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ascilite 2012
FUTURE CHALLENGES | SUSTAINABLE FUTURES
25 - 28 November 2012 | Wellington | New Zealand

Using reward contingencies in online activities to facilitate engagement in a statistics class

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This paper presents the use of an online learning management system to establish a system of reward contingencies to facilitate student engagement in a statistics class. Based on a behaviourist framework, the proposed system uses immediate rewards for weekly studying. It also incorporates punishment to discourage breaking patterns of consistent weekly study. Student evaluations at the end of the semester showed students' acknowledgement that the system led them to study more frequently and consistently than they otherwise would have, and that the feedback made the study more effective. However, some students reported feeling that the punishment system was unfair. An alternative system is suggested in response to this criticism.

Keywords: Statistics teaching, Rewards, Elaborated feedback, Self-control.

Introduction

The current Australian Higher Education landscape, with the increasing number of incoming students resulting in large lecture sizes, poses a number of problems for the implementation of effective student engagement strategies into the future. Student engagement, defined as "the time, energy and resources that students devote to activities designed to enhance learning at university" (Krause, 2005, p. 3), has been shown to be correlated with positive outcomes, not only academically, but also in terms of student satisfaction (Kuh, 2007). It is well understood that a student's baseline level of academic preparation upon entering university is also positively correlated with engagement and success. However, it is important to note that this baseline academic preparation does not only consist of the knowledge of basic subjects, but that it also includes the "study habits and behavioral patterns" (Kuh, 2007, p. 4) that will be associated with success at university.

Krause (2005) reports that in 2004, first year university students in an Australian sample reported devoting a mere 11 hours per week to study outside the classroom. Given the same students reported having an average of 16 contact hours per week, the reported amount of study time is in stark contrast to the idea that students should spend around two hours of study for every hour of class time (Krause, 2005). The reduced amount of time devoted to study may in part be due to a lack of training or understanding of the kinds of activities that constitute study for a particular subject. While it is common practice to give students lists of required readings and other exercises, the relatively small number of hours devoted to independent study is an indication that students are not engaging with the material in the expected manner.

Having students who do not devote the expected amount of consistent weekly effort (as measured by study time) to their university units is particularly problematic in the case of units for which the initial level of motivation is low. This is the case of units such a statistics for behavioural sciences (e.g., Bude et al., 2007; Wiberg, 2009), where motivation has been found to be an important predictor of achievement (e.g., Tremblay, Gardner, & Heipel, 2000). It is important to note that the effect of motivation on achievement in statistics courses for non-statisticians has been found to be mediated by behavioural factors such as persistence and emotional factors such as finding statistics enjoyable or interesting (Bude, et al., 2007). Thus, motivational operations that may increase the likelihood of students engaging in study behaviours may lead to increase engagement and, in turn, achievement. The research on the ways in which statistics can be rendered more interesting and enjoyable has been extensive (for a review, see Zieffler, et al., 2008). However, there do not seem to be as many documented efforts towards establishing persistent study patterns that may facilitate students' engagement with the subject matter. It is possible that the assumption that students will be or should be motivated enough, at an intrinsic level, to engage in independent study is incorrect. From a behaviourist perspective, it is possible to train students to engage in regular and consistent study practices by establishing reward contingencies that support precisely those behaviours (Mazur, 2009).

In a behavioural framework, every behavior is believed to be the result of a choice. That is, every time we are about to do something, we can be said to be facing a choice, at the very least, between performing that behaviour and not performing it. Each of these courses of action is associated with particular consequences, and each of those consequences can be characterized in terms of features that make them more or less preferred, such as the consequence's magnitude, its probability, immediacy, etc. The combination of these features

determines the subjective value of the rewards and, in doing so, affects our preferences and, in turn, our choices. The basic assumption of these models of choice is that the decision maker will always maximize value (e.g. Rachlin, 1995). That is, the agent, at every point, actively chooses the most preferred course of action given the circumstances. Behaviours that lead to more preferred consequences (or rewards), will be chosen more often than behaviours that lead to less preferred consequences (or rewards).

