

Using Game Elements to Make Studying More Engaging

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Abstract: A lot of potential exists for systems that enhance learner engagement using game elements. In particular, elements that support the activity of learning, that are designed around learning but that are distinct from the subject matter a learner is studying. This paper describes such a system, the particular support focussed on is goal setting - setting custom learning goals, independent of the course being undertaken, and tracking progress on these goals in a game like way. Students' approaches to study have been classified by a number of different inventories, perhaps the most popular is Biggs' Study Process Questionnaire (SPQ) which divides students into one of three categories - Utilising (studying no more than is necessary), Internalising (where studying is an intrinsically motivating activity), and Achieving (getting grades for their own sake). Is it possible to facilitate the state of flow, to enable more students to experience study as an intrinsically motivating activity more often? This work explores the design of a system with the goal of answering this question. This system has been trialled with a class of final year BSc computing students in order to assist them with the activity of studying for exams. The aim of the trial was to determine the degree to which the game-like system succeeded in making studying for exams more engaging. This paper describes the design of the system, and the design and results of the trial.

Keywords: game elements, studying, flow, intrinsic motivation

1. Introduction

Students study in many different ways. These approaches have been classified by a number of different inventories, such as SPQ (Study Process Questionnaire), LASSI (Learning and Study Strategies Inventory), and ASI (Approaches to Studying Inventory) (Entwistle and McCune, 2004). Perhaps the most popular such inventory is Biggs' Study Process Questionnaire (SPQ), which classifies students into one of three categories:

- *Utilising* (focussed on obtaining grades and only studying what is necessary, the validity of the material is not questioned);
- *Internalising* (studying is an intrinsically motivating activity, syllabus free - the student sets himself goals);
- *Achieving* (getting the best grades for their own sake, characterised by systematic approach to study e.g. study schedules (Biggs, 1979))

The main study strategy inventories (see for an overview of each (Entwistle and McCune, 2004) each contain an element corresponding to the intrinsic motivation such as in the *Internalising* category above. It is this intrinsic motivation that is highly desirable in learning and learning related activities. "When people are intrinsically motivated, they experience interest and enjoyment, they feel competent and self-determining, they perceive the locus of causality for their behavior to be internal, and in some instances they experience *flow*" (Deci and Ryan, 1985).

Flow is an immensely enjoyable mental state that is characterised by a "complete immersion in what one is doing" (Csikszentmihalyi, 2000). Indeed, it is so enjoyable that people invest considerable amounts of time and money "for the sheer sake of doing it" (Csikszentmihalyi, 1990). That is, people do an activity for itself "and not for the usual rewards of everyday life, like a paycheck or a promotion" (Csikszentmihalyi, 2000), it is intrinsically motivating.

Is it possible to facilitate this state of flow, to enable more students to experience study as an intrinsically motivating activity more often? This work explores the design of a system with the goal of answering this question. The general approach used was Human Centred Design, which is an iterative process with four main stages: observation, ideation, prototyping, testing (Norman, 2013). For the testing phase, a study was conducted to determine the degree to which it succeeds, and to gather feedback to inform the next iteration of the system.

This paper is structured as follows: it begins with a description of related work, then describes the key stages of the design process, the study, a discussion of the findings, and finally conclusions and an outline of future work.

2. Related work

The use of game elements in non-game systems have been used to increase interaction, engagement, and intrinsic motivation, across activities including commerce, education, health, industrial work and intra-organizational systems (Hamari, Koivisto, and Sarsa, 2014). Although this approach has been frequently applied to education and learning, the majority of these applications have focussed on applying game elements directly to the learning activities (Hamari, Koivisto, and Sarsa, 2014). To date the use of game-elements and gamification to enhance the activities surrounding learning in higher education, such as studying and goal setting, has been limited. However, where these techniques are being applied they have shown promising results, such as in the area of new student induction in higher education. The work of (Fitz-Walter, Tjondronegoro, and Wyeth, 2013) looked at using game elements to motivate and engage new students in college induction. This approach tied achievements to real world events that would benefit the students including: geographic orientation, social interaction (meeting new friends), attendance at college events, and awareness of available services and facilities. Similar work by (Smith and Baker, 2011) investigated the use of narratives and puzzles to encourage exploration and learning about library facilities. To further incentivise participation, prize draws and extra course credit were used as additional real world and extrinsic motivators. Despite these successful examples there is limited research being undertaken in this area, even though the activities surrounding learning at higher education, and not just ability, are crucial to success (Tinto, 2006).

