ENHANCING STUDENT MOTIVATION AND LEARNING WITH MONETARY PRIZES IN A CONSTRUCTION MANAGEMENT UNDERGRADUATE SUBJECT

Saw Hoon Lim[1] and Toong Khuan Chan[2]

[1]*Faculty of Medicine, Dentistry and Health Sciences, University of Melbourne, Parkville, VIC 3010, Australia*

[2]*Faculty of Architecture Building and Planning, University of Melbourne, Parkville, VIC 3010, Australia*

This study developed a competition mechanism that is integrated into an industry-sponsored project to enhance student motivation, engagement and learning achievement in a construction management under-graduate program. As part of the formative assessment exercises in a construction technology subject, students were tasked to propose an alternative precast concrete building solution for a four-storey car showroom that was originally designed to be constructed as an in-situ reinforced concrete structure. An industry partner was actively involved in establishing the scope of the project, provided all necessary documents, arranged site visits and introduced the range of precast concrete components that were available for use. A design engineer from the company was invited to present a lecture on the design and construction of precast concrete structures. Students also visited a project where these precast concrete elements were being erected. Students were assigned to work in pairs to develop an alternative precast design and propose a detailed construction plan for the client's consideration. More importantly for this assignment, the industry partner offered cash prizes for the best solutions. An experiment was conducted to examine the effects of the competition by comparing the students' performance in this competitive environment to another assignment in the same subject that did not offer any cash rewards. The results of a survey of the students indicated that many were more motivated, worked at a higher level and attained a more positive experience compared to a previous assignment that had no cash rewards. However, a small number of students reported that they were not influenced by the prize money and did not report any improvement in performance or learning. These findings indicate that individual learning preferences may influence the outcomes from competition mechanisms. This study will inform on future industry engagements with the construction management program in terms of cash rewards to enhance educational value. The pedagogical strategies linking educational outcomes with competition and rewards will have implications for academic teaching and student learning.

Keywords: competition-based learning, industry engagement, motivation

[2]tchan@unimelb.edu.au

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INTRODUCTION

Studies on teaching and learning in the field of built environment have determined that contextualised experience in the form of industry engagement have been useful. In addition to the main objective of giving students an opportunity to gain practical experience by observing and applying the methods and theories learned in the classroom to real-world scenarios, these engagement activities enhance students' networking opportunities with professionals who can potentially provide employment references and future employment, improve students' communication skills and allows students to gain a broader perspective on their intended career path (Burns and Chopra 2017). Examples of industry engagement activities include internships, field trips, guest speakers and problem-based learning using real or simulated industry case studies. In engineering education, capstone design courses have been developed to better prepare graduates to meet the needs of industry. Having an industry-sponsored project-oriented capstone course has resulted in students progressing from feeling responsible and accountable to a project, to having expectations as an industrial "customer". This appears to be an important factor in their learning (Dutson *et al.,* 1997). While the industry partner's involvement may include a liaison engineer to provide the project brief and details, other criteria such as course requirements, learning outcomes, schedules and other university restrictions remain the responsibility of the course academics.

Being fully cognisant of these benefits, the construction program at the University of Melbourne has long been strong advocates of industry engagement with site visits and case studies strongly embedded in the curriculum. Mills *et al. (*2006) were a major proponent of experiential learning from site visits suggesting that the learning experience by being physically on site, observing the construction process and followed up by a debriefing session to unpack their observations far outweigh the logistical difficulties in organising these visits. Academics in the US (Eiris Pereira and Gheisari 2019) who conducted a survey on site visit experiences shared a similar view but reported a decline in the willingness of faculty members to utilise visits citing spatiotemporal challenges as the most significant barrier.

This paper describes efforts to create a pedagogical environment that seeks to influence the learning experiences of students not only with an industry partner but with the additional reward of monetary prizes for the best solutions. Specifically, this paper broadens the lines of inquiry from issues of active and problem-based learning and industry engagement to include competition and reward as motivational factors to support learning. In collaboration with an industry sponsor, an assignment in a construction technology subject in the built environment degree was conceived as a project with an industry sponsor as client. The task was for students to work in groups of two to propose a precast concrete alternative to a conventional reinforced concrete structure. The assignment culminated in an industry-sponsored competition, where student teams presented their solution to a panel of expert judges from industry. The best solutions were awarded cash prizes. The objectives of the study were: (i) to examine the impact of the monetary rewards on the levels of motivation and engagement in the assignment, and (ii) to assess their learning of the intended content for this course.

