Enhancing Design-Build Experiences in First Year Infocomm Curriculum

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ABSTRACT

The Multimedia & Infocomm Technology (MIT) diploma is a three year program offered by the School of Engineering in Nanyang Polytechnic. It has an annual cohort size of about 200 students. In the first year curriculum of the diploma, an introductory course called "Infocomm Systems" is introduced to highlight key technological pillars of the Infocomm industry, i.e. software development, networking and digital media, which support development and delivery of Infocomm systems and services. This course is modelled after the "Introduction to Engineering" course as described in CDIO Standard 4 [1]. It also draws experiences and learning lessons from similar implementation by other educational institutes [2] [3] [4] [5].

The "Infocomm Systems" course aims to build up interest and excitement in Infocomm technologies by providing active learning opportunities for students through problem solving and design-build-test projects. Students' communication skills are also inherently built-up via an integrated project in the course [1]. The integrated project also requires students to relate, draw and apply knowledge and skills learnt in other courses conducted in the same semester.

In this paper, we will explain the background to this endeavour, the curriculum revision supporting it, the criteria, objectives and implementation of the integrated project. Finally, feedback from students and lecturers as well as our learning experiences will also be shared.

KEYWORDS

Introduction to Engineering, First Year, Infocomm, Project, integrated curriculum

BACKGROUND

The School of Engineering (SEG) at Nanyang Polytechnic (Singapore) started its CDIO initiative in 2010. The initiative was kicked off by evaluating 4 of our programs against the 12 CDIO standards. The Multimedia & Infocomm Technology (MIT) diploma was one of the chosen programs. This diploma has a broad-based, multi-disciplinary curriculum, providing up-to-date training for students to be versatile Infocomm and media professionals.

In 2009, just prior to the CDIO initiative in SEG, the program development team for the MIT diploma was made aware of the impending possibility of the adoption of CDIO. At about the same time, we were undergoing a major curriculum review and restructuring for the program. The team made an early assessment of CDIO and found its principle of using product and system lifecycle development and deployment as the context for teaching to be closely matching to our current practices [6]. In particular, the team was attracted by CDIO Standard 4 Introduction to Engineering and decided to recommend it for adoption and implementation

As part of the curriculum review and revision, a first-year course "Infocomm Systems" modelled after the "Introduction to Engineering" course was developed. This course introduces key pillars of the Infocomm industry supporting the development and delivery of Infocomm systems and services. The key pillars are in the area of software development, digital media and networking.

INTRODUCTION

In 2010 and early 2011, the 'Infocomm Systems' course educated students in the core disciplines of the Infocomm domain. It was however taught in an independent manner from the rest of the courses in the same study semester.

This paper presents our approach and experiences in re-designing the delivery of the 'Infocomm Systems" course as well as the re-alignment of four other courses within the same study semester in late 2011. The objective of this re-design was to enable students to relate and draw knowledge and skills learnt in other courses and vice-versa. The re-designed courses provide an enhanced framework for Infocomm practice in application design and development as well as the practice of personal and interpersonal skills.

Another objective is to motivate and excite students in the practice of Infocomm technologies through an integrated project leading to an exhibition and competition. The integrated project also provides an excellent platform for lecturers in associated courses to work together in a coordinated manner to design project assignments as well as to specify assessment components and coverage. It was conceived and designed in such a way to require students to apply thinking and problem solving skills and submit deliverables in the areas of software development, web development and graphic design.

REVIEW AND IMPLEMENTATION

With the "Infocomm Systems" course in place since mid-2010, a critical review of its implementation was conducted a year later. It was found that the syllabus of the course was covered wholly and appropriately. However, the envisaged design-build project that was meant to get the students excited about the Infocomm and media technologies did not materialise. In its place was a series of independent practical exercises, while relevant to the course content, were

however not achieving the original intent. As a result, the program development team set out to rectify this deficiency through analysing the course ownership, inter-related courses, personnel deployment and workspaces. At the same time, some of these aspects which are also described in a paper by Queen's University Belfast [4], were actively being addressed.

Curriculum Review

Initially, the program development team set out to identify plausible projects which meet the twin requirements of encompassing disciplinary knowledge and injection of elements of creativity and fun so as to fire-up students' enthusiasm. However, it soon became clear that in order to achieve the intent, a review of courses in the same study semester is required. A core team, comprising coordinators responsible for the various courses in the semester and key members of the program development team, was then formed. [Note: *In our context, course coordinators are responsible for the conduct, delivery, review and revision of the course.*] In retrospect, this was a key success factor as the individuals brainstorming over the possibilities are essentially the implementers as well, resulting in a sense of ownership of the initiative from the onset. The team works to understand in detail the projects that students are undertaking and the assessment plans across the various courses. In a semester lasting for 15 instructional weeks, students study 6 core courses as illustrated in Table 1.