As with the use of all game-elements, care must be taken in the selection of appropriate elements that are relevant and well integrated in the experience. One approach to ensure this is to adopt a human-centred approach to design that can avoid meaningless or even harmful gamification (Nicholson, 2012). Of particular note is the risk of using of game-elements to promote competition, even though it is not universally motivating (Domínguez et al., 2013).

3. Design

The general approach used was Human Centred Design, which is an iterative process with four main stages: observation, ideation, prototyping, testing (Norman, 2013). Observation involves making observations on the target population, with the aim of understanding their true needs - a limited set of these needs is selected and results in the problem statement; Ideation entails generating ideas that might lead to potential solutions; prototyping involves quickly building potential solutions; testing requires users to use the prototypes “as nearly as possible to the way they would use them” and observing and gathering data to ensure it meets the needs of the users (Norman, 2013). Key elements from each of the stages are described below.

3.1 Observation

Observation for this iteration was done largely from informal ethnographic study and from literature. In terms of the specific studying context of the cohort of students upon which the study is based, students were observed in the activity of studying which consisted largely of reading PowerPoint notes from computer screens. The students also used past exam papers to focus their reading. However, none of the students used any aids to set their study goals or to track their progress.

When it comes to studying, students can be strategic in their use of time and disregard content that they think has a low chance of being assessed. This point is made in a number of places, for example, (Gibbs, 2004) and in (Miller and Parlett, 1974, p.60):

“I am positive there is an examination game. You don’t learn certain facts, for instance, you don’t take the whole course, you go and look at the examination papers and you say ‘looks as though there have been four questions on a certain theme this year, last year the professor said that the examination would be much the same as before’, so you excise a good bit of the course immediately ...”

3.2 Ideation

The key ideas of those generated and gathered were:

The three key conditions of flow

There are three key conditions for flow: first, a person must engage in a challenging task that requires skills and he must believe his skills match the challenges of the task; second, the task must have clear goals - if the goal is clear the person will know, at any moment, whether or not he has reached it; third, the task must provide immediate feedback – that is, information letting the person know how well he’s doing (Csikszentmihalyi, Abuhamdeh, and Nakamura, 2005). Note that the task can supply the feedback (as with the tennis player who can see after each shot if the ball went where it was supposed to) or the person can have a standard internalised in his mind, and he can tell how well his actions measure up (as with the poet who reads the last line he wrote and knows if it is right) (Csikszentmihalyi, 1999).

Game elements

many successful systems use of game elements for changing behaviour, for example Health Month (<http://healthmonth.com>) and stackoverflow.com. This suggests they are a promising approach to follow.

The previous system we developed, for facilitating learners to focus on mastery using learning outcomes representing in a treemap (O Broin and Power, 2014).

Other design inspirations: iTunes interface.

3.3 Prototypes

Several prototypes were generated, and two were selected by the researchers using the following criteria: intuitiveness, ease of learning, and simplicity. The first prototype used the treemap view similar to what was used in a previous iteration of this system (see Figure 1). The other using star ratings (see Figure 2), selected for its ease of learning, to get a baseline with a standard element before exploring the effects of less standard game elements in future iterations. Before starting to study, students can create custom goals, consisting of a set of learning outcomes. These goals map out what will be accomplished in a particular study session, or for a longer term goal such as a class test or final exam (all the learning outcomes for one or more of the topics in the course). The prototypes were developed using JavaScript/CSS/HTML on the client side and using Python with Tornado (Tornado, N.D) and MySQL on the server side and WebSockets and AJAX for communication.

