Personalized Persuasion for Promoting Students' Engagement and Learning

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Abstract. This paper draws from persuasive system design (PSD) and best practices to design a persuasive system for evaluating the effectiveness of personalizing three social influences strategies (social comparison, social learning, and competition) in motivating students to engage in online learning activities and hence promote deeper learning. The system takes into consideration students' privacy while providing them with personalized persuasive visualizations of their class assessments and offers students opportunities to either compare their performance with other students' performance in the course, observe other students' grades, or compete with other students as a way of motivating them to increase their engagement and improve overall performance.

Keywords: Persuasive Technology, Persuasive System Design, Persuasion Profile, Personalization, Learning, Students' Engagement, Social Influence Strategies, Social Comparison, Social Learning, Competition.

1   Introduction

Persuasive Technology (PT) is a term used to describe technologies that are designed for the primary purpose of changing users' behaviour, attitude, and thoughts about an issue, without using coercion or deception [6]. PTs achieve their behaviour change objectives using various persuasive strategies. Persuasive strategies are techniques that are used in PT design to motivate behaviour change. Various research has shown the effectiveness of PT intervention at motivating people to achieve a specific goal in domains such as health [20], physical activities [21], and even in education [4].

In educational domains, teachers tend to apply the principles of persuasion in classrooms to encourage learning. However, technological innovations such as persuasive technology have moved the act of persuasion to the digital domain such that focus is now moving from human-human persuasion to computer-human persuasion. Human-human persuasion involves a human expert persuader trying to persuade a target audience or another person (persuadee) while in computer-human persuasion, computer software is used to motivate a target audience to achieve a specific goal. For instance, Epstein and Cullinan [3] used human-human social comparison in educating and persuading students with a behaviour disorder. On the other hand, computer software has been used for children to encourage them to improve their reading and writing skills

[13]. Most attention has been given to investigating and developing fundamental theories and strategies for persuasion in the classroom. Persuasive technology can, however, be applied outside the classroom to assist and motivate learners without necessarily involving their teachers but using the power of technology and other learners (social influence). Social influence is described as attitudinal or behavioural changes as a result of influence by other people which may be intentional or unintentional [7]. Research has shown that social influence can be an effective strategy for motivating behaviour in the health domain [18].

PTs driven by social influence-oriented strategies such as social comparison, competition, and social learning have been shown to be effective at increasing people's capability to accomplish target behaviour [20]. Considering the increasing applications of social influence principles to affect individual behaviour in various domains, recent research efforts have focused on developing systematic approaches for operationalizing the social influence principles in various application domains. In the field of persuasive technologies, Oinas-kukkonen [16] developed socially-oriented strategies—competition, social comparison, and social learning.

Social Comparison strategy offers users the opportunity to view and compare behaviour performance data with that of other users. The social comparison strategy is more effective if people in the comparison are similar to each other. According to social comparison theory [16], people evaluate themselves by comparing themselves to similar others. This comparison could be upward or downward social comparison. Upward social comparison is normally used for self-improvement as people compare themselves to similar others who are performing well in the specified task. But downward social comparison is used by people to raise self-worth as they compare themselves to other people they performed better than [16]. Research on social comparison in education has shown that students are more often positively motivated by upward comparison as opposed to downward comparison.

Competition strategy provides opportunities for users to compete with one another while performing the behaviour as a way of motivating some desired behaviour. According to Oinas-Kukkonen et al, human's intrinsic motivation to outperform one another drive them to perform specific behaviours [16]. Therefore, competition encourages users to change behaviour and attitude by tapping into the human natural drive to compete. Implementing competition in persuasive technology often involves people competing with either the persuasive system or against another human using some mechanism provided by the system. In persuasive applications, leaderboards, which allow users to view their scores and the score of other users to motivate them and increase their performance of the target behaviour, are the most commonly used implementation of the competition strategy.

