Using Gamification to Enhance Self-directed, Open Learning in Higher Education

Mark Featherstone
Sheffield Hallam University, Sheffield, United Kingdom
m.featherstone@shu.ac.uk

Abstract: This paper reviews the literature on games based learning in the fields of psychology, education and video games, with a focus on the disparity of opinion regarding intrinsic motivation. Work in the field of education has shown that a state of optimal learning (flow) can be encouraged and sustained using a variety of reward based techniques. In contrast, psychological studies have shown that intrinsic motivation is inhibited by external reward techniques. The author's experience as a professional game developer is that there are large commercial benefits and efficacy in a range of reward-based game mechanics. By identifying game design features that could cross over into education this paper will outline a range of techniques that could be implemented using a mobile device platform for use in the classroom within a higher education setting. An experiment is proposed to investigate the impact of this approach to games based learning and a software design is presented to support the experiment's aims. A meta-game is described that links into normal student activities, gamifying them to enhance the student experience.
Keywords: Game-Based Learning, motivation, mobile, gamification, software design

1. Introduction

At the heart of the apparent educational power of games is their ability to motivate individuals to spend many hours acquiring knowledge (even if only about a specific game), developing skills, or engaging in collaborative research, yet it's completely voluntary (Royle, 2009). Much of this power is tied to the concept of psychological reward (Gee, 2003) i.e. unlocking new skills, increasing points, acquiring a new rank, acquisition of in-game items to decorate your avatar, accessing new locations, virtual badges to enhance peer recognition. Yet, in the field of psychology, experiments have shown that rewards reduce intrinsic motivation and lower performance (Deci and Ryan, 2000). Intrinsic motivation is the ability of an individual to want to learn for its own sake, to relish the subject in and of itself, the joy of learning – a condition of being said to result in optimal learning.

This project will involve the development of a virtual 'meta-game' which uses engagement with a higher education subject module to drive achievement and progression. Here, a meta-game is defined as a collection of video game design properties (points, medals, virtual items, leader boards, etc) used to enhance standard student activities (attending lectures, answering questions, completing assignments, etc). The work proposed will examine why games are fun and compulsive. These qualities are present in all successful games and there is a great deal of literature attempting to define the underlying game design principles that contribute to these key drivers (Crawford, 2003, Koster, 2013, Schell, 2008). A 'meta-game' that wraps around existing education practices and content in higher education will be designed and developed with the aim of making lecture activities and the general university experience feed into this 'game'. Pupils will ideally learn that positive engagement in lectures, tutorials and the university in general is the optimal strategy for progression in this meta-game. The intention is that, as 'gamification' (Deterding, et al., 2011), is not subject specific, unlike an educational game, it doesn't impact on the pedagogical approach or curriculum content.

The overall objective of the research is to establish whether gamifying the educational process in this way allows the positive characteristics of game-play to have an impact on the learning process, thereby delivering a better learning performance.

2. Definitions

Establishing what a game is can be quite difficult as there are a number of definitions. For the purposes of this study, a game is an artificial world defined by a set of abstract rules (Bateman and Boon, 2005). Often a game features one or more sets of conditions that are favourable, usually identified by a points score. The player must discover the rules, which are not always clear, and then learn the skills to optimise their behaviour within those rules to maximise their score (Juul, 2011). The 'meta-game' being proposed takes its 'game world' to be the classroom, with favourable conditions being: regular attendance, answering questions, completing tutorial exercises, etc. This engagement will be rewarded with points.