Table 1 Course in Semester

No.	Description	Hrs
1	Programming Methodologies & Practices	60
2	Internet Application Development	60
3	Graphic Design	60
4	Data Communications & Networking	60
5	Infocomm Systems	60
6	Thinking & Problem Solving Skills	30

The need for an integrated project and its aim of having active learning elements were shared with the course coordinators. Principally, the project should allow the student to practice and apply his/her disciplinary knowledge and skills; engage in problem solving and solution design. Finally, to stimulate interest and enthusiasm, it should have competitive elements as well as provide opportunities for showcasing one's creation. With the above considerations in mind, the core team started off by having each of the course coordinators outlining their course coverage. This is summarized in Table 2.

Table 2 – Course Name & Coverage

No.	Course Name	Coverage
1	Programming Methodologies & Practices	Introduction to Programming
2	Internet Application Development	Web Design & Development
3	Graphic Design	Graphical Elements Design
4	Data Communications & Networking	Networking Basics
5	Thinking & Problem Solving Skills	Thinking Techniques
6	Infocomm Systems	Introduction to Infocomm Field

From the sharing and discussion, ideas were thrown up for evaluation. One idea that caught our imagination was that of the usage of an open-source software development kit called 'Robocode' that is used by educational institutes for teaching programming in a fun manner [7].

'Robocode' is a game-like software tool and environment that was originally created by Mathew A. Nelson, a software engineer in IBM in 2002 and subsequently taken up by Flemming N. Larsen who took over the 'Robocode' project hosted at SourceForge. Essentially, a developer uses the Java programming language to create a software robot tank, put it onto a battlefield together with other developers' robot tanks to battle to the end [8]. The tanks can move, scan for the presence of other tanks and shoot at each other. The last surviving tank wins the game.

The core team eventually chose 'Robocode' as the platform for the envisaged integrated project. In-depth exploration and investigation into this idea resulted in the crafting out of appropriate contributions from the various courses. Table 3 illustrates each course's contribution to the student's acquisition of knowledge and skills essential to the integrated project.

Table 3 – Course Name & Contribution

No.	Course Name	Contribution
1	Programming Methodologies & Practices	Algorithmic Design & Programming
2	Internet Application Development	Web Portal Design & Development
3	Graphic Design	Poster Design
4	Data Communications & Networking	Web Portal Hosting & Security
5	Thinking & Problem Solving Skills	Mind-mapping & Strategies
6	Infocomm Systems	Introductory programming with Java Platform for Integrated Project

THE INTEGRATED PROJECT

The platform for the conduct of the integrated project is through the "Infocomm Systems" course. This course is conducted over 15 instructional weeks with students attending 1 hour of lecture and 3 hours of practical each week. Lecture is conducted for the entire cohort of about 110 students while practical classes have about 22 students each.

The lectures introduce key areas of Infocomm industry in software development, digital media, web design and computer networking. For the practical sessions, project teams of 3-4 students learn to develop their own software robot, continuously enhancing them as the semester unfolds.

Importantly, the same project teams exist within the context of other courses such as "Internet Application Development", "Graphics Design" and "Thinking & Problem Solving Skills". This ensures that the project work done in those courses may be re-usable as part of the integrated project helmed by the "Infocomm Systems" course. However, the assessment criteria for the work done in the various courses are different. In gist, the focus of the assessments is broadly divided into technical, content and presentation aspects, to be appropriately applied across the courses. This will be elaborated further. Table 4 shows the deliverables from the courses.

Table 4 – Course & Deliverable

No.	Course	Deliverable
1	Programming Methodologies & Practices	-
2	Internet Application Development	Web Portal for Robot
3	Graphic Design	A3-size Poster for Robot
4	Data Communications & Networking	-
5	Thinking & Problem Solving Skills	Robot's strategies using mind-map
6	Infocomm Systems	Software Robot

To engage and sustain students' interest in the continuous enhancement of their deliverables, an exhibition and competition named "Fight-Out" was conceived. Leading to this event, teams from the same class compete with one another. Software robot tanks are loaded in the same battlefield and compete with one another till a winner emerges. Figure 1 shows the results of a battle involving 5 robot tanks.