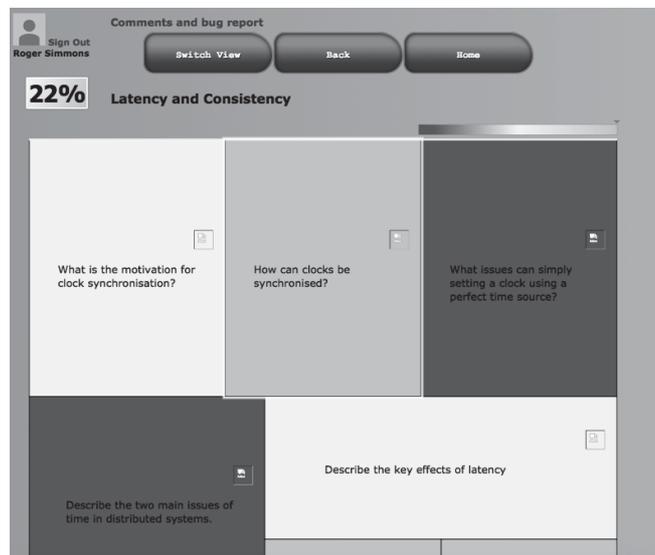


Figure 1: The system showing the treemap element, depicting the learning outcomes for the topic “Latency and Consistency”, and the colour indicates the degree of mastery (red indicates major problems with the learning outcome and green indicates mastery). The overall progress on the goal displayed at top left (22%)

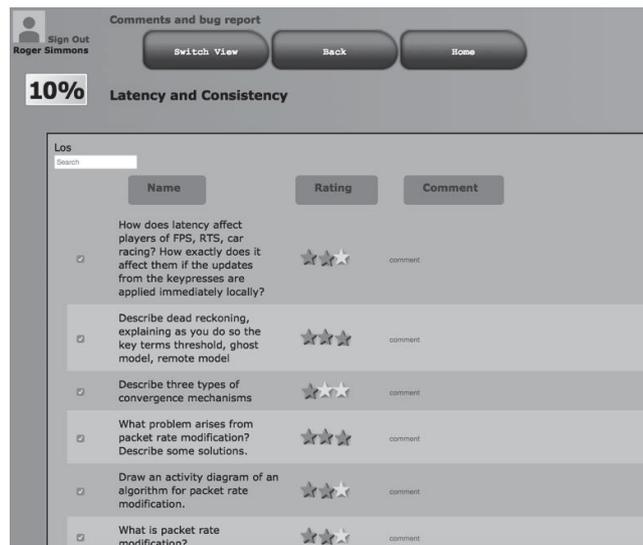


Figure 2: The system showing star list element – users can see the topic (Latency and Consistency), the learning outcomes (under name) and their perceived level of mastery of the learning outcome (0 stars – haven't looked at the learning outcome, 1 star major issues with the learning outcome, 2 star minor issues with the learning outcome and 3 stars, with the learning outcome is mastered)

3.4 Testing

Four usability sessions took place in which two cohorts of students were given one of the prototypes and asked to perform a set of tasks (setting up an account, navigating to a section, rating a learning outcome, and creating a goal). The students were observed carrying out the tasks. Some minor issues arose, and these were remedied before deploying the system for the study.

4. Study

The goal of the study was to learn more about facilitating more students to experience study as an intrinsically motivating activity. The hypothesis is that different people prefer different game elements, and some prefer different game elements for different contexts/purposes.

4.1 Method

A class of final year Computing students (23) was split into two groups, each was assigned to use one of the prototypes for one class test, then the other for another class test. After this, they were free to use whichever version they wished to use.

