Active Learning Strategies for Building Engineering Students for Sustainable Knowledge Development

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Abstract Acquiring building engineering knowledge requires students not only to study technical skills from 'hard' technology subjects based on hands-on experience but also learn their 'soft' management skills from theories to practice. As a result, most building engineering students find it difficult to learn management subjects effectively which indeed forms a great challenge faced by teachers as well to call for an urgent need for effective learning and teaching methods on management subjects. In particular, most students studying engineering-related subjects have been adapted to hands-on exercise in technology and measurement subjects giving them a perception that the more exercise they do the better their performance. As a result, management subjects filled with mostly theories and abstract terms make it difficult for students to learn in an effective manner. This study aims to promote active learning strategies for delivering management courses by introducing a research framework to educate building engineering students, based on a two year active learning research project. The background and the methodology will firstly be introduced, followed by discussions on implementation and evaluation of the project. It is believed that the outcomes of the project can meet most University's core functions nowadays in Learning and Teaching which aims at enriching the students' learning experience by encouraging active learning among the students.

Keywords Active Learning, Intended Learning Outcomes, Building Engineering, Technology, Sustainability

such as traditional lecture that are characterized with simple and direct explanations [2]. Indeed, good teaching should include the use of mixed instructional strategies to reach learning objectives through blended learning [3]. However, Borrego and Henderson [4] noted that engineering educators and education researchers possess limited experience with regard to education and social science theories. This leads to the need for improvements in the learning experiences of built environment students [5].

Group discussion instructional strategy involves collaborative efforts of individual learner in the process of analyzing, synthesizing and evaluating ideas so as to achieve a common objective [1]. While Park et al. [6] believe that the modes of instruction often used within construction education rely on traditional methods, student-centered instruction method has greater benefits over other instructional strategies, including activity-based strategies which have similar learning effectiveness. This is echoed by Lock and Babkie [7] who suggest that students with keen interest in activity-based strategies tend to be more focused and less problematic. Still, limited numbers of educators are trained with effective implementation of other styles apart from conventional teaching [8].

Active learning is a strategy in which instructors allow learners' participation with the use of exercises that encourage learners to apply knowledge acquired to solve certain problems such as multiple-choice questions or class-length project [9]. It can be implemented by advancement in technology which has been one of the essential elements in the learning and teaching approaches. The framework of the current research is based on the Policy Paper from the Learning and Teaching Committee regarding Active Classroom for the 21st Century with a view to cultivating an 'active' studious learning environment for students to induce 'active learning' for sustainability. The policy paper asserts that 'Active Classroom' would provide a stimulating environment for students' effective learning in which active learning has been identified as one of the goals at PolyU. Further to the release of the new Blackboard learning management system, LEARN@PolyU in recent years, both teachers and students should make full use of

1. Introduction

Instructional strategies are regarded as the activities employed to engage learners in the learning process [1]. While individual learners have different preferences regarding information retrieval, processes, and recalls in the process of getting instruction, there are various forms of instructional strategies to engage learners in different ways,

technology for teaching and learning purposes, and the implementation of active learning strategies with the use of LEARN@POLYU should no doubt benefit building engineering students in learning management subjects. As a result, it is necessary for universities nowadays to design appropriate strategies for effective integration and adoption of the new technologies [10]. However, due to large intake of student population at the undergraduate level, promoting active learning in large classes is posing more challenges. In view of promoting active learning among building engineering students in tackling management subjects, this paper presents a teaching and learning project with the following objectives:

1. To identify contributing factors of active learning for construction students
2. To examine ways of promoting active learning of management subjects such as the use of database, brainstorming and fill-in-the-blanks questioning techniques, and blog among construction students
3. To introduce the use of LEARN@POLYU in developing active learning strategies for enhancing students' learning in a sustainable manner
4. To study the impacts of research works on learning management subjects by the undergraduate construction students
5. To evaluate the effectiveness of the proposed teaching methods on achieving the Intended Learning Outcomes (ILOs) of management subjects by the students

The methodology and the impacts on Student Learning will next be described, followed by discussing the deliverables and significance of the project. Evaluation and sustainability of the project will be highlighted at the end of the paper.

2. Methodology

This paper presents a research framework of active learning strategies for construction students with a 3-credit bearing subject, BRE350 Project Management and Procurement in Semester 1 offered by Department of Building and Real Estate (BRE), The Hong Kong Polytechnic University (PolyU) as the real subject at the implementation stage. The approaches of literature review, questionnaire survey and focus group meeting were selected for data collection and analyses. A comprehensive literature review will be conducted to search for contributing factors of active learning for building engineering students, and ways of active learning through literature including journal publications, conference proceedings and EDC circulars. Moreover, a questionnaire survey will be piloted. Literature review provides a solid framework for the survey including motivating factors of active learning, and common ways of active learning for building engineering students. Statistical techniques and software will be employed to investigate the impacts of research works on learning management subjects

by the undergraduate building engineering students, and the relationship between active learning and Intended Learning Outcomes (ILOs) of construction management subjects.