2.1 Why not just build an educational game?

An educational game is purpose built to encourage engagement and support learning in a specific subject, curriculum or set of learning outcomes (Egenfeldt-Nielsen, 2005). This means the teaching staff can be limited in their ability to make last minute changes in response to a unique cohort of students if they don't match the assumptions of the game. A course of study usually encompasses a number of subjects, with each subject covering a range of topics - potentially requiring a different educational game for each topic of each subject. Educational video games will often be judged harshly by players alongside more familiar entertainment video games, many of which carry multi-million pound budgets with very high production values. Educational games are expensive and time consuming to produce. It is often very difficult to embed educational content within the game design and far more common to see it *tacked on* (Habgood and Ainsworth, 2011). It's very difficult to create an educational game that is both fun and delivers appropriate knowledge/skill transfer into the real world, the majority have failed in one or both goals (Van Eck, 2006). Are students just getting better at playing the game? However, it must be remembered that many learning activities can have their efficacy criticised, for example, Bligh (1998) claims that traditional lectures are not particularly effective either.

2.2 Games, play and learning

It has been well documented that there are certain aspects of human behaviour that are (deliberately or otherwise) harnessed in the design of good games (Koster, 2013, Gee, 2003). From the perspective of this research, there are four key aspects which are central to the proposed system:

- Humans can recognise patterns in seemingly chaotic systems and optimise their behaviour to meet changing success criteria (Caine and Caine, 1991). Many games are structured this way (Koster, 2013).
- We are mentally conditioned in our work lives to respond compulsively to promotion, competition, higher status, completion of tasks, often without financial reward - with this conditioning sometimes enhanced by natural pleasure chemicals (adrenalin and endorphins). Many games use the same principles to motivate players (Yee, 2006).
- Our social support groups award high status and wealth to leaders, high achievers and the highly skilled. In games, similar 'virtual' high status or fame can be awarded to those achieving high scores, completing challenges first, finding hidden content first, creating instructional 'let's play' YouTube videos, mentoring others in gaming forums or organising in-game events. There is a desirable kudos attached to these virtual achievements (Behm-Morawitz, 2013, Cruz, Hanus and Fox, 2015).
- To be successful one must explore and understand each new life scenario, develop strategies, practise them and identify success criteria, feedback failure, negotiate with peers, reflect and then develop more optimal strategies. This description could equally apply to real life or aspects of a number of game design definitions (Crawford, 2003, Koster, 2013, Juul, 2011).

This crossover between human behaviour and game design principles suggests games can be motivating even if they feature no real world reward. These inbuilt and external drives to 'play' give us a natural incentive to enjoy games. Games let us practice skills safely, explore new worlds or roles, satisfy our urge to exploit and master scenarios, compete with others, rank our ability against our peers, to succeed and to win. We'll even unconsciously cooperate and adapt games to make them work for us (DeKoven, 2002, Koster, 2013). If this potential could be applied to a student's studies there might be positive results. The proposed 'meta-game' will create a video game like framework around subject specific activities that reinforce the student's engagement with their studies by rewarding appropriate actions.

The proposed software would give each student a virtual avatar to decorate with the trophies of their in-class achievements. These avatars would be shared online and would create a platform for students to proudly compare their progress and compete for higher rank. Studies have noted that virtual avatars can have an influence on the player in real life, affecting their behaviour in meaningful ways (Behm-Morawitz, 2013).

2.3 Gamification

This term refers to the use of design principles characteristic of games in non-game contexts (Deterding, et al., 2011). Many of the game design principles underlying video games have their roots in card games, board games and the playground. Principles such as competition, points scoring, collecting, player reputation, theming, medals, etc. are all transferable between different types of game and are effective in different combinations, even in non-gaming settings.

2.3.1 Criticism of gamification

Gamification is most commonly used to enhance productivity in industry, a common example being to assign points to various work related activities and then publish these accumulated points scores on a leaderboard with financial rewards for achieving targets (Duggan and Shoup, 2013). Often these projects are compulsory activities. High scores, competition and reward are powerful extrinsic motivational forces. This approach has been criticised for stifling creativity and causing resentment, with claims it is only beneficial in rote learning scenarios (Dale, 2014). However, these all too common, but limited applications of gamification do not draw on the full toolkit of game design principles that will be explored in this study.