Social Learning strategy derived from Bandura's Social Learning theory involves people learning by observing what others have done or are doing [14]. The theory defines learning as a cognitive process and states that people learn through observation of oth-

ers that are performing the target behaviours. The major distinction from the other strategies is that there is no obvious comparison or competition involved in social learning. The learner does not have to be involved in the behaviour to learn, they could learn as a passive onlooker. Learning could occur through observation, imitation, and modelling of behaviours. In persuasive technology, social learning implementations often involve enlightening users about what similar other successful people in a target behaviour have done. According to Oduor et al., the social learning software design feature allows users to visualize others working on a similar goal and provide users means to view the progress of their peers [15].

Generally, [10, 17] has shown that personalizing PTs to users is more effective in achieving behaviour or attitude change than "one-size-fits-all" approach. There is growing evidence that personalized PTs are more effective than one-size-fits-all. Personalization means delivering PTs designed with the strategies to which the individual is most susceptible.

There is still a gap in research on how social influence can be applied to promote desired behaviours in education and whether it will be effective. As a first step towards closing this gap, this research focuses on how to design and implement personalized persuasive visualization using the three commonly used social influence strategies (social comparison, competition, and social learning) to motivate students' attitudinal or behavioural change to improve learning engagement.

2   Persuasive Design Strategies

In recent times, various persuasive strategies have been developed to persuade people to achieve a target behaviour. Among these strategies are seven persuasive tools by Fogg [5], and twenty-eight persuasive system design principles by Oinas-Kukkonen [16]. According to Fogg, the development of effective persuasive technologies involves eight step processes: 1) Target a simple behaviour, 2) Know the target audience, 3) Discover obstacle to target behaviour, 4) Use technology channel familiar to users, 5) Identify appropriate persuasive technology examples, 6) Emulate effective examples, 7) Assess and repeat fast, 8) Expand on success. Following Fogg's guideline, we targeted a simple behaviour, which is increasing students' engagement in their online learning activities; our target audience is students taking a first-year Biology course at the University of Saskatchewan. Students are distracted by many things (e.g., social activities, playing games, etc.), which makes it difficult for them to engage fully in learning activities. They often have a wrong impression of what others are doing and don't know how to compare themselves with their classmates. In order to identify appropriate technology examples, we reviewed related literature and found that research [11, 17, 19] has recognised social influence strategies as very efficient for motivating behaviour and attitude change. We started our persuasive intervention design with one course and one class and intend to expand on success by including more courses.

Furthermore, Oinas-Kukkonen et al. suggested four persuasive system principles categories: primary task, dialogue, system credibility, and social support [16]. Social

support leverages social influence strategies to motivate users. It includes social learning, social comparison, normative influence, social facilitation, cooperation, competition, and recognition. Based on Fogg's work [5], Oinas-Kukkonen et al. defined the key issues, the process model, and the design principles to be used for the development and evaluation of persuasive systems. In designing persuasive software systems researchers select persuasive strategies based on the effectiveness and suitability of the strategies in solving a particular problem [16]. Based on the problem we are trying to solve; our system design takes into consideration three strategies from the social support category and personalisation from the primary task category of Oinas-Kukkonen. Table 1 shows the description of the strategies we employed in this work and their implementations, adapted from Oinas-Kukkonen et al. [16].

Table 1. Persuasive System Design Principles implemented, adapted from [16].

Social Support		
Strategy	**Example Requirement**	**Our Implementation**
Social comparison: System users will have a greater motivation to perform the target behaviour if they can compare their performance with the performance of others	System should provide means for users to compare their performance with the performance of other users	Our system provides the students with a means to compare their performance in a course with the performance of other students who did well in the same course (upward comparison). Grades are the bases for comparison.
Competition: A system can motivate users to adopt a target attitude or behaviour by leveraging human beings' natural drive to compete.	The system should provide means for competing with other users.	Our system uses a leaderboard to provide students with a means to compete with each other with respect to their grades to motivate them to engage more in their online learning.
Social learning: A person will be more motivated to perform a target behaviour if he or she can use a system to observe others performing the behaviour.	The system should provide means to observe other users who are performing the target behaviours and to see the outcomes of their behaviour.	Our system provides the outcome of the behaviour, showing the aggregate grade ranges for each assessment and the number of students that have each grade range.
Primary Task Support		
Personalization: A system that offers personalized content or services has a greater capability to persuade	The system should offer personalized content and services to its users.	Our system personalizes the social influence strategies to each user, using the strategy that they are most susceptible to (persuasive profile).

