Impact of Online Quizzes on Engineering Students in Knowledge Development

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Abstract: Due to rapid changes in the communication technologies, the teaching and learning has changed dramatically over the last two decades. The face-to-face (class room based) teaching remains one of the most predominant ways of imparting knowledge to students. On the other hand, different online activities are increasingly being used to supplement traditional face-to-face engagement. In this paper, engagement strategies adopted while delivering one of the computer science engineering subjects (units) from Bachelor of Engineering program. The engineering course includes mathematical manipulation and engineering software learning. In addition, students participate in online in-lecture engagement tool and quizzes, tutorial sessions, group assignments and final exams. While some of the activities in the course such as in-lecture engagement tool and weekly quizzes are online, tutorial sessions are delivered via face-to-face mode. It was found that failure rate was significantly less for students who passed in online quizzes. Thus indicating that online quizzes may lead to deeper understanding of the lecture materials covered under the unit investigated as part of this study.

Keywords: Blended learning, tutorial, face-to-face teaching, in-class engagement, problem based learning.

1. Introduction

Due to rapid changes in the communication technologies, the teaching and learning has changed dramatically over the last two decades. The face-to-face (class room based) teaching remains one of the most predominant ways of imparting knowledge to students. In the face-to-face teaching system the main contact point between teacher and the students is classroom, where students listen to lectures, receive lecture materials and take notes on lectures, and attempt class test and final exams. On the other hand, the online learning is defined as learning that takes place entirely over the internet. A combination of face-to-face and online delivery systems is called blended learning approach (BLA) and is expected to enhance the learning ability of students . In BLA, various learning materials are made available to the students including online availability of recorded lectures and tutorials, hand written tutorial solutions, discussion board and online practice quizzes . Blended learning approach is currently practiced in most of the engineering courses and typically , in a blended learning system lectures, tutorials and final exams are classroom centred activities, however quizzes may be online.

Student activities in the class are core to student's learning , although it is not straight forward what types of activity will keep the students fully engaged in the class and help in learning. Close associations exists between conception of learning through discussions with approaches to face-to-face and online activities and learning outcomes. It would be interesting to know if there is any impact of teacher's efficiency in delivering the lecture, underlying complexity of the course content, group based activities, and connection of curriculum with the industry related problem on student engagement in the class. However, it is observed that breaking up lectures with short discussion times may have positive impact on re-engaging the students to the lectures. This type of breaking up of lectures

can be achieved by implementing various online activities and have received attention by many educators who implemented this type of activities in many engineering as well as non-engineering courses.

Online quizzes, usually on weekly basis, were found by some researchers an effective method of student learning for mathematics and physics for engineering students. One of the advantages of the online quizzes is that it can save some precious class time and also allows large number of students to be involved in the learning activities with little effort from the teacher. However, it is argued that attending the online quizzes did not improve the students' pass rate in a mathematics unit.

In this paper effectiveness of using online quizzes in an engineering unit, is assessed. The assessment is based on students' performance in different activities of the unit. Online quizzes have been assessed as a learning tool compared to other conventional face- to-face systems including tutorial, group based major project and final exam.

2. Course content of "Infrastructure Engineering" unit

The *Infrastructure Engineering* unit provides students with material to assist them with Civil Engineering Construction and Urban Development and Town Planning projects. The unit mainly focuses on the planning, design and construction of transportation facilities using a case of subdivision development. As per the learning outcomes of the unit are concerned, upon successfully completing this unit, the students will be able to:

- Apply principles involved in the design, construction and maintenance of both small and large transportation networks comprising of both roadways and railway tracks;
- Analyse and design transportation hubs and intersections for allowing efficient traffic flow;
- Analyse sustainable transport systems and facilities for both rural and urban areas;
- Apply available design tools and guidelines for transportation network design; and
- Create and contribute to productive and efficient teams for designing and evaluating efficient transportation systems.

The teaching and learning activities of the unit are shown in Figure 1 and discussed in subsequent sections. The delivery of this unit is structured on the principles of "Problem Based Learning."

2.1 Lectures

In this unit the lectures are designed to introduce students to concepts relevant to infrastructure and to brief students on assessment requirements. Lectures are mainly delivered using power point slides and document camera. While the concepts are explained using power point slides, step by step solution to examples are shown using the document camera. To check whether the students understood the concepts an engagement tool, namely, GoSoapBox is used.