2.3.2 Ribbon Hero

A popular implementation of gamification is Microsoft's 'Ribbon Hero' (Microsoft, 2011), this is a plugin for the application Word and attempts to make learning this increasingly complex application more engaging. The plugin was developed as a collaboration between Microsoft's Word development team and Microsoft Game Studios and has millions of users (Faulkner, 2011). New users looking to learn how Word works are presented with a 'video game like' progress screen showing tasks completed, tasks still waiting and their associated point values. A progress bar indicates how close to completing a task group the user (player) is, as seen in the left hand panel of Figure 1.

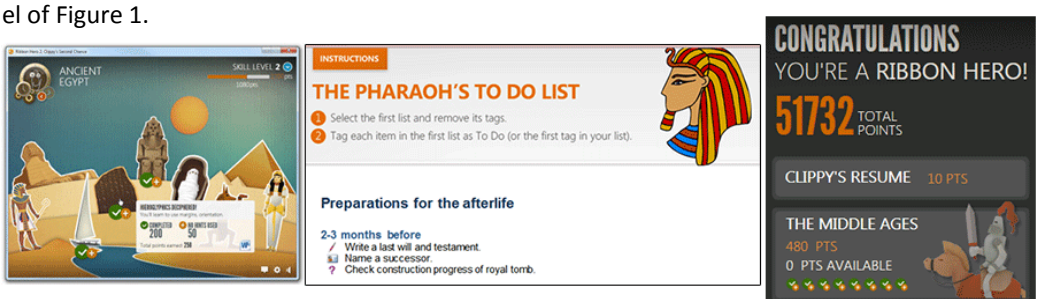

Figure 1. Ribbon Hero2 (Microsoft 2011)

Each task group is then broken down into a Word specific task list and upon completion of the task the item is ticked off and points are awarded, see centre panel Figure 1. A task contains an overall explanation, for example, reformatting a document. This is then broken down into more specific context sensitive instructions that guide the user through the process of performing that task. A comic strip provides a basic reward for progress, mimicking the way narrative is revealed in many video games, where progress is punctuated by each chapter of the story. A summary screen, right panel Figure 1, presents overall progress and this allows the user to choose between task groups and approach lessons out of sequence. Each task group has a different 'fun' theme.

This popular commercial example of gamification features a reasonable range of game design principles: points, medals, video game like graphical themes, narrative, context sensitive help, out of order progress and regular feedback rewards (pleasant sound and visual effects). However, it could be argued that Ribbon Hero drills the user in the operation of Word's interface (rote learning), a common criticism of gamification projects. By directing the user to perform very specific prescribed tasks the software is able to assess completion automatically, the user cannot cheat. To use gamification in a more creative and open setting it will be far more difficult to validate assessment automatically, self-assessment of progress will be essential. Will users cheat, will there be a lack of faith in scores/achievements and therefore peer competition incentives? Gamified processes often have physical rewards (financial bonuses) in industry or feed official assessment in educational settings, cheating could be a temptation and wouldn't be tolerated. In this study the gamification approach is not connected to physical rewards or assessment, but will the participants still be tempted to cheat?

2.4 Smart devices in education

Smart devices are now ubiquitous (Mitchell and Cisic, 2006) and can be so distracting that they are banned in many classrooms, but a number of companies are developing educational software for students to use on their smart devices within the classroom. One example is Kahoot, which has proved popular in the classroom (Dellos, 2015). Usually they focus on multiple choice questions and ranking with a view to making the classroom experience more interactive, personal and competitive. These goals are common in game

development and there is some crossover. In this example, Learning Catalytics from Pearson (Pearson, 2013), students can use a mobile app to answer questions in real time. Learning Catalytics, like many other smart learning platforms, offers a mixture of text and images, using a multiple choice format Q&A, as shown in **Figure 2**. The teacher has a master screen where they can monitor how many students have responded and which answers are being selected. Usually the results can be shown to the students through a web page or direct through their smart device.