Context and Pedagogical Issues

Prior research suggests that learning is facilitated when the learner is provided with the relevant foundations of knowledge, engaged in solving a real-world problem,

guided by appropriate coaching that is gradually withdrawn, and given the freedom to create, invest and explore new ways to use their skills or knowledge. However, despite the opportunity to work independently and actively on realistic problems, higher education still suffers from a lack of student motivation (Cuevas-Martínez *et al.,* 2016) and a decline in academic performance (Figas *et al.,* 2013, Munoz-Merino *et al.,* 2014).

Competition-based learning however has been observed to result in stronger motivation in students and increases their learning performance (Burguillo 2010, Cuevas-Martínez *et al.,* 2016). Competitions in this context refers to tournaments, leader board, or other academic competitions in the likes of mathematics Olympiads, discovery challenges, and robotics contests. Academic competitions, especially those that focuses on collaboration enhances student motivation and promotes interaction with other course-mates (Munoz-Merino *et al.,* 2014). Collaboration and coordination developed in teamwork assignments are also key career requirements. Academic competitions can also expand the scope and depth of content, allowing students to explore subject areas far beyond the opportunities available in a regular classroom (Ozturk and Debelak 2008). An example of a competition is where a tournament is organised at the end of the semester where additional points can be gained from the competition. The learning result is therefore independent of the student's score in the competition. The additional points to be gained from the competition only improves the final mark of the group and do not affect the others negatively. In this case, the competition is among different groups where students must collaborate to enhance their team's performance.

It follows that an extension to competition-based learning would be to offer a reward to the winners of the competition. Sternberg and Baalsrud-Hauge (2015) investigated extrinsic motivation by introducing monetary prizes to two cohorts of students. They observed that monetary prizes have a higher impact on already motivated students who exhibited stronger group dynamics and motivation to not only work for a course grade but an extra prize money. They also argued that students in the less competitive cohort, being in a higher level of education and expected to be responsible for their own learning, were hardly affected by this offer of prizes. Literature suggests that when a person engages in an intrinsically interesting activity, under certain conditions, the imposition of extrinsic rewards may have detrimental effects that have been labelled "hidden costs of reward" by Lepper and Greene (1978).

RESEARCH METHOD

This research project has been granted approval from the University of Melbourne Biomedical Sciences Human Ethics Advisory Group, Ethics ID: 1954376.1, approval date: April 24, 2019.

The construction technology subject was structured as follows. The first part introduced the concepts of steel structures and describes the various framing systems including portal frames for industrial buildings. The second part was devoted to the construction of basements both single and multi-level with the corresponding systems for earth retention and waterproofing systems. Various systems for shallow and piled foundations were discussed. The third and final part was devoted to precast concrete and exemplified by tilt-up construction, prestressed hollow-core floors, and precast beams and columns. The course was delivered through 30 hours for lectures, 11 hours of tutorials and discussions, and around four visits to construction project sites. Assessments consisted of two reports to be completed during weeks 5 and 9 of a 12-

week semester followed by a final exam at the end of the semester. The first assignment was to report on the design and construction aspects of a steel portal frame. The second assignment, which was the competition task reported in this paper, was to propose an alternative precast concrete solution for a conventional reinforced concrete structure. Students were required to find their own partners to work in groups of two for these assignments.

Cash prizes were offered for the best solutions for this second assignment. In order to separate the activities of the competition from the regular teaching and learning activities in the course, the assignment tasks and grading were conducted in accordance with the usual arrangements. Students were given three weeks to complete the task, and reports were graded by the instructor within a week. Participation in the competition was entirely voluntary with the top ten groups with the highest grades invited to present their solution to a panel of expert judges.

A questionnaire survey was created to explore three aspects of this competition-based assignment: motivation, engagement and learning. Motivation is defined as the reason for wanting to do something whereas engagement is the actual commitment or effort put into the activities. Learning, on the other hand, is the knowledge or skills gained from the activity. Students were asked to compare their level of motivation, engagement and learning between the two assignments - the first without, and the second with an offer of prize money. Students' responses were recorded on a seven-point scale ranging from 1 point, strongly disagree, to 7 points, strongly agree. A free-text question sought qualitative feedback on the students' competition experience.

The schedule of activities relevant to the competition was as follows:

1. Assignment 1 (Week 5): A first assignment on steel portal frame construction was completed by the students. Students worked on this assignment in groups of two and was run conventionally without any competitive mechanism. The assignment was worth 15% of the total subject grade.
2. Lectures (Week 6): The instructor covered the concepts of precast concrete design and explained the construction process of using these precast elements in a multi-storey project in the lectures. These lectures were supplemented by photographs and videos of visits to previous sites where precast concrete was used.
3. Assignment 2 announcement (Week 7): The project and competition briefs were released to the students together with a set of drawings (site layout plan, building floor plans and elevations). The project brief was from a car showroom and warehouse project that the industry partner had been working on recently.
4. Site Visit (Week 8): A project site visit was organised by the industry partner to a building site where similar precast concrete components were being erected. Students spent more than an hour at the project site and were given detailed briefings by the design engineer and construction manager.
5. Submission of reports and Questionnaire Survey (Week 10): The survey was conducted in a session when students submitted their reports. The survey was administered in-person by the first author who is a teaching specialist at the same university but not involved with the teaching of this construction subject. The second author who was also the instructor in the course left the room when the surveys were carried out. Student reports were graded according to an assessment rubric. The ten best groups were invited to present their project

to a panel of expert judges. Participation was voluntary, and all ten groups agreed to present.