2.2 GoSoapBox

The unit contains, 3-4 questions are asked using GoSoapBox tool during the lecture time depending on the content of the lecture. The questions are generally simple and straight forward type. These questions are mainly intended to test the understanding of the concepts introduced in the lecture by the students. When asked, the students log in to GoSoapBox with an access code given by the lecturer and complete the activity. Through the use of this tool students are able to convey the message that they have either understood or not the concepts introduced in the lecture. On the other hand, it is an instant feedback mechanism on the students' understanding of the lecture materials to the lecturer. Based on the feedback received the lecturer decides on either explain the concept further or move on to the next topic.

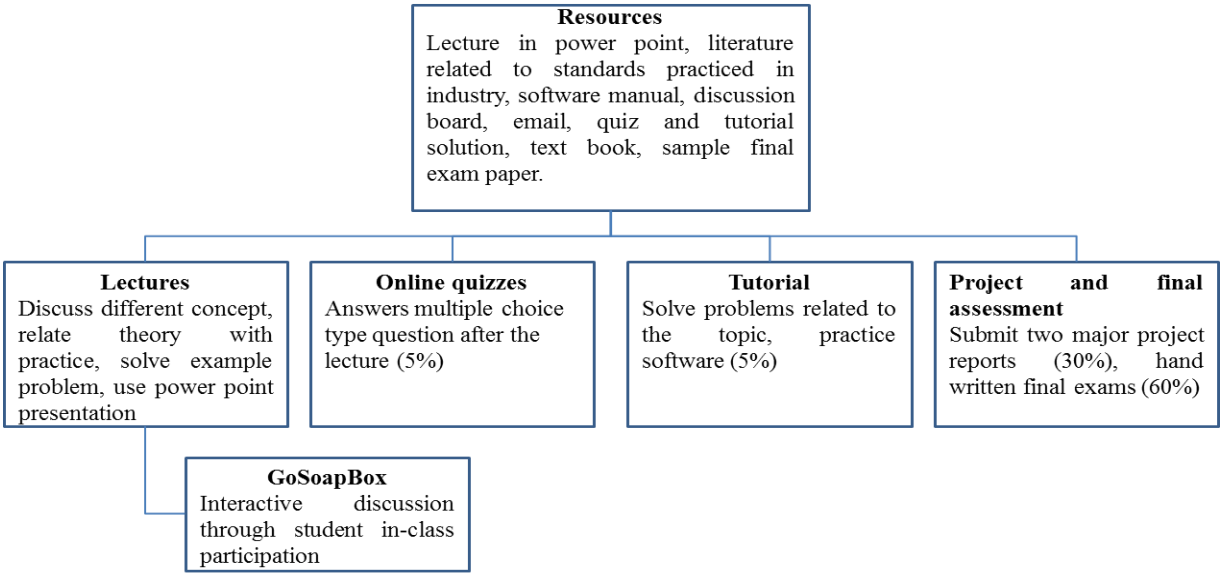

Figure 1 Learning and assessment components of Infrastructure Engineering unit

2.3 Tutorials

In tutorial classes, the students perform activities to reinforce the concepts introduced in lectures. Tutorials are held in tutorial rooms or computer labs where students get chance to work together on their projects and to learn the relevant software. Students are encouraged to participate in tutorial classes by allocating 5% of the total marks for attendance. Each student must answer all the tutorial questions and/or follow the steps to use the software. Tutor, if required, assists individual students for solving the tutorial questions or the use of particular software. Each student is expected to work independently and, at the end of the tutorial class, submit the answers to all the questions or show the output from the software.

2.4 Online quizzes

Online quizzes are in addition to GoSoapBox quiz questions, where students are asked to answer 6- 10 questions. These questions aim to test the understanding of underlying concepts of the topic discussed in the lecture. The students need to attempt all 13 online quizzes based on the weekly lectures. The students are allocated 6 days to answer the questions in an online quiz. Students must take these quizzes in order to gain the participation marks for this assessment component. The overall mark for this assessment component depends on the performance of each of the students in each of the online quizzes. For example, if a student receives 100% in each of the quizzes over all 13 quizzes, the student will be credited with 5 marks towards his/her final mark. The students are given feedback on their answer in the following week of each lecture.