A condensed version of the USE questionnaire (Lund, 2001) was used to measure usefulness, ease of use, ease of learning, and satisfaction and the instrument's scales go from 1 (strongly disagree) to 5 (strongly agree). In addition, the questionnaire specifically addressed the participants' preference of the different systems. User activity was measured from the system to enable the participants' responses relating to certain areas to be corroborated – for example, a participant says she prefers the star element, and then the activity measured shows that she uses the star element four times as often as the treemap element.

4.2 Findings

A summary of the results of the survey of the 23 students who completed the course are shown in Figure 3.

As with the previous similar system, high levels of usability, usefulness and satisfaction were recorded, as shown in Figure 4.

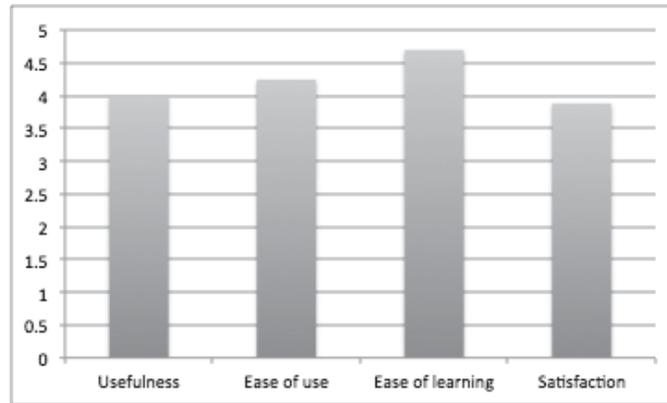


Figure 3: Both systems (the system with treemap element and the system with the star list element) demonstrated high usefulness, ease of use, ease of learning and satisfaction

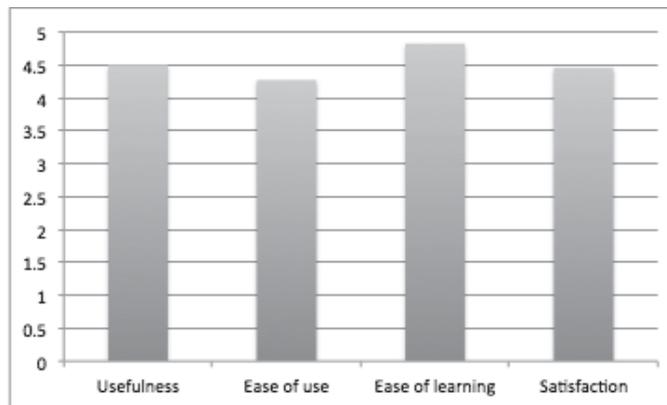


Figure 4: The results from a previous iteration of the system (2013) comparable (only slightly higher than the current one)

The preference of participants was for the star list element (65%), 25% preferred the tree map element, and 10 % did not prefer one over the other (see Figure 5).

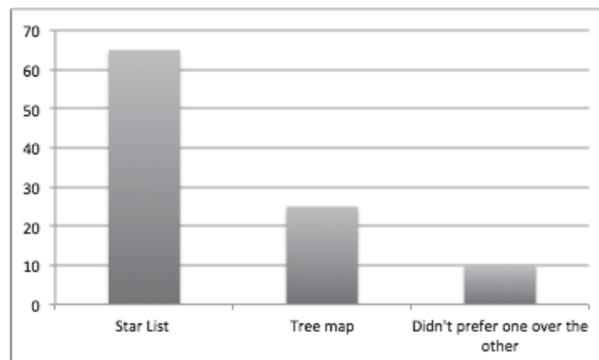


Figure 5: Comparison between the star list element and the treemap element in terms of user preference (percentage of users).

It was found that self-reporting corroborated with actual user activity in terms of preference for one element over the other. This can be seen by comparing user preference (Figure 5) and user activity (Figure 6) when students were free to choose either element.

