Supporting student motivation through Social Comparison

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Abstract

Learning Analytics provides a methodology for the collection and analysis of learning data. Pedagogical research has always been inspired by ideas from applied psychology to discover and evaluate methods to boost motivation and engagement of students. Past research has shown that people often compare themselves with their peers in various contexts, including education. Social comparison has proven to be an effective motivation factor. Most of the recent research is based on using leaderboards to motivate individual comparison or open social student models to enable comparison with the course average. However, students' preferences towards social comparison can vary. For example, some people tend to compare upwards, while others mostly compare downwards, and some do not rely on social comparison at all.

This research aims to study how Social Comparison can be used to motivate students. In particular, it focuses on its effects on students' behavior, engagement, and performance on students from different demographics, with different psychological and motivation profiles. We will explore more adaptive approaches towards social comparison which adjust the direction and the magnitude of social comparison to suit students' needs and preferences.

Keywords

Learning Analytics, Motivation, Self-Regulated Learning, Social Comparison

1. Introduction

Social Comparison (SC) is the ability and tendency to gain self-evaluations by comparing oneself with their peers. It is an innate human trait and has been observed in kids as young as two years. We evaluate our opinions, skills, abilities, and achievements by comparing ourselves to others to define the self. Due to this, Social Comparison is a strong motivator and has always been leveraged in avenues ranging from commercial advertising to political discourse. Technology Enhanced Learning (TEL) environments provide feedback and supportive interfaces to help the students understand their progress towards the learning goals. Knowingly, or unknowingly, educational tools introduce social comparison as a tool through gamification elements such as leaderboards and halls-of-fame. In my research, I aim to design and evaluate mechanisms for adaptive Social Comparison.

1.1. Social Comparison

Festinger [1] proposed the theory of Social Comparison in 1954 which stands on the premise that humans have an innate desire to evaluate their abilities and opinions. A person's understanding about the situation and their abilities together have a bearing on their behavior. However, this requires accessing abilities even when objective information is not available, and then, they do so by comparing themselves with each other. It is found [2] that people may compare downwards to increase their subjective well-being which may enhance their self-esteem.

The concept of SC has been observed [3, 4] in children as young as preschoolers. Veroff [4] proposed that the concept of achievement begins in elementary school students, while the social comparison orientation increases as they grow older, the autonomous achievement orientation drops. As they grow up, they emphasize on demonstrating superior performance in comparison to others. In a usual classroom, the reward system provokes students to compare themselves socially. Similar effects were observed by Seidner et. al. [5] who noticed that the sense of pride of older students is affected more by comparing their performances with their peer rather than mastery.

The INCOM Scale [6] was developed for measuring individual differences in Social Comparison Orientation. It was found that two factors were responsible for explaining 38% and 10% of the variance. These two fectors reflect the perception of abilities and orientation based on Social comparison. They explained that such SC information may help ascertain the SC behavior of individuals and provide them interventions accordingly. It is also studied that the demographics like age, sex, race, or socio-economic status can be a factor of who students compare themselves with [7, 8, 9]. Studies [8] also show that students generally prefer compare themselves with friends and aquitances. Besides the target of comparison, the direction of comparison is also different [10]. Students may compare at the same level (laterally) [11], or upwards [12, 13, 7] or downwards [6, 14]. Thus it can be summarized that the target and preference of social com-

parison may change depending on target, time, mood, motivation etc.

1.2. Leveraging Social Comparison to Improve Learning

Though SC is a psychological trait, SC can be further leveraged or manipulated by a researcher, a teacher, or a learning aid including learning support systems. SC can also serve as a feedback mechanism for self regulated learning [15]. Activity and progress visualizations [16, 17], and student model based tools [18, 19, 20] for conveying SC information as a feedback to the students have been created. However due to difference of how we perceive SC information, there is a need of the theories and implementations that provide adaptive SC based on temporal, demographic and situational differences. This paper proposes my ideas and plans to deeply understand the mechanisms to use Social Comparison in Technology Enhanced Learning (TEL) and study the need of adaptive SC that is capable of motivating and engaging a student based on their behavior and motivation profile.

Rest of this paper is organized as follows. Section 2 discusses how TEL systems leverage Social Comparisons, their different forms and the ideas which have been proposed in the past two decades. Section 3 explains the research plan by highlighting the research problem, research questions, explaining the concrete tasks that are planned for the next stage, and details of the TEL system that will be behind this research. Section 4 gives a brief outline of the experiments which are planned in the next few years. The Section 5 concludes this paper with discussion about the expected outcomes of this research, and the role of those outcomes in designing TEL systems that use SC effectively.