2.5 Major project and final exam

Students need to submit two major projects carrying a weighting of 30% and attend final exam. The final exam carries 60% of total marks.

3. Methodology

Data related to students' performance in different activities of the unit were extracted from results of Autumn 2015 session. Regression analysis was performed to find the effect of students' performance in online quizzes on the final marks. Similar analyses were carried out to find the effect of tutorial, major projects and final exams on the final marks. For this purpose linear regression technique was used, which attempts to model the relationship between independent and dependent variables by fitting a linear equation to the observed data. In this study, the relationship between the dependent variable and the independent variables are assumed to be linear. The following represents a multiple

linear regression equation (Montgomery et al 2012):

$$YY = \alpha\alpha + \beta\beta_1 XX_1 + \beta\beta_2 XX_2 + \cdots + \beta\beta_{kk} XX_{kk} \quad (1)$$

where, $\alpha\alpha$ is the model intercept, $\beta\beta_{1,2,3\ldots kk}$ are the slope coefficients, and k is the number of independent variables.

Statistical analyses were carried out using Minitab™ statistical software. Data on students' response on the unit was collected from Student Feedback on Unit (SFU) for Autumn 2015.

4. Results and discussion

In the Infrastructure Engineering unit, the marking criteria were set as *fail* or *unsatisfactory (F)* when student received 0-50%, *pass (P)* for 50-64%, *credit (C)* for 65-74%, *distinction (D)* for 75-84% and *high distinction (HD)* for 85-100% marks. Distribution of students' marks in individual sections of the unit is shown in Figure 2. It can be seen from Figure 2 that students performed well in tutorial and in major projects compared to online quizzes and final exams. In online quizzes, 38% students received less than 50% marks, which is 40% for the final exam. In tutorials and major projects, 12 and 5% students were failed, respectively. Overall, 22% of the students failed in this unit.

Investigation was carried out to see the impact of the students' performance in each assessment component on the final overall marks (Figure 3). As shown in Figure 3, both quizzes (R^2 = 0.25) and tutorial marks (R^2 = 0.13), are positively correlated with the final score, however, quizzes show higher correlation compared to tutorial. In both cases, the predictor variable was significant as the p-value was less than 0.001. The low p-value suggests the predictor as a meaningful entity in the regression equations. Similar observations were made for major project and final exam marks (Figure 3c and 3d). It appears that the final exam was the deciding factor for the final mark of each student.

Weak correlation between tutorial mark and the final mark may be partly attributed to several reasons. Some possible reasons for this may include:

- Often the tutorials are very prescriptive and students fail to pay attention;
- Not much opportunity for students to think;
- Blindly follow the tutor in solving the design problem;