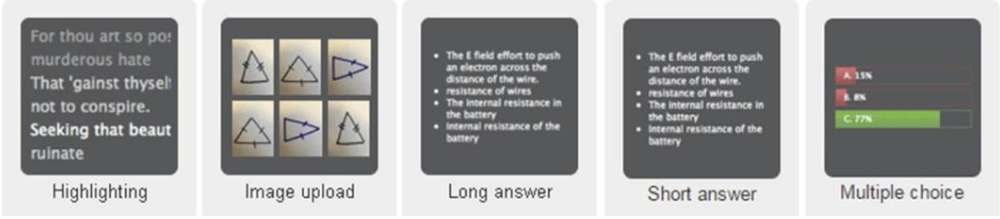

Figure 2. Smart device question types (Pearson 2013b)

2.5 Intrinsic vs extrinsic motivation

Intrinsic motivation refers to our innate psychological need for competence, autonomy and relatedness, as defined by self-determination theory (Deci and Ryan, 2000). Intrinsic motivation results in a state of optimal learning where the student engages with some subject for no other reason than the joy of learning. Extrinsic motivation refers to the use of external rewards or pressures to coerce someone into learning. An example might be gold stars in a primary school child's maths book or a performance related pay bonus in industry.
Extrinsic motivation has been criticised for reducing intrinsic motivation, because it reduces the feelings of self-determination, competence and autonomy within the learner (Deci and Ryan, 2000). Someone exercising their innate interest and passion for a subject is said to be in a state of optimal learning, but if we then add goals and rewards, the individual's sense of freedom to explore the subject is diminished. Extrinsic motivation underpins gamification which is often applied to rote learning scenarios where intrinsic motivation is not so important.

Video games are famous for their ability to engage players, yet all games include some forms of extrinsic motivation, whether it's points, leader boards, forums, virtual items, progress bars or achievement medals. Why the apparent discontinuity? To positively reinforce or reward learning, we usually have to categorise, label and measure what is learnt. Often this involves defining a prescribed course of study, regular assessments to signpost learning and commensurate rewards tied to careful measurements to ensure fairness and detect cheating. Such processes can drain the intrinsic motivation from a student.

A video game is played for fun and the medium's best examples are well known for context sensitive reactive rewards that do not constrain the player's choices, do not enforce any one particular role or restrain how the player explores. This study proposes a gamification of the student experience that applies similar loose virtual rewards. Rewards are context specific, the student can engage with them out of order. Rewards are student driven and open ended, for example, a lecturer giving a student an ad-hoc reward at their own discretion. Virtual rewards, couched in video game themes, are fun and have no real world impact. This is one possible explanation of why the video game approach to extrinsic motivation may not reduce intrinsic motivation.

2.6 Competition and learning

Competition is a key part of many video games, either directly through online play or indirectly through leader boards. It's often used within a learning context, for example, school children competing for prizes based on acquiring "achievement points" gained in class. It's a powerful extrinsic motivator, but it has been criticised, alongside all extrinsic motivators, in that it reduces intrinsic motivation and so reduces opportunities for optimal learning. Research has shown that children losing competitions perceive themselves as less competent than the winners and this depresses their intrinsic motivation (Vallerand, Gauvin and Halliwell, 1986).

Video game design principles address the negative aspects of competition in a variety of ways:

- Player matching – a game may automatically assess players and split them into many different ranks. This promotes competition amongst evenly matched players. A player who feels the competition was evenly matched may find failure less demotivating.

- Constant re-evaluation – many games don't end, real time evaluation allows winners and losers to shift over time, so there is no point where a player feels the competition is over and they've lost.
- Multiple winners – many video games don't have just one winner, they often allow for individual and team competition with a wide range of categories increasing the number of chances any single player has to win, which may counteract the demotivating effect of losing.

3. Design

Which games design principles make sense in an educational setting? Gamification projects usually focus on points scoring, leaderboard and rewards, but there are many more common game design features that might be included, as detailed below.

