

[5] Cypher is a graph query language used in Neo4j database.

CNs are in turn subsumed under the Content Managers ("CM"). Each CM can contain a few of these CNs which are joined by the relation links (or arcs) that depict how these contents are linked to one another.

All these CMs and CNs are eventually connected to the Root Node of our (graph) database. The Root Node can be seen as the ultimate starting point from which all CMs and contents within our content database are linked to. Further, every first CM ("First CM") connected to the Root Node provides descriptions on the subsequent CMs and the contents (or CNs) which they contain. The First CMs are in fact empty nodes and does not contain any CN – they can simply be seen as a Subject or Topic node.

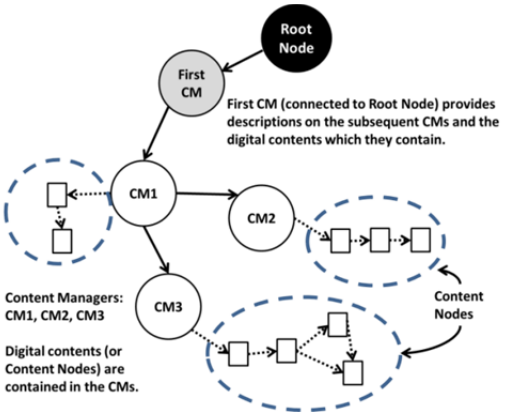

Figure 4a: Content database structure of iLiT-Platform.

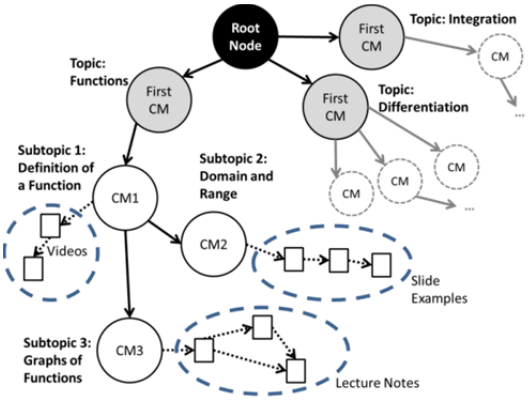

Figure 4b: Example of contents and relationships stored in iLiT-platform's database – contents are stored as nodes while the arcs determine the "flow" of content sequences.

(C) Learning Paths Generation and Recommender System: Any user, upon selecting the desired learning contents, will be presented with a collection of learning paths. Ideally, we want the generated learning paths to fit the user's profile – learning ability as measured by his/her academic grades, learning styles, level of studies, etc. Further, we want the learning paths generated for a user to also include contents that are well-regarded (through some form of ratings) by other users with similar profiles.

Here, we describe two learning paths generating procedures which have been developed (so far) for our platform. Our paths generating approach hinges on the fact that we adopted a graph model for the platform's content database, enabling the searching of all nodes and paths between selected nodes more efficient through graph traversals[6].

(i) *All Paths*: This generates[7] all possible learning paths that include the contents selected by the user. When a user selects a set of contents, he/she may not know what are the perquisites or prior knowledge needed to fully understand and benefit from the contents/resources selected. By generating all learning paths containing these selected contents, a user can now be provided with a clear "roadmap" and see all the required components needed for successful learning of the contents chosen (see Figure 5 for a simple example).

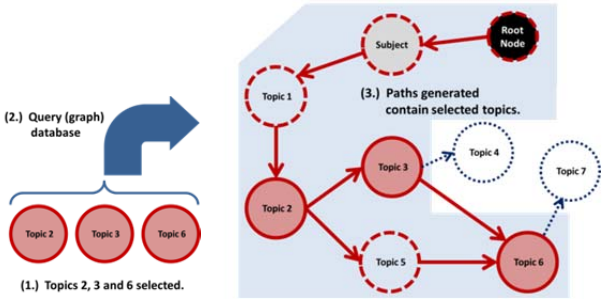

Figure 5: Generation of all possible paths containing contents selected.

(ii) *Collaborative Filtering*: Collaborative filtering ("CF") recommendation techniques have been widely used in the retail space (such as Amazon, Netflix[8], etc.). The main idea behind CF-recommendation hinges on the notion that people with similar ratings on items are supposed to have similar shopping interests (see (Balabanovic *et al*, 1997; Herlocker *et al*, 1999)). It makes predictions about a user's preferences or tastes based on the preferences of a group of users that are considered similar to this user.