Focus group meetings will be organized where building engineering students of management subjects will be the targets of the meeting who will be solicited about the impacts of research works on learning management subjects, and the effectiveness of self learning, peer learning and blended learning towards understanding management subjects. Results of the motivating factors of active learning and common ways of active learning for building engineering students, research impacts, and the relationship between active learning and outcomes of construction management subjects will be released to the focus group for validation purpose. The other colleague co-teaching the subject concerned will also be another important target for solicitation by peer review and the triangulated approach can enhance the credibility of the Project.

3. Intended Learning Outcomes for Building Engineering Students

In order to study the impacts of active learning strategies on building engineering students undertaking management subjects, a subject at undergraduate level, namely BRE350 Project Management and Procurement in Semester 1 has been selected for implementation. Take this subject for reference, the Intended Learning Outcomes (ILOs) of construction management subjects relevant to this study are as follows:

1. Apply knowledge of time, quality, safety and environmental management for construction projects
2. Communicate with others in a clear and articulate manner.
3. Identify and propose solutions to problems.
4. Identify the different forms of procurement and assess their impacts on the success of a project.
5. Describe the principles underlying the choice of appropriate procurement systems.
6. Apply and compare alternative procurement systems for all types of construction work.

4. Impacts on Student Learning

Apart from relevance of course content to job-related situations, the choice of appropriate teaching and learning approach is equally important. The current project is believed to induce challenges to the traditional mode of teaching management subjects: In most cases, building engineering students acquire knowledge of management subjects through the use of in-class lecture and tutorial which may not be the most effective and efficient way to learn the subject contents. While a sincere call for 'new blood' to join the construction industry following the Policy Address made by the Chief Executive, CY Leung in 2013 and the booming

construction activities nowadays, students can benefit from a proper database housing the features and characteristics of the current construction projects.

Teamwork can be fostered. With the use of the database, students can start by self learning the construction management issues and then share with fellow classmates to induce further discussions for peer learning. This should be strongly encouraged as construction activities are interrelated and coordination is extremely necessary for getting the job done. Together with communications with other higher diploma graduates, and building and surveying participants, teamwork and team spirit of the students can early be developed which are essential for learning to be professionals in future. Moreover, competence in school work can be built. The information in the database can be digested and manipulated by students to quote examples in attempting exam questions and group reports, the work of which have long been criticized as lacking sufficiency. The e-learning activities designed for the Project also enables self-check on the actual performance. Responses to the brainstorming questions reveal the lack of basic understanding and wrong concepts of the students to enable subject contents to be adjusted accordingly. Results of the evaluation enable students to understand what they are expected to perform in order to achieve excellence.

Closer network with the industry will be maintained. With the use of the blog, students can become more knowledgeable in terms of the practice of the construction sector and the associated technical skills required by the stakeholders. The knowledge acquired from the subject through the ways as advocated by the project and the well

acquaintance with the industry further promote active learning for students' benefits. Indeed, students' readings should not just be confined to lecture materials and textbooks but also be extended to research papers related to the topics concerned. With the use of the database, students can early develop their habits of reading research papers which enables them to understand how new knowledge in the management field can be created, and provides them with insights on how research findings can be put to practice.

Students should no longer be spoon-fed by the lecturer and tutor but appreciate the beauty of active learning which is conducive to themselves and the class as a whole. They can also be aware of the new ways of learning construction management subjects through the database, the blog and the brainstorming techniques which not only enable them to achieve the generic outcomes of sharpening interpersonal skills but also encourage them to develop know-how, and network with their peers and other professionals in the industry.

5. Deliverables from the Project

In order to achieve the objectives as proposed for the project, relevant literature will firstly be retrieved to identify contributing factors of active learning and ways of active learning for construction students to learn management subjects. In addition, a Database will be developed for exploring ways of promoting active learning of management subjects by building engineering students (Fig. 1).

Figure 1. Interface of Database from LEARN@PolyU

Figure 2. Interface of Blog from LEARN@PolyU

Similarly, a blog will be established that should be ready at the start of the semester to provide an informal platform for students to express opinions on the real project examples on the problems, reasons for the malpractice/strategies and remedial measures for improvement and recommendations (Fig. 2). It should also be constructed with the use of LEARN@PolyU far as possible or otherwise to cater for the need of users outside PolyU. Other issues of concern including the current job market should also be of interest among the final year students and be communicated via the blog not only among the fellow classmates but also other undergraduates, research students, and building and surveying professionals.

Both the database and the blog bear the properties of continuity and sustainability in that students can apply the information collected to other subjects of similar nature, such as the subjects of Integrated Project, and Maintenance Technology and Management. The term, 'sustainability' was replicated in this Project with a view to making the best use of the knowledge derived from the active learning strategies and applying it to other subjects for perpetual use. The deliverables enable students' life-long learning and interactions with peers by relaying the knowledge to other degree subjects including, but not limited to Construction Engineering Management and the final year project –

Dissertation. Students of other undergraduate programmes of management nature may also benefit from the Project in the learning process. These deliverables provide students with a wider spectrum of integrating all management-related subjects into a single platform for deliberation and a reflection between theories and practice.