This characterisation of the environment has been useful in the study of self-control dilemmas. In this framework, a self-control dilemma can be characterised by the choice between a smaller immediate reward and a large delayed reward. This choice is said to pose a dilemma when the preference for an immediate small reward is at odds with the long term pattern of behaviour required to obtain the delayed larger reward (Rachlin, 2000). For example, in the context of studying in a first year statistics for behavioural sciences unit, students can be considered to be facing repeated choices between studying and not studying. For students who do not typically engage in studying, one can assume that studying is less preferred to not studying (which is why they do not engage in frequent studying on the first place). However, the mere fact that they have enrolled in the unit means that, at the very least, the student must prefer passing the unit to failing it. These two sets of preferences are at odds with each other (hence, the dilemma). If at every point when the choice is available, the student follows their preference for not studying, they are unlikely to attain the long term reward of success in the unit. Like the dieter who must avoid the chocolate which is preferred right now in order to be thin in the long run, the student must avoid the pleasantries of doing things other than study if they want to be successful in the unit in the long run. If this is a correct characterisation of students' choices, the introduction of immediate rewards for smaller routine study-related tasks should facilitate students' engagement in those behaviours (making them more immediately attractive than before). Current online learning management systems (OLMS) provide a unique opportunity to introduce some such measures. This is because they facilitate the delivery of working exercises on a frequent basis even in classes involving large cohorts of students. Further, OLMS also facilitate the provision of fairly detailed feedback for performance, which has also been shown to be correlated with engagement (Kuh, 2007) and which is likely to increase preference.

In the present paper, I present an initial attempt at establishing a set of contingencies aimed to increase the likelihood and consistency with which students in a statistics unit engaged in study behaviors (keeping up with readings and lecture notes). This was achieved via the delivery of weekly online exercises (OEs) consisting of multiple choice questions on the topics covered each week in class. In particular, the OEs were designed so that students received immediate, detailed feedback on their responses. Further, the program included contingencies that reinforced regular weekly work. The program presented here was developed in an attempt to (a) increase the frequency of study behavior and (b) provide students with detailed feedback on their learning.

A program of incentives for studying

The first year statistics unit for students enrolled in psychology degrees at the Australian Catholic University is an introductory statistics unit covering basic concepts of measurement, data display, and descriptive as well as some inferential statistics (e.g. t-tests and correlation). The unit in its present form was first taught in Semester 2, 2011 and had an enrolment of 232 students. It consists of two hours of lecture time per week plus one hour of tutorial time. Attendance at lectures is required for all students, but is not monitored. The tutorial sessions take place in groups of 25 to 27 students and involve activities in which student participation is required. Students in this unit had a final exam at the end of the semester. In addition, they submitted a written assignment.

To encourage students to study consistently during the semester, ten weekly OEs, consisting of 20 multiple choice questions, were introduced in week 3. The questions required students to understand statistical concepts and the relationships between them (e.g. the inverse relationship between standard error and sample size), and to apply them to simple problems. Immediately after the student submitted their answer to a question, they were told whether their answer was correct or incorrect and provided with detailed feedback on the reasons why that was the case. This form of feedback (i.e., elaborated feedback, see Dempsey, Driscoll, & Swindell, 1993), has been shown to facilitate deeper conceptual understanding (Bangert-Drowns, Kulick, Kulick, & Morgan, 1991).

Online exercises opened every week at the same time and closed exactly seven days later. Students were allowed to complete the OE any time during that seven day period from any computer with access to the university's OLMS. Students were encouraged to make use of the book and the lecture notes while completing these exercises, as it was emphasized that the purpose of the exercises was to encourage study. Each OE was worth up to two points towards the final mark in the unit. Strict rules were in place for the establishment of a regular and consistent study pattern. First, students had to complete the exercise during the week that it was available. If they did not complete it during that seven-day period, they could no longer have access to it (other

than for study purposes at the end of the semester). Second, in order to ensure that students kept up with the material, a system of rewards was introduced such that in order for students to have access to a weekly exercise they had to have completed the previous one in time (i.e. if a student missed one exercise, they did not have access to any of the subsequent weekly exercises). Third, to avoid chance performance, students had to answer at least six questions correctly to get any points. Students were told the rules of the OE system at the beginning of the semester. These rules were explained in detail during the first two lectures and the first two tutorial sessions, before exercises were introduced. In addition to this, on Tuesday, Thursday and Saturday of every week, students who had not yet completed that week's exercise were sent an email reminder that the exercise would close on Sunday.

Outcomes

The average student performance across the ten weekly OEs was M=60.86 (SD=10.35). Further, and not surprisingly, average performance in the OEs was significantly correlated with the final exam mark, r=.35, n=205, p<.001. Figure 1 shows information relative to the percentages of students missing completion of the exercises every week. Note that every week a very small proportion of students missed the exercise relative to the number of students who could have completed it (open circles). This, of course, results in an increase in the cumulative number of students who had missed an exercise (closed circles). When looking at the open circles, note that the first point is fairly high (almost 10%) but the line flattens and remains low at around 4% until exercise number nine, at which point it increases (to 8.9%). Further, the highest point in that line is the point for the last exercise, for which 16.9% of students who were eligible to complete it, missed it. This result supports the usefulness of the contingencies that were introduced regarding the sequencing of exercises, as at that point the consequences of missing an exercise are not as severe as at the beginning.