6. Questionnaire Survey (provided on submission of project):
7. Presentation to judges (week 12): Ten groups presented their proposal on a Friday afternoon. The judges scored each group during the presentations and results were announced at the end of the session. Cash prizes were handed out immediately to all the winners.

Given the small cohort and sample of students in the course, the data generated from the survey was processed manually in a Microsoft Excel worksheet. Students' responses were statistically analysed to determine if there was a statistical difference in their perceptions of motivation, engagement and learning between the competitive and non-competitive assignments. A significance level of 0.05 was adopted in this study.

RESULTS

From a total of 74 enrolled students, 37 survey questionnaires were returned indicating a response rate of exactly 50%. This survey response rate is very similar to the subject experience survey carried out online at the end-of-semester. Internal consistency is measured using Cronbach's alpha. The responses over the nine questions produced an alpha value of 0.9032, indicative of a strong reliability or self-consistency (Taber 2018). This high value of alpha may also suggest some redundancy in the survey questions. The t-test result of $P<0.05$ suggested that the responses for all nine survey questions were significant.

The survey results indicate that the students were broadly in favour of the competitive assignment with the means exceeding 4.0 in all the questions across the three dimensions of motivation, engagement and learning, as shown in Table 1. The highest agreement was in challenge and stimulation to learn more while motivation was only slightly above neutral. The competition also resulted in students being more engaged with more time spent on the assignment and more collaboration between team members. Twenty-four students indicated that the prize money was an extrinsic motivator for them compared to seven who disagreed. A further six students were indifferent.

In terms of engagement, students reported spending an additional 3 hours on the competitive assignment 2 (22.1 hours) compared to assignment 1 (19.1 hours). Nearly three-quarters of the students reported spending more time on this assignment while only five students reporting spending less. Twenty-four students agreed that the competition contributed to a greater engagement between team members to achieve this common goal compared to the non-competitive first assignment.

The most significant results were from the learning perspectives where more than 80% of the participants agreed that the competition stimulated them to learn more. More than half the students surveyed agreed that the competition has resulted in a better output for the assignment task and that their overall experience was better. There were about seven students who did not agree with these outcomes and another dozen or so who felt indifferent.

Students were given the opportunity to provide additional feedback on the competition experience via a free-text question and during a focus group meeting. Some examples

of comments from students who reported positive perceptions of competition were as follows:

> The whole competition with industry engagement was all win, win, win.
>
> Money was an incentive, but we were just trying to get it done.
>
> No negatives, except the extra step of the presentation.

Most students mentioned that the cash prizes did not make a difference to the number of hours put in or to the quality of the work as they were more concerned with their marks. Another student forgot that the assignment had a competition component. They said:

> The group experience was awesome with or without the competition, but it would have been better to get the industry person involved earlier.
>
> I forgot it was competitive Lmao
>
> The nature of this course doing both architecture and construction leaves me with little time to spare. Therefore, my marks come first before money

The negative perceptions were related to the difficulty of the project and lack of time to complete:

> My mental wellbeing is not okay - I have hardly slept.
>
> It wasn't the competition that made me spend more time or the money. It was that the assignment was so difficult."
>
> Luckily, I've got an extension for my assignment of another subject - otherwise, I might have been completely exhausted by now.
>
> I'm so sleepy now - I wish subjects in the same faculty can be due in different weeks rather than adjacent days. I have to stay overnight this week (though I shouldn't have started so late.)

Table 1: Mean and standard deviations of the student survey (Responses were recorded on a 7-point scale with 1-Strongly disagree and 7-Strongly agree)

Comparing Assignment 2 (competitive) vs Assignment 1 (non-competitive)	Perspectives	Mean	Standard Deviation	Signif.
More challenging	Learning	5.84	1.38	P<0.001
Stimulated me to learn more	Learning	5.81	1.17	P<0.001
Spent more time and effort	Engagement	5.49	1.76	P<0.001
More long-term gains	Learning	5.46	1.22	P<0.001
More collaboration	Engagement	4.84	1.66	P<0.01
Time well-spent	Learning	4.78	1.53	P<0.01
More motivation	Motivation	4.78	1.73	P<0.05
More positive experience	Learning	4.70	1.39	P<0.01
A better product	Learning	4.68	1.45	P<0.01

DISCUSSION

The results show that 65% of students were motivated to a greater extent and likely resulted in higher engagement during the assignment with the competition and offer of cash prizes. Students who reported higher motivation also reported greater engagement and consequently better learning outcomes. This is compatible with Tauer and Harackiewicz's (2004) finding that competitions made students become more involved in the activity and Chen and Chiu's (2016) observations regarding

higher engagement among team members. In fact, Tauer and Harackiewicz argued that combining cooperation (two students in a group) and competition in the form intergroup competition leads to the most positive outcomes.

