Design and Development of Game Based Evaluation and Learning (GABEL) for Applied Thermodynamics course for Active Learning

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Abstract

This article describes the application of Game based Evaluation and Learning in the classroom for formative assessment. The author caters large class of 194 second year students in Applied Thermodynamics course and evidence showed that this game enhances students' attendance and learning in the course. The students got motivated to learn the course as it is active learning which much better as compared to the regular rote learning. The amalgamation of gamification as part of evaluation tasks is a complex process in active learning. It takes into attention not only the surrounding or motivational aspects of the activity, but also the quality criteria that are compulsory from the evaluation perspective. In the course, the Stock Market game was designed and customized for the active learning and evaluation in a structured fashion. In order to assess the effectiveness of it a survey was conducted. This activity received accolade from the students.

Keywords
Game based learning, Student Engagement, Formative Assessment, Active learning

1. INTRODUCTION

Relate to traditional teaching, the teacher has to create original ideas in 21st century to face some important problems around student motivation and engagement. To cater large classes and low rates of student retention is a serious problem in higher education. Large classes are less effective as compared to small classes for achieving knowledge retention with changing student attitudes due to influx of technological development.

Play is a kind of voluntary, motivated activity and is associated with recreational pleasure and enjoyment (Garvey, 1990). It is required to fulfil basic desire for relaxation and entertainment and this technique is used for formative evaluation purposes. It is used in various contexts for numerous purposes and at almost all levels of education (Becker, 2007). Games are an outer expression of play. It involves sets of rules, activities in order to achieve a crucial purpose, namely fun. Gamification increases user's motivation and engagement. In higher education, games have been found to be beneficial for academic achievement, motivation and classroom dynamics (Sharples, 2000). Motivation is demonstrated by an individual's choice to engage in an activity and the intensity of effort or persistence in that activity (Garris et al., 2002). The author presents a game based method in gamification. It is well-defined as "the use of design (rather than game-based technology or other game-related practices) elements (rather than fully developed games) characteristic for games (rather than play or playfulness) in non-game contexts (regardless of specific usage intentions, contexts, or implementation media)" (Deterding, Dixon, et al., 2011). There is strong evidence that shows the relationship between game playing and increased motivation. During game based learning, students are so engaged and motivated that they are learning even they are not aware of it (Burguillo, 2010). Therefore, games can be made an integrated part of a traditional classroom lecture to improve learning, motivation and engagement (Wang, 2007; Owston, 2009). Retention levels of the students can be enhanced when active learning methods are used (McKeachie, 1999; Silberman, 1996).

The evidence supports that there is a positive correlation between class attendance and academic performance within college classes across disciplines. (Nancy Fjortoft, 2005). But in the present era, the students are physically present but are mentally absent in the class room. This is the major issue teachers are grappling with in higher education system. This is owing to the technological development as information is available on finger tip of the students on their cell phones through internet. So merely enforcing the attendance on the students is not necessarily

enhance their learning. In order to have effective learning and knowledge gain, interest for learning is to be enhanced among the students. This is possible with active learning techniques. In the course "Applied Thermodynamics", the authors have implemented active learning in the form of game based evaluation and learning (GABEL).

2. Game Based Evaluation and Learning

Engaging twenty first century students in traditional teaching system is becoming challenging day by day. This problem aggravates in especially bigger class rooms. Applied thermodynamics is the course offered to second year engineering students at BITS, Pilani were about 194 students are enrolled. This course is very important being core course in second year and covers basics for the courses offered in third and final year. Many studies have shown that learning motivation and efficiency can be enhanced through games based learning. Active learning in the form of games has improved efficacy and motivation for learning (Cheng and Su 2019, and Liu and Chen 2013). So, in order to make the course more and more interesting and to make students interested in class room, active learning by gamification of course have been experimented by authors. For this purpose, a game was designed and developed for active learning. The name given to the game is Stock Market, owing to its nature of play, it is inspired from normal stock market. Thermodynamic cycles like Carnot cycle, Rankin Cycle, etc., are very basic and foundation part of mechanical engineering and each cycle is composed of combination of different thermodynamic processes. Each cycle has different combinations of thermodynamic processes and also has different Pressure-volume (P-v) and Temperature-entropy (T-s) plots. Students were finding it difficult to learn and retain these cycles and their P-v and T-s plots. So, these thermodynamic cycles were selected for the game.