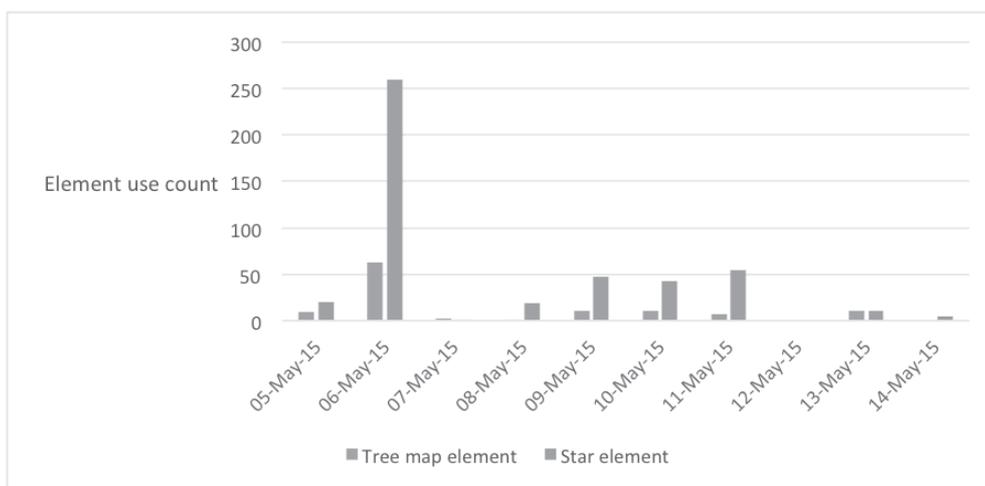


Figure 6: User activity compared between the two systems – the star list (orange) vs tree map; this is actual use, which corroborates with self report

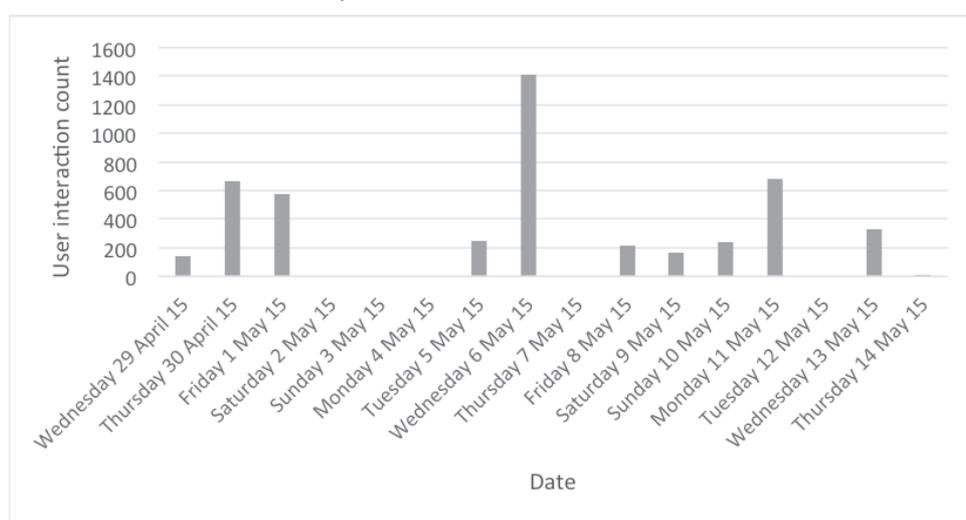


Figure 7: Overall use – this indicates the level of activity of the users – the spikes of highest activity are before exams

As an indicator of the usefulness of the system, it was found that usage activity dramatically increased right before exams (see, for example, 6/5/2015 in Figure 7).

Several issues were identified with the treemap element. Firstly, it used multiple clicks to rate (one click to change a learning outcome rating to red (meaning major issues), another to yellow (minor issues) and another click to change it to green (no issues/learning outcome is mastered). This was compared unfavourably to the 1 click system of the star list. Other issues mentioned were that there was no search (“if I want to view my comments I have to manually search for them. It’s a major issue that prevented me from using the tree-map view for revision.”), comments were more difficult to add and read than in star list, and the lack of order of the learning outcomes in treemap (“I really disliked how the information wasn’t easily readable due to not being ordered.”)