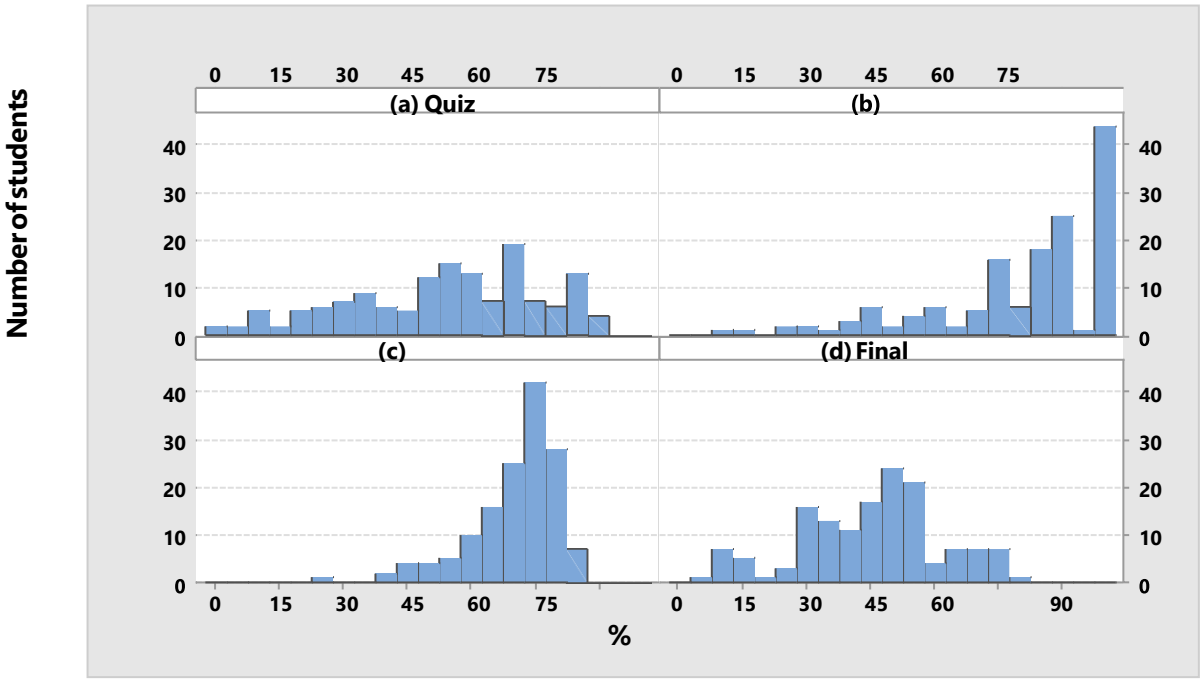

Figure 2 Histogram of students' score in (a) quiz (b) Tutorial (c) major project and (d) final exam

In relation to the last item, the participation mark was given to students as far as they demonstrate the participation in the tutorial activities by showing the completed solution to the particular question. While marking the tutor may not check whether the student has understood the solution method and the basic concepts. This is mainly due to the time limitation that the tutor will have for marking the tutorial papers.

It was interesting to see that students who failed the online quizzes, 31% of them got F as the final grade; only 5% of the students got C and the rest as P. On the other hand, students who passed all the quizzes, only 17% of them got F as the final grade; however, 19% of the students scored C and 12% of the students D. No students scored HD in the unit. The results explain the effectiveness of online quizzes for students' learning. Similar observations were in an engineering unit (*Computer Systems)*, where students found online quizzes an interesting way of learning. Accordingly, 70% of the students found the online quizzes useful for testing their knowledge and for focussing on important topics in the course; 58% of the students found the quizzes a more interesting way of learning rather than just attending lectures and tutorials. The data presented in Figure 3 appear to reinforce the above findings. The students may find the online quiz an interesting way to learn the subject because of its flexibility. The online quizzes can be done anytime and anywhere. The system provides opportunities to undertake the activity with greater flexibility by students who live long distances from campus, have children or lead busy lives. Many of the students in the *Infrastructure Engineering* work part-time and took the advantage of accessing the quizzes in their preferred time. It is also possible that some of the students may have collaborated with their peers before answering the quiz questions. Similar observation was made by Martins regarding online quizzes. However, in the current study attempts were made to minimise the possibility of collaboration between peers by presenting the tutorial questions and possible solutions to the questions in random orders. Also in some cases the questions were presented from a bank of questions, which minimised the possibility of presenting the same question between two students.