Brainstorming and Fill-in-the-blanks questions/answers will also be constructed (Fig. 3). In this era of knowledge, most students should have some pre-empt or basic knowledge and ideas regarding the subject contents. In regard to this, students will be given a sample of brainstorming questions which are in the form of open-ended questions to test their basic understanding and concepts. At the end of the lecture, students will be provided with some fill-in-the-blanks questions which are in fact transformed from the solutions to the open-ended questions to correct any misconceptions if detected and students can benefit in a self-learning manner. The brainstorming and fill-in-the-blanks questions are not only part of the important deliverables for the Project, but also provide a device for students to experience its usefulness to comment on its effectiveness on learning outcomes. This deliverable can be considered as one important method to evaluate the quality of the Project by the actual performance of the students.

Figure 3. Snapshot of Brainstorming questions

Management is considered as a 'soft' subject with mostly theories and abstract terms for students to learn, which is fundamentally different from other construction subjects like technology and measurement which provide students with more hands-on exercise. It is of vital importance to promote active learning in management subjects for construction students to arouse their interest and strive for excellence. While a number of measures have been introduced in the subject of Project Management and Procurement, students should have feedback regarding the teaching methods on learning. Hence the effectiveness of self- and peer- learning via the devices of brainstorming and fill-in-the-blanks questions/answers, and the database and the blog can be evaluated with the use of an on-line survey in the form of paper publication as one deliverable.

Dissemination of information by means of publications will definitely be one other important deliverable from the project. A questionnaire survey will be conducted which will be due to complete by the 3rd teaching week before the end of the semester and students should complete the survey based on their perceptions on the effectiveness of self learning, peer learning and blended learning via the teaching and learning strategies including database, the brainstorming technique and the new Blackboard learning management system, LEARN@PolyU (Lam et al., 2015a) [11]. Details of the Project, including objectives, methods, deliverables and outcomes will be properly documented for possible publications in conference proceedings or journals to share findings and invite comments from other counterparts for

future improvements (Lam et al., 2015b) [12].

6. Significance of the Teaching and Learning Project

Before the implementation of the Project, the subject of Project Management and Procurement is delivered through lectures and tutorials which may not be effective enough for the students to learn the subject. Besides, there is minimal use of the on-line platform - Blackboard at LEARN@POLYU which requires students to download lecture and tutorial materials only. Information regarding the research works done by BRE related to the areas of construction management is lacking with no universal platform or database for students to acknowledge the relevant research works with the corresponding management topics in the subject. The lack of a common platform in the form of a blog even discourages students from exchanging opinions with each other while the absence of a database makes it difficult for students to quote relevant examples in coursework and examination.

PolyU is renowned for training future assets of society with theories and practice, and students' ability and competence to apply knowledge to the real situation is one of the important learning outcomes the BRE Scheme aims to pursue. After the implementation of the project, it is expected that information collected from the database widens students' horizons in the way that student learning

should not be confined to textbooks and lecture notes only but extended to real cases and examples in the local region or international arena. Class contact hours will be reserved for each lecture to figure out any updated project examples from the database for elaborating on the similarities with or differences from the theories. Such discussions provide students with more insights in preparing their reports and answering exam questions.

The database, together with the blog, essentially advocate peer learning among students who are required to work in groups to cite case examples from newspapers regarding construction management issues and hold online discussions to provide comments to their peers on the analysis of the cases. Peer review can also be fulfilled by sharing real cases in the blog, and exchanging construction management practice with the graduates and professionals. At all time, students are encouraged to initiate discussion topics and share news related to the subject matter.

From the perspective of teaching, responses from the students in the blog and tackling brainstorming questions enable the teachers to have a better understanding of the ability of the students. Students' actual performance can demonstrate what the students' common problems are, where their misconceptions lie and the areas they are not competent with. The arrangement of the lecture and tutorial sessions can then be adjusted to focus more on the students' shortcomings and invite more their contributions on what they have learnt. More effective communications can be facilitated between the teacher and the students, between the students and the industry participants, and the research community, and among the students themselves for mutual learning and self learning purposes.

7. Conclusions

This paper demonstrates the need for a more interactive approach for building engineering students to learn management subjects besides the traditional classroom conditions. A research framework of active learning strategies for a teaching and learning project was introduced, and the benefits from the perspectives of student learning and teaching were highlighted with a view to improving students' performance in acquiring knowledge in management areas. Indicators by means of student feedback, observations of the teaching staff, study behavior of the students and actual performance in the subject can be used to evaluate the quality of the Project.

One important feature of the Project is concerned with sustainability from perpetual use of database and the blog. While the former developed from the project trains students to investigate problems and suggest solutions, the latter provides an informal platform for exchanging ideas not only confined to subject contents but also real practice of the construction industry. From the sustainable point of view, real examples from the database, and students' performance in the brainstorming and fill-in-the-blank questions highlight students' deficiencies in the subject which gives directions

for restructuring the subject contents and syllabus as a whole for future intake for the subject.

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