3.1 Avatars

Students will create a video game like character, known as an avatar, which will represent them. Studies have shown that players will project their identity onto the avatar and care about what happens to it even though it's virtual (Behm-Morawitz, 2013). Customisation of the avatar will allow every student to have their own unique character. Similar systems are common in console games, as in the Xbox Live game console example below in Figure 3.

Figure 3. Xbox live avatar selection (Microsoft 2016)

3.2 Pets

Along with the virtual avatar, many video games provide virtual pets for players to spend their credits on. An example could be a dragon in a fantasy game, the pet doesn't need to actually perform any specific function other than to add status to the player amongst their peers. For students it provides another reason to earn credits, another incentive to complete tasks.

3.3 Economy

The proposed software platform would offer the student a range of desirable virtual items, but they have a virtual price attached. As well as scoring points by performing tasks, successful activities are rewarded with virtual credits. This creates a simplistic economy, work is rewarded with credits, which are needed to fulfil the desire to acquire virtual items. So there would be two separate, but related numerical values, a score which is a permanent indication of progress and credits which are earned and spent on virtual items.

3.4 Virtual items

The software platform offers the student a range of desirable virtual items, but each has an artificial scarcity. They are only available by paying virtual credits for 'booster packs', each pack contains a fixed number of items, but the user doesn't know what they are. For example, there might be a 25% chance of a pack containing a common item like a steel sword, but only a 1% chance of a pack containing a rare gold sword. Managed scarcity and reward increase the compulsive nature of the activity (Skinner, 1963).

3.5 Leader boards and competition

Video games often provide a public platform for players to compare or boast about their progress through a game, it encourages competition, the example below is from Xbox Live, Figure 4. Within an educational setting this competition could result in increased motivation of students.

Figure 4. Xbox Live leaderboard (Microsoft 2016)

3.6 Player matching

Where a video game allows multiple players and facilitates competition, how do players find an opponent? Sometimes a player may have a friend in mind, but often the game will suggest an opponent, unknown to the player, based on their ability level. The goal is to always have new people to play with who are of similar skill to the player. A competition between well matched players is closely fought, hard won and more likely to result in satisfaction for the winner and loser. Repeated competition amongst different closely matched players is more likely to provide continuing fresh challenges than repeated competition with the same opponent.

3.7 Clan home

Many video games attach a permanent group presence to a game by allowing players to band together into 'clans' (Jansz and Tanis, 2007), some go further and allow the clan to create a virtual home. For example, students in a particular tutorial group might setup a virtual town, with each student buying a home. Peer groups such as this encourage bonding, belonging and friendship. Different clans can compete against each other using a variety of metrics: group scores, biggest populations, most impressive homes, etc.

3.8 Ad-hoc meetings of peer groups

Students could be encouraged to meet outside timetabled sessions to further bond as a peer group (Barefoot, 2000). Smart devices feature GPS sensors so the student could trigger a meeting with the software detecting when students on the same course are in close proximity and rewarding those attending with credits.

3.9 Tutorials

Tutorials often feature guided activity worksheets, created to compliment lectures. The software could reward students for completing each tutorial task with credits. Completing groups of tutorial tasks, perhaps all those linked to a specific lecture, could result in higher credit rewards and 'unlocking' an achievement medal. The most flexible approach to awarding credits would be via self-assessment, although this does risk cheating.

3.10 Medals and achievements

Medals and achievements signpost desirable activities, provide a virtual reward for progress or completion of tasks and are powerful motivators (Cruz, Hanus and Fox, 2015), the example show in Figure 5 is taken from Xbox Live. Within an educational setting, achievements are linked to: maintaining high levels of attendance, completing tutorials, answering questions in lectures, completing assignments, etc.