3 The Study

The goal of our study is to examine the effects of personalized persuasion via social influence on students' learning behaviour. In particular, we are interested in determining whether we can entice students to spend more time in an online learning environment when influenced by persuasive technologies. The setting for our study is a large freshman Biology course where students already receive personalized messages each week coaching them to access useful learning resources and services. Weekly messages are constructed from templates with constraints and triggers engineered by a course content expert and the messages are delivered via the learning management system.

Our study builds on this personalized support by inserting visualizations designed to stimulate different social influence strategies into the advice templates. Near the beginning of the semester, students were surveyed using a questionnaire based on Busch et al.'s persuadability inventory (PI) [1] to identify their persuasion strategy preferences and to construct a simple persuasion profile for each student. The PI scales consist of 6 items for measuring the *social comparison*; 5 items for assessing the *competition* strategy, and 5 items for assessing the *social learning*. We designed a questionnaire with the PI. The questions were slightly adapted to reflect the target domain, education. All questions were assessed using participants' agreement to a 9-Likert scale ranging from "1 = Strongly Disagree" to "9 = Strongly Agree".

According to Busch et al. [1], *"participants having higher scores in one or more of the scales are expected to be more susceptible to these specific persuasive strategies (p.36)."* This approach was adopted to help us in determining among the three social influence strategies the one that each participant find most appealing. Knowing the social influence strategy that each participant is most susceptible will enable us to personalize the persuasive intervention to each participant using their most preferred strategy.

241 of the 690 students in the class completed the survey. Based on the results, the students were grouped into the social comparison group, social learning group and competition group using their persuasion preferences. For *competition*, we combined the students' preference for *competition strategy* with their predicted grades in the course in order to avoid the undesirable effect of competition when students are not performing sufficiently well, as illustrated in [18]. It has been demonstrated [2] that grouping people with equal strength and ability in competition makes competition more enjoyable and desirable. As a result, we employ a gamification construct called game balancing in addition to the persuadability of students in the *competition grouping*. Kappan and Orji [9] have shown that gamified elements and persuasive strategies can influence people to achieve a desired goal. To make sure we balance the ability of students grouped under competition we check that they have high susceptibility to competition strategy and have top grades (75% and above in their biology predicted grades). Also, half of the students with low persuadability preference in all three constructs but with high predicted grades (80% and above) were assigned to competition. The remaining students with low susceptibility to all three constructs were randomly assigned to social comparison and social learning. This acts as part of the control. The groups under the