Rank	Robot Name	Total Score	Survival	Surv Bonus	Bullet Dmg	Bullet Bonus	Ram Dmg * 2	Ram Bonus	1sts	2nds	3rds
1st	Group1.M5_vWarZone*	39115 (25%)	16750	1960	18383	1700	275	47	49	21	23
2nd	Group1.M3_FirstBlood*	35386 (23%)	17200	1240	15674	1103	160	10	31	45	28
3rd	Group1.M4_Beech*	33073 (22%)	16200	1600	14101	979	181	12	41	25	30
4th	Group1.M1_triderBot*	28099 (18%)	12900	1000	13164	828	204	3	26	20	30
5th	Group1.M2_WIB4*	17967 (12%)	11800	160	5120	99	774	14	4	39	38

Figure 1 – Robot Ranking and Results

On "Fight-Out" day, the top 2 teams from each class go on to compete with other top teams in a 'live' shoot-out. All teams are also required to exhibit their poster for assessment at the exhibition.

Learning Objectives & Assessments

The 3 main learning objectives for the course are exciting first-year students in the Infocomm field, appreciating inter-relationship of various courses that are being undertaken and providing enhanced opportunities for acquiring presentation and team skills. These objectives are also mentioned in various other implementations of introductory courses as well as design-build projects. [2][3][4][5]

The assessment components for the "Infocomm Systems" course comprises mainly of the integrated project, tests and submissions. The integrated project is designed to be a culmination of the student's learning journey. The tests and various submissions are designed to enable the students to gain confidence of the requisite software development skills, 'Robocode' APIs and critical thinking techniques.

The integrated project is worth 40% of the total assessment marks within the "Infocomm Systems" course. Out of this, 10% each was allocated for the presentation of the project poster and the web portal. Although these 2 deliverables do not constitute major portion of the assessment marks in the course, the students still devote significant amount of time to work on them. This is probably due to nature of the assessment, that of an open exhibition. The design and performance of the robot tank takes up the remaining 20%.

For assessment of the student's presentation during the exhibition, the criteria for grading include organisation and appropriateness of the information in the poster, the students' grasp of the subject knowledge i.e. design of the robot tank and the students' ability to articulate and answer questions that were posed to them by the assessors.

For the remaining 60% of the assessment marks of the course, the students are required to take 2 quizzes relating to understanding of the Infocomm field, submission of a mind-map exercise for exploration of features of their software robot, submission of 2 practical 'Robocode'-related software development exercises and an in-class practical test to assess their ability to program a specified software robot.

EXHIBITION AND COMPETITION

The "Fight-Out" competition and exhibition is scheduled in the last week of the semester as this was found to be the most appropriate and suitable period. Figure 2 shows a competition banner that was put up to advertise the event and also serves to provide a sense of formality and excitement in the competition venue. Assessment activities for the 1st and 2nd run of the event are shown respectively in Figures 3 and 4 below.

Figure 2   Competition Banner

Figure 3   1st Run (Feb 2012)

Figure 4   2nd Run (Aug 2012)

To enhance the motivational factor for the competition, prizes were awarded for the "Best Robot Tank", "Best Poster" and "Best Web Portal". This resulted in a healthy degree of rivalry between teams during the intra-class and inter-class competitions. In the cohort-wide competition, there was plenty of cheering for teams representing each class.

FEEDBACK AND LEARNING EXPERIENCES

After each run of the "Fight-Out" exhibition and competition, surveys were conducted to gather feedback from students on the event as well as the "Infocomm Systems" course. Lecturers who are involved as assessors during the exhibition are also requested to give their feedback.

Student Survey

Students were asked a series of questions that seeks to validate the objectives and conduct of the introductory course, design-build experiences as well as the integrated curriculum. The results on the quantitative aspect of the surveys are as shown in Table 5.

Table 5 - Survey results for 2012 Semester 1 and 2011 Semester 2

SD = Strongly Disagree D = Disagree A = Agree SA = Strongly Agree	2011 Semester 2				2012 Semester 1			
	SD	D	A	SA	SD	D	A	SA
Learning objectives of this course are clear	2%	6%	80%	12%	2%	6%	50%	42%
Course is well organized	0%	8%	76%	16%	0%	8%	46%	46%
Pace is just right	2%	14%	72%	12%	0%	14%	52%	34%
Course stimulates my interest to learn more about Infocomm technologies	2%	20%	62%	16%	4%	12%	42%	42%
Course are relevant to other courses that I am studying in the semester	0%	12%	54%	34%	0%	8%	42%	50%
Feedback by lecturers are helpful & timely	0%	6%	74%	20%	2%	8%	44%	46%
Grading criteria are clear and fair	0%	8%	70%	22%	0%	10%	46%	44%
Overall, the courses are worthwhile	0%	8%	66%	26%	0%	6%	40%	54%