2. Social Comparison in TEL

SC has been an active area for research in the past decades. The idea of SC was first studied in depth by Festinger [1], who wrote that "There exists, in the human organism, a drive to evaluate his opinions and abilities." He mentioned that people have a constant need to evaluate their abilities and test the validity of their opinions. Social Comparison [21] "consists of comparing oneself with others in order to evaluate or to enhance some aspects of the self." The effect of social comparison has been widely studied in education and pedagogical research.

This relates with the idea of Self Regulated Learning (SRL) [22], which is described as a cyclical process with three stages, namely, Forethought, Performance, and Self-reflection. Social comparison is active and affects students' decisions and actions at all the three stages [23],

and thus, TEL systems should provide support to the students during all the three stages.

Social comparison as a tool in Technology Enhanced Learning has been implemented in form of comparative charts or leaderboards [24, 25, 26] for a long time. They have been found effective in improving engagement and participation. However systems focussed on improving the SC feedback and studying the effects of SC are relatively recent topics.

One of the popular works in using comparative visualizations in education is Comtella [27] which was originally designed to motivate cooperative user behavior in peer to peer networks. It was proposed for exchanging resources and services in research/study groups by persuading the user to particupate in the sharing community through attractive and informative visualizations. This shows user's contribution in form of a star whose color, brightness, shape depends on user's interest, contribution and cooperation. It created a visualization that compares the whole class on multiple parameters in a single view and was validated [28, 29] to improve participation and contribution in the classroom. Their work highlighted the importance of developing the right visualization with respect to the goal.

Progressor [30, 31, 32] introduced Social Visualizations in an interface that helps students find relevant resources. It was observed that due to social comparison, class leaders provide a guidance to the rest of the students, and eventually lead to more engagement, and thus higher success rates.

Several ideas related to Open Student Models [33, 34] have been explored. Reading Circle [35] combines the idea of Open Student Models and Social Comparison to encourage students to read. A textbook reading support interface called Reading Mirror [36] shows SC information uses a grid-like interface that shows a student's own progress and the class average with respect to sections/chapters of a textbook. It was found that most of the students felt that SC information altered their behavior positively. More recent works have used these interfaces [37] for encouraging motivation and engagement. An interface called Mastery Grids [38, 19] is a chart that shows students' performance and compares with the class average. This form of visualization was shown to improve the motivation and engagement of the students.

A recent implementation [39] that gives younger students an understanding of their mastery of concepts in the achieving multiplication table fluency and can be used to give additional information, including SC cues. A study on the effect of a dashboard widget [40] for Massively Open Online Courses (MOOCs) that provides students more crisp infromation about their progress as well as SC cues improves the course completion rates. A dartboard like interface for multidimensional comparison From the past works, it is evident that accessing SC

information helps students achieve more motivation and engagement, and leads to a higher success rates. Meanwhile it has also been observed [41] that peer comparison doesn not necessarily improve, but in some cases, hamper the motivation of students. In some cases that though students prefer personalized recommendations, they may not find peer comparisons as useful or motivating. It was also found [42] that students' SC own preferences do not necessarily align with their best interests.

This leads to a challenge of analyzing the design as well as the effect of social comparison at a finer granularity. Social Comparison for better learning experiences needs further exploration. I plan to explore methods and create adaptive SC interfaces that can be effective tool to promote meaningful learning.

3. Research Plan

The main objective of this research is to devise effective mechanisms for using adaptive Social Comparison to improve students' motivation, engagement and learning outcome.

3.1. Research Problem

Typically, in most TEL and e-Learning softwares, SC information is usually provided to all the users the same way. However it has been found [43] that demographic and cultural backgrounds have a significant influence on self-construals based on social comparison which may affect the motivating factors. Apart from demographics, the SC orientation and direction also determines whether a person is motivated, challenged, or demotivated by SC information [6, 44]. That is, someone might get inspiration from someone who's performing better than them, while someone else may feel dissatisfied, or envy. [45] mentioned that though we all engage in social comparisons all the time, some people are more concerned and influenced by social comparison than others.

The differences in perception and effects of SC don't end with demographics and personality - but even at individual level, they expand over temporal and contextual dimensions. We engage in comparisons with others over time[46, 47] or our own past selves[48].

The popular Social Comparison approaches don't capture all these dimensions of social comparison and implement a one-size-fits-all solution regardless of individual and contextual differences. The issue with standard one-size-fits-all approaches is that though they work in some cases, they might affect some users rather negatively.[49]

This leads to the idea of a system that adapts the SC interface to the user based on their demographics, social comparison orientation, motivation profile and psychological profile.

