ACTIVE LEARNING IN QUALITY CONTROL AND STANDARDIZATION IN PRINTING AND PACKAGING

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ABSTRACT

A Quality Control and Standardization in Printing and Packaging course in Digital Printing and Packaging Technology program, Faculty of Mass Communication Technology at Rajamangala University of Technology Thanyaburi (RMUTT) has adopted a CDIO framework in developing better teaching and learning strategy. Students who take this course will develop knowledge in basic concepts of Quality Control (QC), recognize quality tools and understand a process of QC planning. In the past, only traditional lectures, midterm and final examinations were used as tools for teaching activities and assessment methods. The student struggled in class and could not nurture deep learning. Thus, the instructor seeks for methods to overcome this challenge. This paper, hence, aims to share the redesign of active learning activities to encourage students for learning (standard 8). Formative and summative assessments (standard 11) were adapted to the class. In addition, to provide the student with design-build experience, project-based learning was initiated. Feedback from students in redesigned classrooms was expressed regarding the student engagement and the pedagogical improvement process

KEYWORDS

Active learning, quality control, printing and packaging, CDIO standards: 2, 5, 8, 11.

INTRODUCTION

The printing industry is an important manufacturing industry in many countries. Printing processes convert original text and pictures into an image on a carrier. The main types of process are named according to how this image is carried. Types of printing industries regarding their main techniques can be classified as follows: Relief, Lithography, Engrave, Stencil, and Digital Print. The Relief Printing uses a printing surface that is in relief. Letterpress and flexography are examples of this process. In the Lithography Printing, the image and non-image areas are in the same plane on a plate, which can be of metal, plastic or paper. This

type of printing is known as offset. Engraving technique is applied for gravure printing. In this technique, the printing areas are tiny recesses inscribed on a cylinder below the non-printing areas. These recesses are filled with ink, the surplus ink is removed and the substrate is pressed against the printing cylinder. Screen printing is an example of the Stencil Printing, in which the printing and non-printing areas are carried on a screen. The non-printing areas are formed by blocking out parts of the screen, while the ink is forced through the non-blocked parts onto the substrate. The Digital Printing produces an image directly onto a substrate using digital information without the creation of an intermediate permanent image. In recent year, disruptive technology has an influence on the printing industry. New technology offers lower cost but having higher ancillary performance. Digitization is one of the disruptive technologies by which the printing industry is affected (Kilkki et al., 2018). Smyth (2017) forecasts a size of the publishing market will decrease from 20% to 17% and commercial printing markets from 16% to 15%, respectively. This disruptive technology also impacts the working skills. In 2014, the European Union carried out the survey in the topic of future skills in the graphical industry. The result showed that cross-media, digital management, engineering, teamwork, and entrepreneurial skills were required as important skills. It is noticed that teamwork and entrepreneurial skills associate with CDIO syllabus (CDIO, 2019; Crawley *et al.,* 2011).

The CDIO framework was first introduced in mechanical and aerospace engineering and then has been widely implemented in the field of engineering education (Crawley *et al.,* 2007). Not only CDIO framework was adopted in the field of engineering, but also in the field of non-engineering (Doan et al., 2014; Malmqvist, 2015; Malmqvist *et al.,* 2016; Hladik *et al.,* 2017; Tangkijviwat *et al.,* 2018). The Digital Printing and Packaging Technology (DPPT) program has adopted the CDIO principle as a context since 2015. The program objective is to produce hands-on professional graduates who meet the industrial and social requirements. CDIO Syllabus was tailored to match the printing industry's knowledge and skillsets. CDIO Standards were fully implemented for continuous improvement of the quality of teaching and learning. In order to enhance student engagement and deeper learning, the active learning concept was initiated. The active learning enables students to learn and retain information better than through traditional lectures (Rotellar and Cain, 2016). This paper, therefore, is dedicated to the redesign of teaching and active learning activities, the change of learning environment, and the improvement of assessment to promote student learning and engagement for the Quality Control and Standardization in Printing and Packaging course.