social comparison and *social learning* conditions comprised the participants with high susceptibility to the corresponding strategy (tailored conditions). Half of the students who are most susceptible to social comparison were assigned to social learning and vice versa, to determine the effect of personalizing the persuasive intervention to students' susceptibility (cross-over condition).
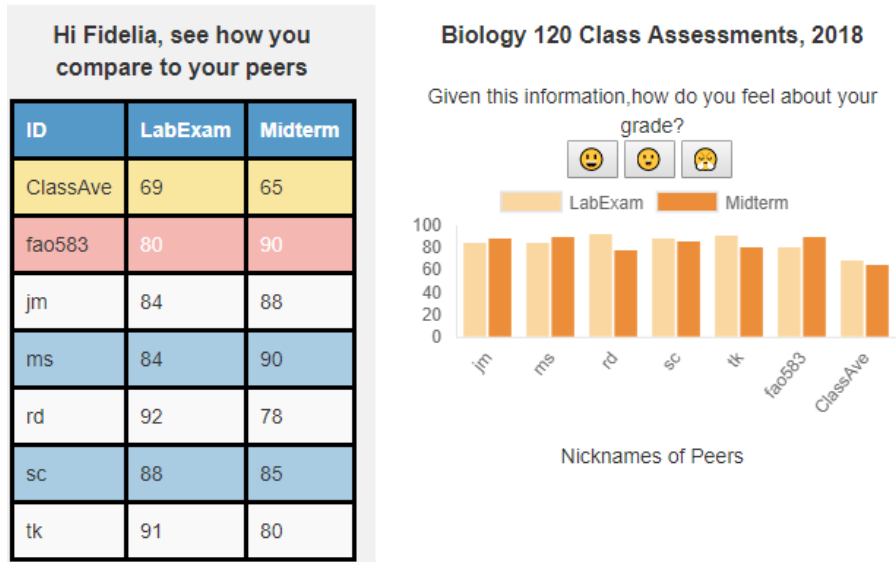
Moreover, we grouped the students who did not complete the persuasive survey as follows: we randomly assigned some students with high predicted grades (80% and above) to competition and divided the remaining students into three equal sized groups and assign one third to social comparison, one third to social learning and one third to a no interface group. Apparently, these students will be assigned to groups with persuasive strategy that is not tailored to their preference. This will help us to determine the most effective strategy on average.

We have developed a web application that operationalizes three social influence strategies; social comparison, social learning, and competition. This web application offers persuasive visualisation tailored to the three distinct groups of students.

It is important to consider the issue of security and students' privacy as we use individual (but pseudonymized) students' information to develop the application for social comparison and competition. Social learning also uses students' information but in an aggregated form. Students log in to the learning management system with their students' identification number (Id). To solve the privacy problem, we use an anonymized student Id to display students' grades and points except for the target student. For the target student, we use the student's actual Id and name to further personalize the visualization.

3.1   Social Comparison Persuasive Visualization Version

The social comparison visualization was designed to be personalized to individuals' susceptible to social comparison. It uses a table and grouped barchart in displaying the information so that all the students involved can fully understand it. The visualization displays the target student (real name, real id, grades in different assessments in the biology course), the class average for each assessment, and grades of five random students with anonymized Id who have higher grades than the target student. The five-random display of other students' grades gives different combination of display patterns for students based on their grades. We limited the number of other students we display to five to make it easy for the target student to visualize and compare. The visualization changes with subsequent assessments and gives the target student an opportunity to compare (upward comparison) their grades in all the assessments to that of their peers in the course and to the class average for each assessment. Also, the visualization provides an opportunity for the target student to send feedback about their feeling using three buttons, satisfied, surprised, and frustrated as shown in Fig. 1.

| Hi Fidelia, see how you compare to your peers		
ID	**LabExam**	**Midterm**
ClassAve	69	65
fao583	80	90
jm	84	88
ms	84	90
rd	92	78
sc	88	85
tk	91	80

Fig. 1. A display showing the target student grades and grades of five random students with anonymized id who have higher grades than the target student (upward Social Comparison).