This can be divided into following research questions:
RQ1. What are the current state of the art interactions to show social comparison and what are their effects on students' learning experience?
RQ2. How is the effect of social comparison on motivation and engagement related with personality traits?
RQ3. Are there distinct effects of using different types and direction of SC interfaces with different students? What are these effects?
RQ4. How to match a student with a social comparison method fine-tuned to promote their learning?

These will be studied and validated through a Learning Support System that will be used to supplement students' learning experience. Some of the initial experiments have been thoroughly discussed and planned to occur in the academic year 2022-23. The students will be asked to use Studylens as a Learning Support System (LSS) that will allow them to attempt ungraded assessment tests related to the concepts in the course, and I will analyze their performance and engagement with respect to the interface provided.
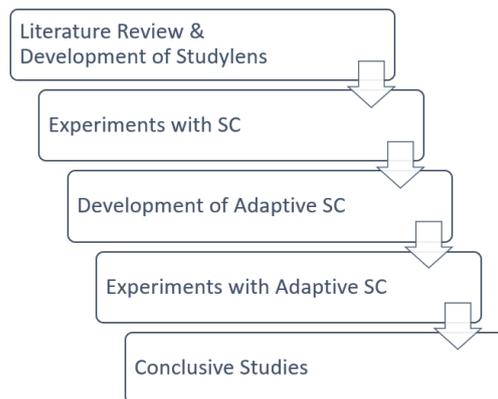

Figure 1: Overview of the Research Plan

3.2. Preparation and Setup

The first activities towards this goal are to study the existing research in Social Comparison in TEL and study the methods and tools used to convey the SC information to the students. This will be executed in parallel with development of a TEL system that can act as a Learning Support System.

3.2.1. Systematic Literature Review

A systematic literature review helps aggregate the existing research and ideas related to how SC has been used in TEL and what are the state of the art methods to use

SC as a tool to motivate students. This literature review is driven by the following research questions:

- What are the common ways of conveying SC information in TEL tools?
- What are the effects of context and direction of Social Comparison?
- What are common systems that allow students to actively engage with Social Comparison?
- What are the unexplored directions of utilizing SC in Education?

This is being performed with a hybrid methodology based on SPIDER [50] and PRISMA [51]. SPIDER helps summarize the study on the basis of (S) Sample size, (PI) Phenomenon of Interest, (D) Study Design, (E) Evaluation and (R) Research type. PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analysis) provides a structure for conducting the literature search and summarizing the analysis in a detailed manner. Meanwhile for each research that is included in the study, we also explore what was the SC method used and how was its effect studied.

3.2.2. Development of Studylens

Studylens is a Learning Support System built at the Utrecht University. It is a relatively lean implementation of the system which has been used with several university courses over the past few years [42]. The new implementation has been designed to have only the most necessary features that enable us to closely study the impact of social comparison.
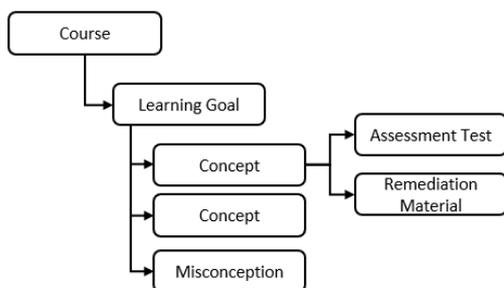

Figure 2: Organization of course content in Studylens

Studylens provides students a dashboard for exploring their expertise of the concepts covered in a course. It allows students to attempt self-assessment quizzes, which are associated with concepts and misconceptions that are part of a course inventory. When a student chooses to view the results of the test, they are shown their performance over each concept, and accordingly, remidiation

material is recommended. Figure 2 shows the organization of a course into constituent Learning Goals each of which have one or more Concepts related to it.

When the next Learning Goal is activated, the student can take the self assessment test. The Knowledge Map is updated that helps student get feedback about their expertise of the topic. Figure 3 shows the current version which is expected to be further updated. In the social comparison setting, the student is shown the average performance of their peers as well. For research purposes, visibility of the social comparison widgets is configurable to provide a different view to each student based on their experiment group. The student can explore their knowledge and take the right remedial action through a list of learning resources.

At the time of writing, Studylens is planned to be used as a part of courses related to Evolutionary Biology at Utrecht University in The Netherlands. The courses are conducted over three-month terms and expected to be taken by 120-480 students. Studylens is recommended to the students as a self evaluation tool that can help them find their strong and weak points, and recommend remediation material to improve their understanding of the topics.