2.1 Stock Market Game

In this game, all the thermodynamic cycles were typed and printed on the paper. Each cycle consisting of name of the cycle, all the thermodynamic process in the cycle and their respective P-v and T-s plots. All the cycles along with their respective plots were shared with the students few days prior to the schedule of the game. The students were asked to go through the shared content and come prepared for the game. This game was kept as a fun oriented evaluative component for 5% weightage. The sample cycle (Carnot Cycle) is given in Fig 1 for the reference,
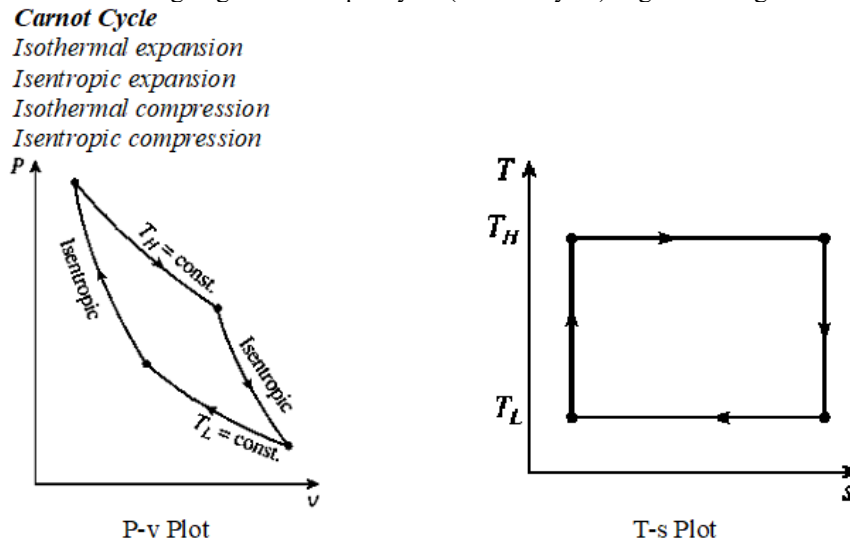

Fig 1. A Sample cycle

The individual processes were then distributed randomly to the students and students were asked to find out their team members who have the remaining portion of the cycle. The marks were given on first-come-first-serve basis. In order to find out the students with remaining portion of the cycle, students have to shout and find out other members like in the real stock market the shares are traded. The weightage for this game was kept low owing to the random nature of the game. The game was an instant hit among the students. The pictures in Fig 2a and Fig. 2b presents the game in progress.