3.2   Social Learning Persuasive Visualization Version

Social learning allows students to observe others' performance, which they will passively learn from [12]. For the social learning, the visualization shows the real name of the target student. All the students doing the course are grouped based on their grade ranges. We aggregate the grades for each assessment and group them into six different grade ranges: 100-90, 80-89.9, 70-79.9, 60-69.9, 50-59.9, and less than 50 (Fig. 2). We show the number of students belonging to each grade range for each of the assessments. This allows the students to use the information as a benchmark to model their own behaviour and progress and hopefully motivate them to work harder to improve their learning outcome.
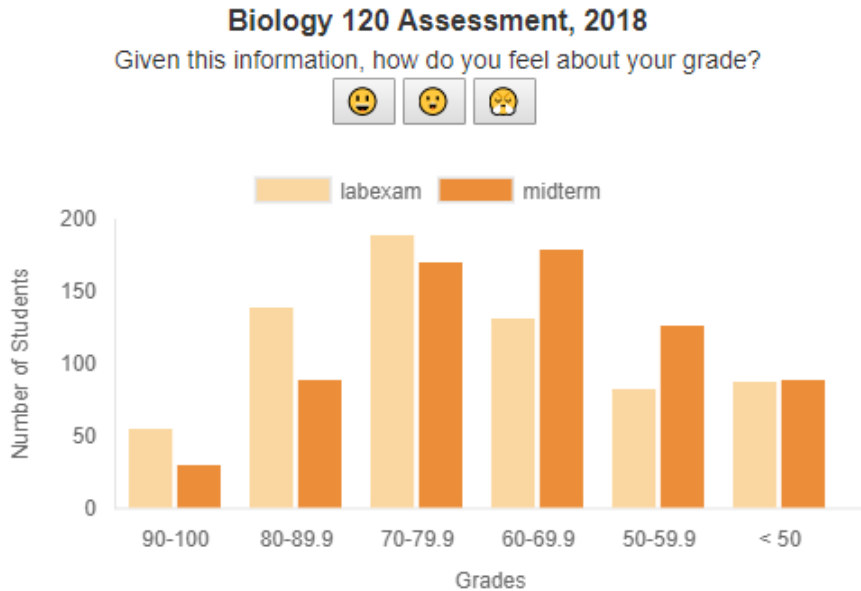
Fig. 2. A display showing grade ranges for a course and the number of students that has each range (Social Learning).

3.3   Competition Persuasive Visualization Version

For the competition visualization, research has shown that some people tend to perform better when they are encouraged to compete [8]. To create the competitive environment, we use a leaderboard to display and rank students based on their performance. Students' point totals are calculated using a weighted score for different assessments. The visualization displays eleven students on the leader board, which includes the top ten students and the target student. The leaderboard also shows the target student's position in the competition relative to other students in the leaderboard. The target student attention is drawn to his/her position in the leaderboard by using the student's real identity, Fig. 3. Again, for security and privacy reasons, other students' identities are disguised. The leaderboard is programmed to automatically update itself using students' subsequent assessments grades, which are dynamically retrieved from the learning management system.

Fig. 3. A display of students' ranks based on their performance (Competition).

4   Study Status

At the time of writing this paper, the study is just getting underway. Our persuasive intervention will be implemented starting in the middle of the semester. Students' learning engagement prior to the intervention will be measured by the amount of time they spend in their online learning. We will try to measure any changes in their online activity that may stem from the persuasive interfaces. Because of the way students are assigned to persuasive interfaces, we hope to be able to test the following hypotheses:

H1. Personalizing the social influence strategies employed in persuasive technology design will increase their effectiveness at motivating students to engage more in learning activities.

H2. Other factors being equal, social comparison will motivate students to engage more in learning than social learning or competition.

From this study we hope to learn more about how persuasive visualizations can be and should be personalized in learning environments. As we proceed with data collection and analysis, we hope preliminary results will be available to share at the workshop.

5   Conclusion

Application of persuasive technologies is increasing in importance as they help people improve and sustain positive attitude in diverse contexts such as health, physical activity, and education. The study presented in this paper provides researchers and PT designers insights on how the designing and personalization of persuasive system using three social influence strategies can be achieved in persuasive software to facilitate attitude and behaviour change. Our persuasive visualizations preserved students' privacy while personalizing the system. We personalize our system to match each students' susceptibility to the three social influence strategies; social comparison, social learning, and competition. More importantly, we show how the persuasive system can be personalized to each participant by personalizing the strategies used. In the near future, we will evaluate the effectiveness of these visualization (personalized and non-personalized) with respect to their ability to engage students and promote learning.

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