From the surveys, majority of students think that the learning objectives are clear and found the course to be well organized and conducted with the right pace. This indicated that they understand and know the deliverables that are expected of them. Most students also found the course to be stimulating their interest to learn more about Infocomm technologies. As the courses are closely related, majority of students were able to apply knowledge learnt from the different courses. When it comes to assessment, grading criteria were deemed as clear and fair as an open assessment rubric was used. 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 course, their answers include:

- "Everyone figuring out the algorithm and group discussion"
- "Class bonding with teacher"
- "Killing brain cells, battle, competition thrill and teamwork"
- "Creating a robot increases my programming knowledge"
- "Integrated project – a fresh change to our courses"

Although surveys for the course prior to its re-designed curriculum were conducted, the survey questions are focused mostly on the quality of delivery and course materials, teaching environment and equipment. Such surveys, which are conducted for all delivered courses, are unfortunately not useful for obtaining feedbacks about the curriculum change.

Staff Survey

Lecturers were also asked for their feedback on the exhibition and competition and the following were some of their responses:

- "looks like they [students] are having fun in learning"
- "adds variety to the conventional lecture-tutorial-lab stuff"
- "helps to bond relationship with their friends and also motivates them perform better"
- "[students] seems to understand how different courses are interlinked"
- "students are able to apply what they have learn"

Student Learning Experiences

Students form teams throughout most of the courses and have the opportunities to work together and learning to be good team players. For example, in the "Graphic Design" course, teams of students brainstorm for the name and description of their robot tanks, debate and decide on the elements of design to be used and coming up with a tagline to brand their robot.

In the area of software programming, students were observed to be more focused in formulating algorithms and highly captivated when their robot tank performed as programmed. They also reflected more deeply on solutions to overcome flaws in their robot tank after a losing battle.

Faculty Learning Experiences

From our experiences of going through the conceiving, designing and implementation of the "Infocomm Systems" course and its integrated project, there have been a number of learning lessons. To kick-start such an initiative, it is crucial to formulate an initial proposal that looks interesting and feasible and to seek support from management and faculty.

Secondly, it is necessary to identify and form a core team who are knowledgeable over the program curriculum as well as being representative and influential over the cross-section of the faculty that may be involved in such an endeavor.

Thirdly, faculty's guidance of students during the delivery process can make or break the students' interest and enthusiasm for the integrated project. Hence, it is essential for the program development team to be able to make or recommend assignment of faculty to the pioneering classes.

Fourthly, for this project to be sustainable, the core team needs to continue to obtain 'buy-in' from the program manager and department heads that are in positions of influence over the program and course curriculum and the allocation of resources. For the faculty, it is observed and also as seen from their feedbacks, that the integrated project experience is positive and well-accepted.

Going forward, the core team will be reviewing specifically the thinking skills exercises and how they could better relate to the integrated project from the perspective of the students, the coverage of networking elements and the nature of the integrated project for added variety.

CONCLUSION

The revised "Infocomm Systems" was first conducted in late 2011 with 110 Multimedia & Infocomm Technology students taking the course. Students were observed to have a perceivable and sustainable interest in the software design and development of the robot tank. Evidence of continuous efforts to improve the conceptual design and branding of their tanks are present in their versions of poster and web portal. Lecturers were also observed to be pleasantly surprised with the amount of enthusiasm and efforts seen in their charges. Feedback from both students and lecturers indicated that the objective of incorporating "fun", "creative" and "competitive" elements to excite and engage students were achieved.

In summary, we believe that the 3 main learning objectives of the course are achieved through the implementation of the integrated project and exhibition, underpinned by assessment components that are well-aligned. This is evident from the feedbacks of not just students but also fellow lecturers. The CDIO approach of having practical introductory exposure to Infocomm activities coupled with built-in exercising of communication skills and teamwork was shown to be not only achievable but also innovative and refreshing.

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BIOGRAPHICAL INFORMATION

Edmund Teo joined Nanyang Polytechnic in 2000 and is a Senior Lecturer in the School of Engineering. He graduated with a Bachelor of Applied Science (Computer Technology with Merit) degree from Nanyang Technological University and has a Master of Technology (Software Engineering) from the National University of Singapore. He is currently the program manager.

Cynthia Tan joined Nanyang Polytechnic since 2007 and is with the Internet Solutions Group in School of Engineering. She graduated from Royal Melbourne Institute of Technology (RMIT) with Bachelor of Applied Science (Information Technology) and passed with Distinction. She is part of the core team who implemented the initiative in the "Graphic Design" course.

Seah Ban Wah is a Senior Lecturer in the School of Engineering. His main research interest is in the area of smart services enabled by Internet of things. He is part of the core team which developed and pilot run the integrated project for the "Infocomm Systems" course.

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