It must also be emphasised that seven students did not agree and a further six reported neutral responses that the promise of cash rewards increased motivation. This corresponded closely to Bolocofsky's (1980) assertion that the inconsistency may be due to differences in student's cognitive style. Students who are intrinsically motivated will not require an additional reward structure to achieve higher marks. It was not possible to ascertain if there were detrimental effects brought about by the offer of extrinsic rewards as the survey was anonymous. Lepper and Greene (1978) have earlier suggested that the offer of extrinsic rewards for an intrinsically interesting activity may have detrimental effects under certain conditions.

Written feedback from the students indicated that many were working under significant work and time pressures. With most subjects having two formative assessments during a 12-week semester, these assignments will invariably fall around weeks 5 and 9 leading to heavy workloads during these periods. Many students accept this as part of the challenges of higher education, but a small number may be overwhelmed by these pressures and this was reflected in their free-text responses. The additional pressure of a competitive assignment structure will add undue stress to these students.

The industry partner who shared their project with the students, sponsored the cash prizes, organised a visit to their project site, delivered a guest lecture and contributed to the panel of expert judges were extremely pleased with the outcome. They observed that the students' proposals were all very similar to their final solution and that their estimated erection schedules were also within days of the actual work program. All the participants were able to answer probing questions from the judges. The construction manager later presented their solution to the assembled students with pictures and videos of the actual erection process. These activities were closely aligned to the best practices for effective industry engagement reported in Massey *et al. (*2006) and Male and King (2014). The value of such contextualised teaching especially in construction studies was held in high regard by Tennant *et al. (*2015). Pedagogical studies suggest that experience-led, contextualised teaching offers students enhanced education value. The level of industry engagement in this study was far in excess of the carefully orchestrated construction site visits including onsite briefings, project documentation and hand-outs that Tennant *et al.,* were referring to.

It became apparent after the competition that industry engagement and competition could appear as confounding factors in this study. Massey *et al. (*2006) observed that direct industry involvement not only allows the showcasing of skills and knowledge by the students but facilitates recruiting and employment opportunities for graduates. Dutson *et al. (*1997) also alluded to the fact that students feel more responsible and accountable to an industry client which may be an important factor in their motivation and learning.

CONCLUSION

The issue of integrating a competition into a problem-based learning assignment with significant industry involvement was addressed in this study. A simple competition mechanism was added onto a regular course assessment task for third-year students enrolled in an under-graduate course in construction. The study was designed to

compare students' perception of motivation, engagement and learning between competitive and non-competitive assignments.

As the principal findings in this study indicated, competition could be a useful motivating strategy that can be introduced to collaborative problem-based learning tasks. While confirming previous research that competitions and rewards can improved motivation, engagement and learning, it has also flagged that some students who are intrinsically motivated may choose to ignore these offers or reward or in a more radical response, react with disdain over the extra pressure to perform.

The small number of negative responses indicate that no single method can be recommended for the diverse personality traits of the students in a cohort. Innovative methods of teaching and learning have to be studied and trialled in various environments and under different conditions to expose potential shortcomings.

This study also demonstrates the difficulties in the integration of a competition and cash prizes into an existing course structure and the obligation to maintain educational integrity and equity in the teaching and learning. Not only was participation in this study voluntary, students had to be assured that their grades will not be in any way affected by their performance during the competition.

While this study has resulted in findings that have both theoretical and practical implications, some limitations should be clarified. Firstly, the competition and prize money were sponsored by a leading local manufacturer and supplier of precast concrete components. With such strong industry involvement acting as client and facilitating visits to their project sites, it is possible that the motivational factors may be influenced by industry engagement and the nature of problem-based learning. Therefore, the finding that cash prizes serve as motivation and engagement may not be as applicable to other cases where the independent variable was only competition. Second, since this study was carried out on a group of final year construction students who were keen to demonstrate their work readiness and employability to a panel of judges from industry, caution should be exercised in generalising these results to a broader range of students. It would be of interest in future studies to investigate the effects of competition and monetary reward by considering the students' different interpersonal orientation towards competitions, their individual learning preferences and motivations.

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