THE APPLICATION OF CDIO STANDARDS

Students who take this course will develop knowledge in basic concepts of QC and quality tools for the printing process, recognize the QC planning as a process for enhancing the productivity in printing and packaging industry. After taking this course, the student should be able to:

1) have the basic knowledge of QC
2) select the suitable QC tools for the printing production control
3) design and evaluate a QC plan for printing and packaging industry
4) have experience in a collaborative working environment

Standard 2 - CDIO knowledge and skills set survey

CDIO syllabus v.2.0 (CDIO, 2019) was adopted as a guideline into the DPPT curriculum. The stakeholder survey was conducted to acquire CDIO knowledge and skills proper to the printing and packaging industry. In 2018, the stakeholder survey of CDIO knowledge and skills set was

collected from the printing and packaging companies and fourth-year students who have experience in cooperative education (Tangkijviwat *et al*., 2018). The result in the top three of desired learning outcome was expressed as first, second, and third ranking, respectively as shown in Table 1. In the section of technical knowledge and reasoning, both of industry and student aspects agreed that core fundamental knowledge is the most important skill. In the section of personal and professional skills and attributes, we founded a different requirement between industrial and student aspects. The industry focused on system thinking, professional skills and attitudes, and personal skills and attitudes, while the students indicated system thinking, reasoning and problem solving, and professional skills and attitudes, respectively. There was clearly a result in the interpersonal skills section. The consensus was as followings: teamwork, communication, and communication in foreign languages. The skill of conceiving and systems was required in general in the section of enterprise and societal contexts. In addition, enterprise and business context skill was found in the industry side, while leadership skill was expressed in the student side. In sequentially, the obtained CDIO skills are integrated into the curriculum to ensure that the qualification of graduates will meet industry expectation. In this study, teamwork and communication skills, hence, were adopted in the subject as intended learning outcome. A variety of learning activity such as collaborative working, think and share, project-based-learning, and gallery walk was arranged for giving the student experience in teamwork and communication skills.

Table 1. Desired CDIO knowledge and skills set from stakeholders.

	Industrial aspect	4th year student aspect
	1.Technical knowledge and reasoning	
1st Rank	1.2 Core fundamental knowledge	
2nd Rank	1.3 Advanced fundamental knowledge	
3rd Rank	1.1 Knowledge of underlying science	
	2. Personal and professional skills & attributes	
1st Rank	2.3 System thinking	2.3 System thinking
2nd Rank	2.5 Professional skills and attitudes	2.1 Reasoning and problem solving
3rd Rank	2.4 Personal skills and attitudes	2.5 Professional skills and attitudes
	3. Interpersonal skills: Teamwork & communication	
1st Rank	3.1 Teamwork	
2nd Rank	3.2 Communications	
3rd Rank	3.3 Communications in foreign languages	
	4. Enterprise and societal contexts	
1st Rank	4.3 Conceiving and systems	
2nd Rank	4.5 Implementing	4.7 Leading endeavors
3rd Rank	4.2 Enterprise and business context	4.5 Implementing

Standard 5 – Design and build experiences

The design and build experiences were used to promote the development of new skills and reinforcement of fundamentals in the CDIO approach (Crawley *et al., 2014).* Project-based-learning (PBL) delivered in the Quality Control and Standardization in Printing and Packaging course. The students were divided into five/six person groups for solving the project as group work. This project offers opportunities to demonstrate and develop learning and professional skills, such as system thinking, teamwork, communications, and leadership skills. The aim of this project is to design quality planning and build quality control tools for the printing and packaging company. Each group was asked to design the quality planning for enhancing print

production productivity. The C-D-I-O steps were tailored to P-C-D-I-C as a stage of the project that was followings:

Preparing stage: The objective of the assignment was given to the student. The instructor provided guidelines formatively throughout the learning process. They were aware of how to achieve the project goal.

Conceiving stage: The student performed literature reviews, proposed a company where they would like to collaborate and prepared an interview question. Then, they collected information and requirement from the company. The conceiving information was received from both literature reviews and company's interview. A brainstorming and post-up techniques, then, were used for analyzing the information.

Designing stage: The combination of fundamental knowledge and conceiving information were used for designing the quality control system. Each group was asked to design the printing process diagram, the workflows of the printing process, the key process requirements, the quality control points, and the key performance indexes for the printing and packaging industry.

Improving stage: The student presented their projects in a gallery walk environment. Peer feedback using Bono's six thinking hats technique was conducted. Each student group received valuable comments and suggestions from their peers and from the collaborating company.

Conclusion state: The final stage required oral presentations of the finished projects from all student groups. The communication and presentation skills were assessed using rubric scores.