3.2.3. Technical Details

Studylens is built with Flask, a Python web framework at the backend. The database is MySQL, and the front end is based on a popular Javascript framework that provides a highly extensible component based design. The system is designed to provide user interfaces based on the experiment groups a user is allotted to.

A minimalistic Learning Record Store (LRS) is implemented in the database that stores users' activities in terms of actor (the student), verb (loading an activity, answering a question etc), and object (question or learning material). At later stage, this may be replaced by a full fledged LRS based on research requirements.

4. Planned Experiments

In the second year of this project (July 2022-June 2023), we have planned a project to explore different methods for personalized support with focus on exploring SC as a vehicle to motivate students with non-mandatory educational content. Studylens will be used as a learning support system for three courses at the department of Biology. These are all related to Evolutionary Biology at Year 1 and Year 2 of their undergraduate degree program.

Students will be able to take formative tests and a dashboard (Knowledge Map) will display their progress of mastery with respect to the Concepts covered in these courses. The interactive dashboard will help them explore the topics, learning goals, concepts better and de-

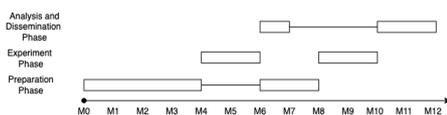**Figure 3:** Screenshot of Studylens Knowledge Map

Figure 4: Experiments in Academic Year 2022-23

cide the learning activities that can help them fill the gaps in their learning.

At certain points in these courses, we will also use motivation inventories to understand different motivation profiles. We will also monitor app logs and User Experience logs to monitor user's engagement with the application. This can be used for comparative studies based on controlled experiments. We are specifically interested in analyzing the effect of the proposed SC interface in the TEL system on students' motivation, engagement and learning. We will examine user activity in the system, their grades outside the system, and possible changes in their motivation profile.

In these experiments, we will attempt to collect and analyze the data to be able to answer second and third research questions mentioned in the previous section. This will allow us to validate our hypothesis about the impact of social comparison information. The fourth research question may need further refinement based on the results of these experiments. The timeline of these experiments is shown in Figure 4. This offers us enough data collection, analysis and further improvements to the system.

4.1. Social Comparison and Motivation Inventories

A sub-task during preparations for the first experiment will be to study and develop questionnaires that can help us understand students' perceptions and inclinations based on different types and directions of social comparison and motivation profiles.

The need of this research may lead to creation of an inventory that can provide us insight into how SC affects a students' motivation. We are currently exploring using the items from Goal Achievement Framework[52] for studying performance and mastery orientation. Identification Contrast Scale[53] has been used to study effect of social comparison on cancer patients. We will test if this can be modified to use in studying SC in educational setup. Another highly popular inventory based on Self Determination Theory [54, 55] is a 22-item Motivation inventory that focuses on studying intrinsic motivation. 6-item Social comparison Concern Questionnaire [56] examines SC concern that can help us support the claim for adaptive SC in TEL.

4.2. Privacy and Ethical Concerns

We have thoroughly analyzed the privacy and ethical concerns related to any experiment of this kind. To mitigate the privacy risks, we have devised that the user's details in the system will be synthetic, and the teachers of the courses would map the user ids with actual students in the class. Meanwhile the teachers will not have access to the database or any internals of our system. This creates a safe barrier, thus allow anonymity during the data col-

lection and analysis. Meanwhile use of the software, data collection, and participation in the motivation profiling surveys will be voluntary.

The aim of any TEL system is to devise the ideas that lead to discovery of more effective learning methodologies. This research can potentially impact how the Social Comparison information is visualized and used in learning softwares.

4.3. Plans for Future Work

The first set of experiments will be concluded by the middle of 2023 which would give adequate insights on the factors that determine the effect of SC on students' motivation and learning outcome. This will help in the development and refinement of effective interfaces for conveying SC information. This would be followed by providing adaptive SC interfaces to the students and comparing their effects with respect to student controlled and static social comparison.

5. Expected Contributions

This research will contribute to the empirical knowledge in Technology Enhanced Learning and Pedagogy domains. The outcomes of this research will allow us to gain a thorough and coherent understanding about how Social Comparison affect different behavior profiles, and create a system that adapts to a learner's behavior and provides them the Social Comparison cues that will motivate them.

The learning support system being built as a part of this research, Studylens, will be used to help students towards Self Regulated Learning. Though the experiments that are planned in the next year are related to Biology students, the tool and the ideas are domain independent and can be easily applied to other subjects and areas like computer science and soft skill training. We believe this research would lead to adaptation of SC methods that help the students achieve their learning goals.

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