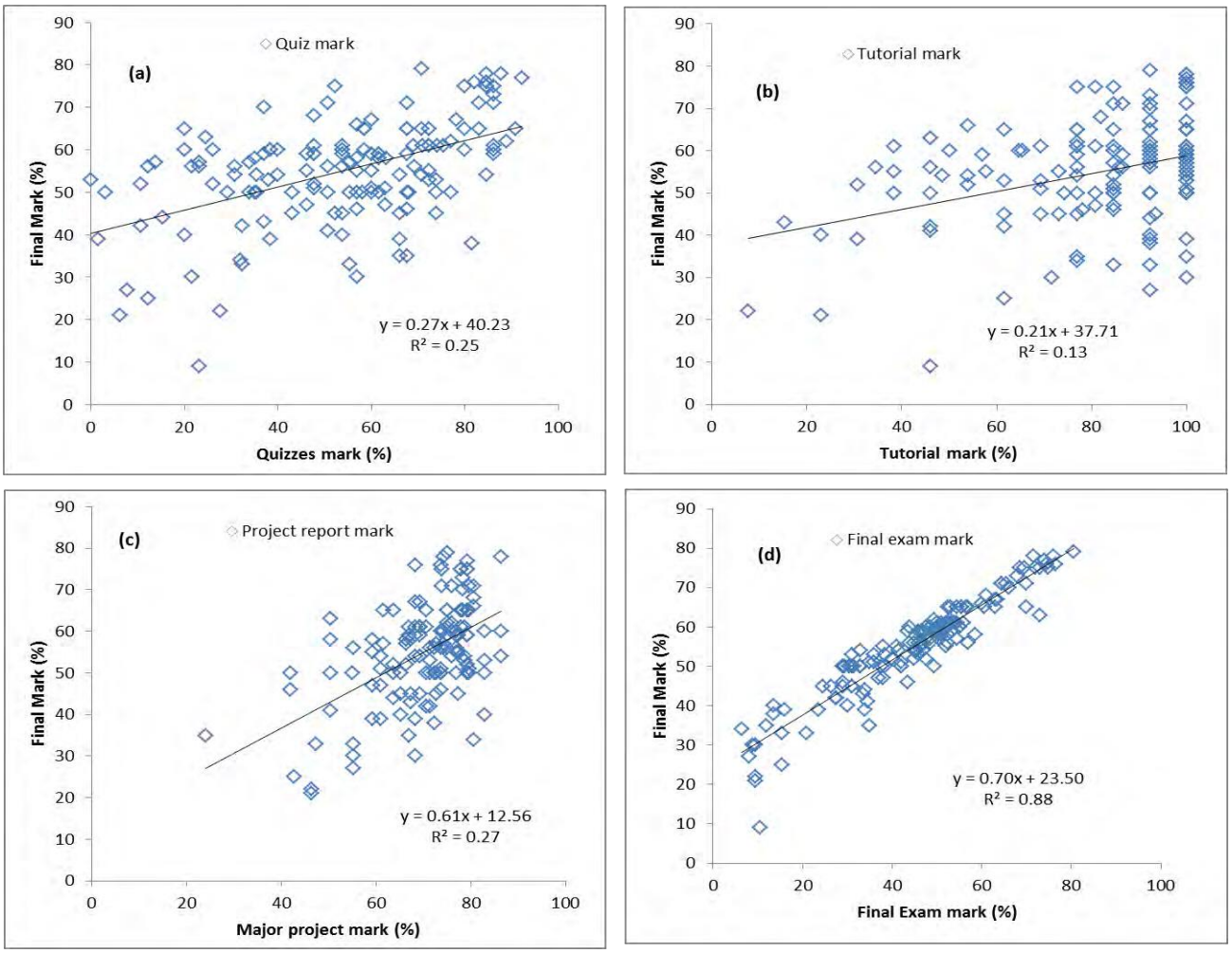

Figure 3 Correlation of students' final score with (a) quiz (b) Tutorial (c) major project and (d) final exam marks

In the case of tutorial, the students who failed the tutorial, 47% of them got F as the final grade and 57% got P. On the other hand, students who passed all the tutorials, only 19% of them got F as the final grade; 16% of the students scored C and 9% of the students scored D. In comparison to online quizzes, higher failure rate was observed who passed all the tutorials; percentages of C and D were also lower compared to online quizzes. Again reasons behind this observation are same those observed earlier, lack of attention during the tutorials and rigor of marking.

To provide more engaging tutorial classes, it is necessary to hands-on sessions such as interactive multimedia software. However, students should be willing to accept such interactive as well as multimedia enhanced lectures and manage their time more efficiently to access and practice the software in their own time. This will also save time and money for providing additional classes to learn the software.

5. Conclusions

This study investigated the use of online quizzes and tutorials as tools for students' deeper learning of an engineering subject, and compared with other face-to-face learning activities. Online quizzes showed relatively higher correlation between the mark obtained in the quiz and the final mark. Thus indicating that online quizzes may lead to deeper understanding of the lecture materials covered under the unit investigated as part of this study.

The study provided statistical analysis based on limited data, however, students' performance data from different years will make the analysis more meaningful. The study provided a glimpse of students' response on the unit . Nevertheless, questions asked is addressed only general issues related to the unit. Questions should be more specific to different activities (e.g. quiz, tutorial, major project) practiced in the unit. This will allow students to comment for further developing the unit. Online in-lecture engagement tool (e.g. GoSoapBox^{TM}) practiced in the unit, may have impact on the student learning, which needs further investigation.

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