CF-recommendation techniques have also been proposed for usage in educational context, especially in e-learning (for instance, see (Zaiane, 2002)). Some examples of CF research applied to an educational setting lies in areas such as: using CF as a diagnostic

[6] A graph traversal is a "walk" along the elements of a graph: from a node, to arc (or edge), to a node, etc. As this walk progresses, aspects of the graph can be saved or manipulated.

[7] We essentially use the MATCH clause (a Cypher command for querying Neo4j's graph database) which calls upon Neo4j's traversal framework to find all the nodes and relationships (or arcs) in the database that match the user's inputs.

[8] See also article on the Netflix prize (http://en.wikipedia.org/wiki/Netflix_Prize).

tool for grading (of students' work) (Loll and Pinkwart, 2009); as a tool in ranking questions set based on difficulties (Segal *et al*, 2014); as a recommender system that puts more weights (in the recommendation calculations) for users with greater depth of knowledge (Bobadilla *et al*, 2009).

Here, we proposed a CF procedure (see below) for the generation of learning paths which takes into account: (i) the contents selected by the user ("first user"), (ii) ratings (on a scale of 1 ("dislike") to 5 ("highly recommended")) of selected contents by other users, (iii) profiles of other users who rated the selected contents and (iv) other contents positively rated by others with similar profiles as the first user.

CF-Recommendation Procedure

Input: The set S_A of contents selected by user u_A.

Output: The set of learning paths containing the content set S_A.

Procedure:

(1) For each $s \in S_A$, find all users whose ratings on the content s is above a fixed rating threshold t.

(2) Add these users found in (1) to the set U_1.

(3) For each user $u \in U_1$, compare u with u_A. If u is "similar" [9] to u_A, add u to the set U_2.

(4) For each user $u \in U_2$, find all contents which are rated (by u) above the fixed rating threshold t. Add these contents to the set S_F if they are not already in S_F. (Note that the set S_F may contain some elements of S_A.)

(5) Generate learning paths containing elements of the content set $S_F \cup S_A$ (using the All Paths procedure mentioned earlier).

The motivation behind the above CF-recommendation is that a learner who selected the desired contents from the platform may be interested to find other useful and interesting contents not already selected by him/her. Instead of searching through the vast quantity of contents deposited in the platform for more useful resources (which can be extremely time-consuming), this user can call upon the above CF-procedure to get learning paths recommendations with the help of the other "similar crowd-users".

[9] We measure "similarity" between two users using a predefined metric system which takes into the account the users' learning styles and the level of academic competencies.

In our "crowd-sourcing" approach, we essentially first find other users of similar profiles who rated highly the contents selected by our first user. Then, we find other contents in the platform which are also highly rated by this group of "other users" and recommend them to the first user. In other words, our first user will be recommended with contents that are well-liked by other users of similar profiles.

Conclusion and Further Work

In (Svensson, 2004), it was mentioned that e-learning courseware should not be limited to just content and should include other components to enhance learning. It was also pointed out in (Schott *et al*, 2003) that a lack of physical interactions (guidance) make e-learning students feel isolated and apprehensive. We could not have agreed more. With the surge of e-learning materials there is a danger that learners are unable to select appropriate learning materials – that is, of relevant content and of suitable level. Hence there is a genuine risk of information overload (Berghel, 1997; Borchers *et al*, 1998). The idea behind the iLiT-platform is to bridge the gap and change a somewhat "content heavy" existing e-learning technologies to a better system where not only is quality content available, but guidance is also provided (through the platform's recommender system) to lead users to achieve their learning objectives.

Through our proposed platform and its recommender system, we aim to provide a more dynamic environment that enables learning sequences or paths to be recommended based on inputs by learners (when they select the contents) as well as their profiles. We hope to provide a more personalised learning platform where learners of diverse background can readily and easily navigate through the learning materials and enjoy a better e-learning experience.

For instructors, we want the iLiT-platform to be a repository of not just contents, but also of teaching strategies and sequences. Instead of "re-inventing the wheels" each time a trainer embarks on a new teaching assignment, he/she can use the platform to call out learning sequences that have been deposited and either use them directly or customised them for individual preferences. We also envisioned the iLiT-platform to be a "station of collective wisdoms" of various instructors where contents of various distinct disciplines can be deposited and cross-disciplinary connections established.

Finally, further work will continue in developing the platform into a more dynamic system. In particular, we will be progressively testing and fine-tuning our (already developed) recommendation procedures with students from the polytechnic. The research will also continue to explore and implement other

recommendation techniques as well as to look at suitable clustering methods for the contents stored in the platform's content database.

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