Fig 2a Stock Market in progress

Fig 2b Stock Market in progress

3. Feedback survey

After conducting this game based evaluation and learning component, in order to find the effect of the game a feedback survey was conducted. For the same a feedback form consisting of 10 statements was designed and the students were asked to give feedback on 5 point Likert scale with 1 being "strongly disagree" and 5 being "strongly agree". An online feedback form was prepared to conduct a survey amongst the students and link were shared with the students on their email addresses. All 194 students participated in the feedback survey. The result of the feedback survey given by the students is as shown in Fig 3 (a, b, c, d, e, f, g, h, i, j, k) in the form of bar chart.
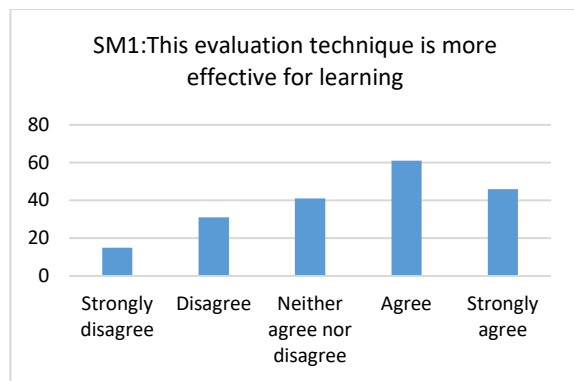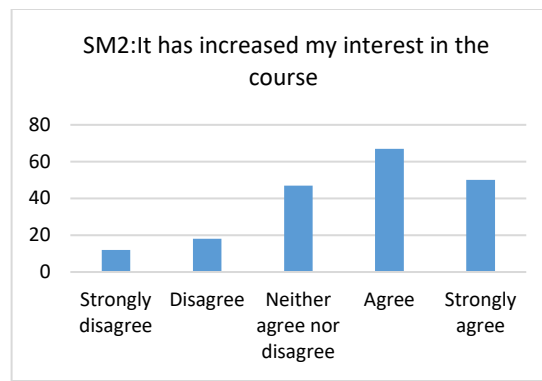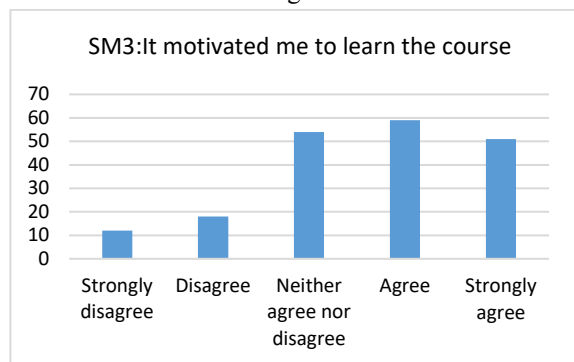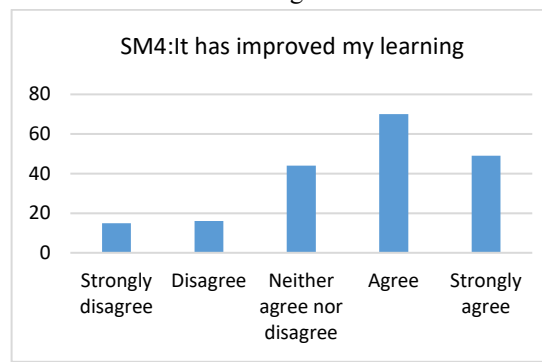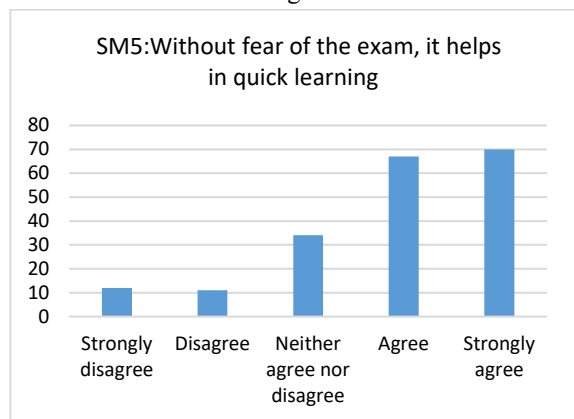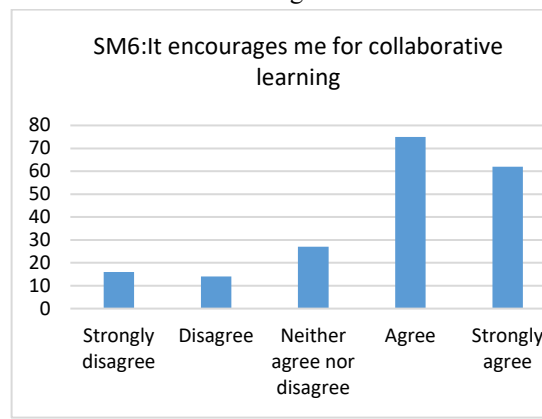
Fig.3a