In the end of the project, we found that PBL provided the learning environment to integrate system thinking, teamwork, communication, and leadership skills. The PBL concept has encouraged students to participate actively in class and constructed their knowledge. Our result corresponds to the previous study by Weerakoon and Dunbar (2018) in applying a PBL technique as a framework for a second language, communication and engineering learning outcomes. They found that PBL is a tool for enhancing the communication and language skills for engineering graduates.

Figure 1. Collaborative working in the Quality Control and Standardization in Printing and Packaging course.

Standard 8 – Active learning

To improve teaching and learning, an active learning concept was adopted in this course. In the past, this subject consisted of traditional lectures given by the instructor with problem-solving exercises in class. There were very few interactions between the instructor and the student. The communication among the student was also very limited. It was noticed that the student neither participated nor contribute their knowledge in class. In addition, they misunderstand the significance of quality planning for controlling the process and cannot apply their knowledge into the real-life working situation.

Active learning is an important approach to develop students' learning skills. Bonwell and Eison (1991) stated that during the use of active learning, student move from being passive recipients of knowledge to being participants in activities that encompass analysis, synthesis and evaluation. In order to fulfill the main objectives of this subject in terms of knowledge, understanding, and the application of theory and concepts, the active learning approach was implemented through various activities. The instructor had redesigned the active learning activities that aligned with the learning objective for particular topics. There are Jigsaw classroom, Collaborative team learning, Think-pair-share, Group discussions, Brainstorming for problem-solving and Gallery walk presentation. Figure 1 shows a collaborative working classroom.

The reflection after class revealed that active learning can encourage and engage students for their own leanings. Our result showed a positive perspective as the same as that found in the previous study by Sivan et al. (2000).

Standard 11 – Learning assessment

In the past, only a summative assessment is major for giving grades. For this course, the A-F grade system is used. Out of 100%, 90% was allocated to the final examination and laboratory reports, with 10% of class attendance. We noticed that the students did not have the motivation to study this course. For this reason, an increasing of formative assessments was required.

The formative assessment is used to monitor students learning style and ability and to provide ongoing feedback for improving student learning. In the recent class, the instructor had added a number of formative assessments: one-minute paper, self-reflection, classroom contribution and peer feedback. Peer assessment was introduced to the student to reflect their own collaborative teamwork both inside and outside the classroom. This tool is effective in problem-based learning as reported by Segers and Dochy (2010). A one-minute paper technique was also used for checking student's understandings on a specific subject matter. For monitoring the improvement of learning, students were asked to reflect their perspectives and ongoing self-feedback. We found that formative assessment helps students identify their strengths and weaknesses and target areas that need additional work. It also helps the instructor recognizes where the student struggle and address problems immediately.

For summative assessment, report writing and oral presentations were added to the traditional final examination. A written examination was used to assess the extent to which students are able to define, analyze and solve problems. These assessment tools were selected based on the alignment with the learning outcomes and classroom activities. Moreover, in some assessment, the criteria were co-design together with the student, such as the assessment rubric for teamwork and presentation skills.

STUDENT PERSPECTIVES ON ACTIVE LEARNING

For the second semester of the academic year 2018-2019, there were 28 3rd-year students enrolled. In the first week of the class, the students were asked to reflect their past learning experiences in terms of learning environment, learning activity, learning assessment, learning outcome, and lectures with a questionnaire provided by the instructor.

For the learning environment, the students reported that they feel bored due to a long lecture. They could not concentrate for a long time in a passive learning environment with very few chances of participation in the class. In the case of learning activities, students proposed that it would be better if the teacher can offer several class activities. Many courses did not provide course learning objective. The student did not fully understand the core knowledge. This caused a weak connection between knowledge constructions and assessment tools. There were limitations for students to involve their assessment criteria. Some assessment lacked fairness. The misalignment of the learning outcome, teaching and learning activities and assessment cause surface learning. The student could not detain knowledge from previous classes to apply with the other classes. The student's reflection on their past learning experience was used to redesign a variety of learning activities and assessments in this course.