Several of the participants mentioned employed the different elements for different purposes, for example:

“I found the treemap view better for initial study planning. When I first opened up a list of LOs, I found it easier and much quicker to scroll through all of them in the treemap and mark off what I already knew.”

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"after filling in the list view i found the map useful for an overview of questions you dont know well which i found very useful for revision as i didn't have to search the lists to find questions it was all there in the tree map"

"I used both for different purposes. It's easier to find a question using the list and more satisfying to update it using the tree map."

A particularly interesting insight from a participant stressed the effect the treemap had:

"The Red/Yellow/Green colours also stand out more (and have more effect) than the stars in the list view. Seeing a LO in a red tile impressed upon me that I should revise it far more than seeing it with one plain star beside it."

Two of the participants mentioned uncertainty as to whether they had mastered a learning outcome, and suggested:

"i would also put in a system that you can submit answers that can be looked over by a lecture and decide if the answer is correct or not so the user knows for definite if they are going in the right direction"

Some students in the Utilising category found the system beneficial:

"it helped me to pick certain things to study instead of trying cover everything. "

And some found other benefits which had not been envisaged:

"good tool to use for feedback to the lecturer as you can ask questions you might be embarrassed to in class the lecture gets direct feedback of topics to cover for revision."

5. Discussion

The issue of users having to click an excessive number of times could be readily addressed by overlaying star ratings on each rectangle of the treemap, thus enabling rating with one click as can be achieved in the star list. Searching could be addressed also (by automatically scrolling to the relevant element). It is not clear how the issues relating to adding and reading comments and the lack of order can be addressed. It may be that they can't be, and that the elements work better for different purposes.

Beyond this, some deeper issues emerged. One is that the system in its current form is syllabus bound (Biggs, 1979). This can be addressed by enabling participants to add their own learning outcomes (and indeed a number of participants requested this feature). This would facilitate Biggs' Internalising.

In addressing uncertainty over mastering a learning outcome, the suggestion of referring answers to a lecturer would be one possibility. Another method might be to provide an objective measure in addition, such as a multiple choice quiz game tailored to different player types.

Another drawback is that there is significant work required by staff to use this system - in particular, the complete list of learning outcomes for each topic in a course needs to be identified and set down in a spreadsheet.

Despite the challenges encountered there was support for the hypothesis that preferences for game elements vary between individuals and between contexts of use. It is anticipated that this may prove to be a useful heuristic in further iterations of this system.

6. Conclusion and future work

This work described the latest iteration of a system designed to enable more students to experience study as an intrinsically motivating activity more often. While it has demonstrated success in terms of usefulness and usability among its users, there is potential for more game elements that align with user preferences and context. The most interesting outcome of this work in terms of future iterations was how different elements were not preferred over competing elements, but that both alternatives were used by some users for different purposes. A drawback that was noted is the significant effort required by staff to use this system for a particular course – mainly importing the complete list of learning outcomes for each topic. We aim to address this issue in future iterations of the system.

There is potential for many other game elements that go beyond just representing progression. Examples of game elements to explore include: a map for progress e.g. Crayon Physics (www.crayonphysics.com), adding sessions and end of session animations like GamiCAD (Autodesk Research, N.D.), adding a more juicy interface including sounds and particle effects (Whitkin, 2014). Also, the issue of the uncertainty of rating learning outcomes could potentially be addressed by complementing the subjective measurement of learning outcomes with an objective measure. For example, a quiz game with different mechanics tailored to different player types. A second approach is to explore integrating rubrics for handling more complex learning outcomes that cannot be easily measured by the present system. What is essential in these explorations is that the game elements added do not encourage surface learning (Marton and Säljö, 1976) e.g. Utilising and Achieving - but rather *Internalising*.

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