Fig.3b

Fig.3c

Fig.3d

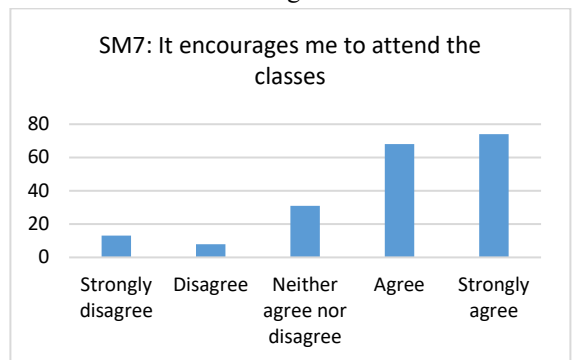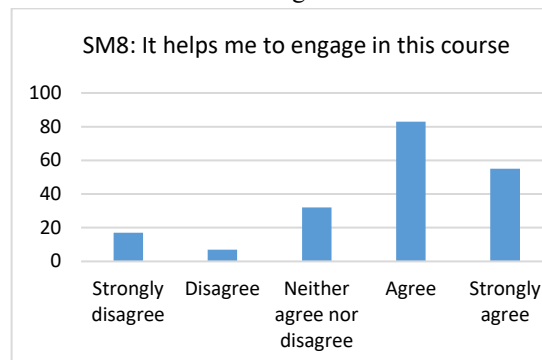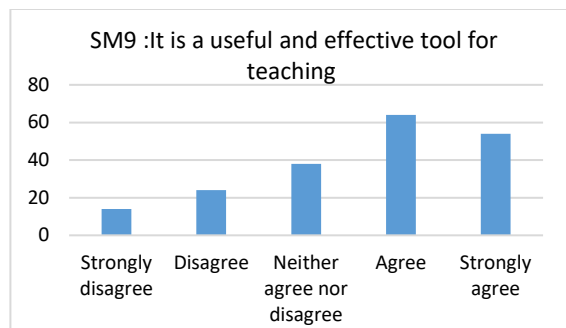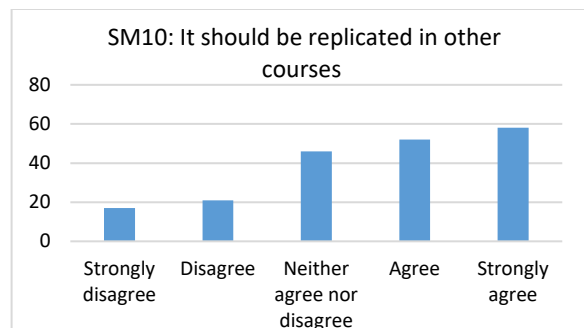
Fig.3e

Fig.3f

Fig.3g

Fig.3h

Fig.3i

Fig.3j

Fig.3 Feedback Survey

The feedback survey indicates that the majority of students agreed that the GABEL is a very effective way for learning. Apart from fun it has increased their interest and motivated them to learn the course. It has improved their learning. Most important point was more than 80% students agreed that it has helped them in quick learning without fear of exam and helped them in collaborative learning. Also same percentage of students agreed that this has helped them to engage more with the course and encouraged them to attend classes. They also agreed that it is a useful and effective tool for teaching and should be replicated in other courses. The overall the feedback shows that GABEL is a very effective tool for evaluation as well as learning. Though some students have not agreed to the statements, which may be due to the reason that they have not gone through the content shared with them or could not have completed the activity timely.

Conclusion

The biggest problem that teachers face in Engineering education is keeping students interested and motivated in their studies. For this 21st century generation traditional teaching method is not sufficient to keep them engaged and motivated to learn course. So GABEL is an effective tool to make students interested in attending the class and also stimulate them to learn.

Exam fear is one of the biggest cause of depression amongst the students, with GABEL being tension free and stress busting evaluation and learning system, it has helped students to reduce their exam related anxiety and simultaneously helped them to improve their learning. Also it has facilitated them in quick learning which is much better than rote learning. So, GABEL is one of the strong tool for active and quick learning amongst the students.

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Biography

Manoj Kumar Soni is an Associate Professor in Mechanical Engineering department at BITS, Pilani. He has total teaching and research experience of 22+ yrs. Prior to joing BITS, he was a faculty at VNIT Nagpur. He has total 29 publications in high impact factor international journals and international conferences in his name. His coveted lecture on Spiritual thermodynamics is very well appreciated by the students, academicians and industries. He has delivered this lecture at University of South Florida, many Indian universities and industries.

Tamali Bhattacharyya completed her Masters in Economics (1989) from Calcutta University and PhD (2012) from the School of Education Technology, Jadavpur University on Impact of educational software on learning outcome in secondary school children. Currently she is engaged with the Teaching Learning Center, BITS Pilani as a consultant. She has been offering an online course on Outcome based pedagogic principles for effective teaching under SWAYAM/MOOC from IIT Kharagpur and has conducted several Faculty Development Programmes organized by IIT Kharagpur over the last 5 years. In the recent past, she has been a Research Project Manager in several education technology based projects at IIT Kharagpur. During her free time, she runs an NGO "ASMA" in West Bengal which among other activities, runs a school employing technology for tribal under privileged children in a village near IIT Kharagpur campus.