In the last week of the class, the students were asked to carry out a questionnaire. The questionnaire consists of a variety of topics as followings; learning environment, learning activities, learning assessments, learning outcomes, and the instructor. They have reflected their perspectives with 5-point Likert scale from 1 (strongly dissatisfied) to 5 (strongly satisfied). The students respond specifically based on their level of satisfaction in each subtopic. Table 2 showed the response from student perspectives. In general, the student reflected a positive satisfaction in all subtopic with a score that is higher than 4.0. The top three of highest score occurred in subtopic of a variety of activities in the class, lecture spend time for Q&A in the class, to promote your participation in the class, opportunity to collaborate work with your friends, lecture is open-mind for the opinions of others, and creating the learning environment with a mean score 4.8, 4.7, 4.6, 4.6, 4.6, and 4.6, respectively. Our result implied that the active activities offered were effective to encourage student engagement. Our results agree with previous studies (Bonwell and Eison, 1991; Sivan *et al*., 2000; Leslie *et. al.,* 2018; Meikleham *et. al.,* 2018; Shimizu *et. al.,* 2018; and Weerakoon and Dunbar, 2018) and suggest that the active learning help student for enhancing their learning.

CONCLUSION

The aim of this work was to share the effectiveness of an active learning concept as a mode of teaching delivery. We have shown that CDIO framework can be adopted into non-engineering program. The case of the Quality Control and Standardization in Printing and Packaging course expressed how to apply active learning activities (CDIO standard 8) into the course. A variety of summative and formative assessments were applied for enhancing the student skills (CDIO standard 11). A PBL was also used as a learning activity to provide the student with a design-build experience (CDIO standard 5) as well as teamwork and communication skills. The reflection from the student indicated that they had more chances for participating and contributing their knowledge and skills in the course. Furthermore, positive perspectives from both the student and the lecturer appeared. Future work to improve this

course can be a comparison between pre- and post- evaluation to increase the learning effectiveness of the students.

Table 2. Mean response of satisfaction from the student perspective in the class of quality control and standardization in printing and packaging.

Topics	Mean	S.D.
Learning environment		
To promote your participation in the class.	4.6	0.62
To stimulate your attention during learning.	4.0	0.61
To activate your idea or your thinking.	4.2	0.44
To help you take more responsibility.	4.2	0.53
How much you enjoy in the class?	4.1	0.60
Learning activities		
Opportunity to contribute your idea.	4.1	0.70
Opportunity to debate among lecturer and your friends.	4.4	0.71
Opportunity to think and decide in the class.	4.1	0.70
You play as important role in the class.	4.1	0.66
A variety of activities in the class.	4.8	0.56
You have fun and pay attention in the class.	4.1	0.70
A variety of teaching materials.	4.5	0.62
Opportunity to collaborate work with your friends.	4.6	0.62
Learning assessments		
You know the objective of course before learning.	4.4	0.62
You know the criteria of assessment in each activity.	4.3	0.69
Your participation in learning assessment.	4.4	0.62
Fairness in assessment.	4.5	0.51
Recommendation and suggestion by lecturer for your improvement.	4.3	0.59
A correspond between learning activities and assessments.	4.4	0.62
Learning outcomes		
To promote your memory.	4.2	0.66
To promote your understanding.	4.2	0.75
To apply for other course.	4.2	0.56
To further develop and expand your skills.	4.1	0.56
To encourage your lifelong learning	4.1	0.75
Instructors		
Open-mind for the opinions of others.	4.6	0.57
Spend time for Q&A in the class.	4.7	0.47
Stimulate student attention.	4.4	0.61
Create a supportive learning environment.	4.6	0.51
Understand in a student aspect.	4.2	0.75
Pay an attention to all students.	4.5	0.80

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BIOGRAPHICAL INFORMATION

Uravis Tangkijviwat received Master of Engineering and PhD in Integrated Science and Engineering from Ritsumeikan University, Japan and is currently as an assistant professor at the digital printing and packaging technology, faculty of Mass Communication Technology, RMUTT. His professional interests focus on colour science and human vision. As a deputy dean for academic and research affairs, he promoted the CDIO to faculty members and adopted the CDIO to undergraduate programs for enhancing the graduates in the field of mass media.

Natha Kuptasthien is currently as assistant to president for International Relations and an associate professor at the industrial engineering department, faculty of engineering, RMUTT. She has conducted a number of CDIO workshops at the faculty of Mass Communication Technology to promote CDIO with non-engineering programs. Natha graduated with a Bachelor of Engineering in Industrial Engineering from Chulalongkorn University, Master of Science and PhD in Engineering Management from University of Missouri-Rolla, USA.

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