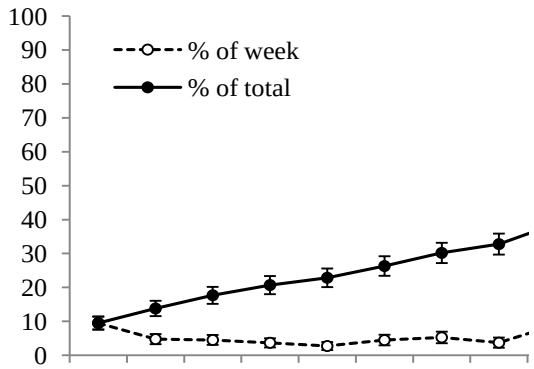

Figure 1: Percentage of students who missed an online for every week it was available (± one SE). Open circles represent the percentage of students who missed the exercise each week; closed circles represent the cumulative percentage of students having missed exercises each week.

During the unit evaluations (which consist of a series of standard Likert scale items), students were encouraged to provide additional written feedback regarding the OEs. Of the 50 students who made any references to the OEs, 31 had positive comments and 19, negative comments. All negative comments referred to the fact that the contingency was believed to be unfair. Positive comments included three main types of content, namely (a) those that stated finding the exercises useful because they "forced" them to study, (b) those that pointed out that the feedback had been useful and (c) those that made explicit reference to both criteria.

Conclusions

The present paper presents an initial attempt to establish a system of reward contingencies that encourages students to partake in regular, consistent study practices. It is important to note that the purpose of this program was not to assess performance per se, but to provide students with the opportunity to (a) track their own progress, (b) motivate study and engagement with the relevant material on a weekly basis, and (c) provide opportunities for the students to understand how to focus their study. Given that this unit, in its present form, was running for the first time when this intervention took place, there are no baseline data to compare it to. However, the students' reflections show that students are aware of the fact that the contingencies, "forced them" to engage in weekly study. Specifically, they note that these activities led them not only to read the book and their notes, but to do this in the context of the completion of a specific task. Second, in noting that the exercises "forced them" to study, students are also acknowledging that this is not the behaviour they would have

necessarily chosen to engage in had these contingencies not been in place. Finally, students' comments also show that the provision of detailed feedback, allowed students to better direct their learning and, in their own words, understand what was wrong about an incorrect answer.

On the other hand, the implemented program also led to complaints and displeasure regarding the punishment associated with the missing of an exercise. Students who, after having missed one exercise, missed all the subsequent ones, believed this to be an unfair system. In response to this criticism, the strict reward contingencies will be removed next time the unit is taught. It will be interesting to examine the effect of this change on study behaviour and exercise completion rates, as well as on the final performance of students in the unit. Alternative systems of reward contingencies for the purpose of encouraging engagement in the unit are also possible. In particular, it is possible to develop a system in which students get rewards for every completed exercise but also get a bonus cumulative reward for the number of weekly exercises successfully completed in sequence (i.e., without omissions). This alternative system would not only provide an immediate reward for the performance of each individual weekly exercise, but it would also provide rewards for the consistent long-term pattern of study behaviour (rather than providing punishment for breaking the pattern).

The adoption of a behaviourist framework could provide part of the answer for the issue of student engagement, understood as "the time, energy and resources that students devote to activities designed to enhance learning at university" (Krause, 2005, p. 3). The present paper does not attempt to claim that this type of interventions would have an effect on intrinsic motivation, as this was not the focus of the intervention. Rather, the claim is that if the interventions increase engagement in effective study practices, they will have effects in learning outcomes. The OLMS currently used by all universities in Australia and abroad provide a unique opportunity to implement this kind of contingency programs in the future. This is because they facilitate the management and delivery of such programs in classes with a large number of enrolled students. In doing so, they may provide with an opportunity to facilitate student engagement. Whether these would in turn lead to changes in attitudes towards statistics and feelings of self-efficacy over the long-term or not, remains an empirical question.

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Please cite as: de la Piedad Garcia, X. (2012). Using reward contingencies in online activities to facilitate engagement in a statistics class. In M. Brown, M. Hartnett & T. Stewart (Eds.), Future challenges, sustainable futures. In Proceedings ascilite Wellington 2012. (pp.267-271).