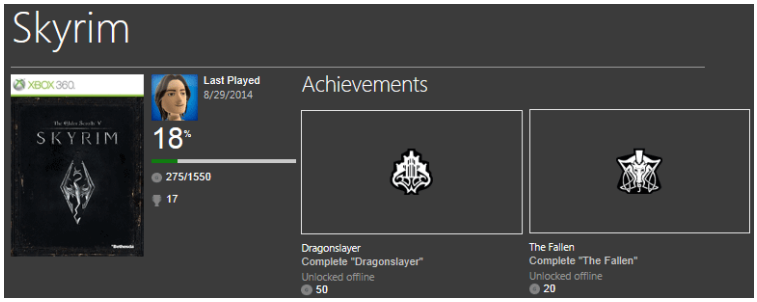

Figure 5. Xbox Live achievements (Microsoft 2016)

3.11 In-class Q&A

Lectures could be enhanced with periodic multiple choice questions, with credit rewards for correct answers. Instant feedback smart device 'clickers' are now commonplace in education, the Learning Catalytics product being one example (Pearson, 2013). The proposed software would not only provide the desirable instant feedback, but allow credits to be awarded for participation and correct answers.

3.12 Chance

To make answering in-class questions feel more compulsive, students could wager an amount of their existing credits on the outcome, for example, doubling their wager if their answer was correct. A secondary benefit is this provides another way for credits to leave the virtual economy and reduces the need to develop and offer more and more virtual items for students to spend their credits on.

3.13 Attendance

The majority of smart phones and tablets have cameras and can use QR code scanners to 'scan' a visual tag that encodes a URL and potentially a small amount of data that can be passed to the URL. A lecturer could be given a card QR tag that encodes a server URL and passes an encrypted identification code. A backend database could track specific students, courses and subjects to log attendance at lectures and tutorials as in Figure 6. Attending each session would reward the student with game credits and contribute towards acquiring virtual medals, for example: bronze - 70% attendance, silver - 85%, gold - 100%.

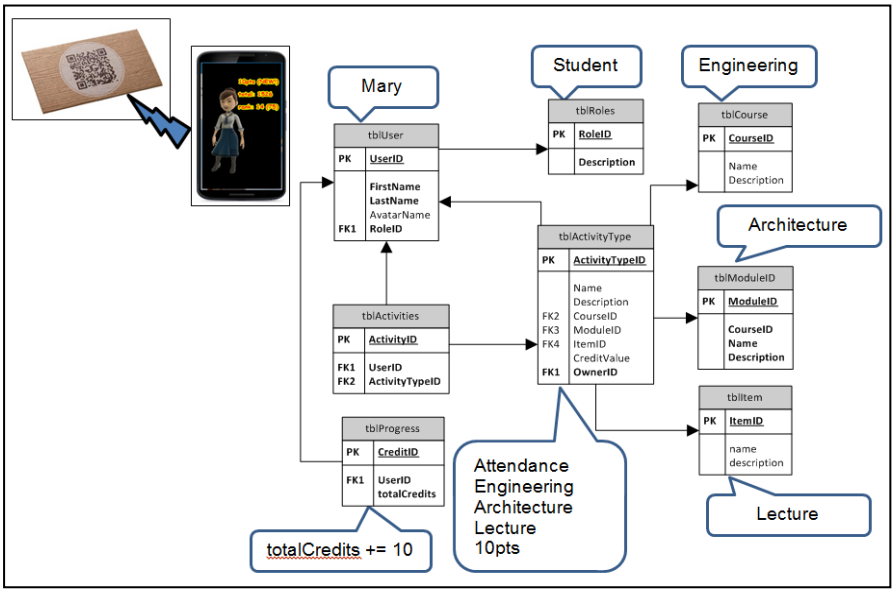

Figure 6. Attendance tracking design

3.14 Ad-hoc rewards

Some assessments are so ad-hoc there isn't time to prepare formal feedback, such as a student asking an unexpected question. The teaching staff should be able to award points (credits) immediately. Similarly the student should have confirmation instantly and directly, without effort, that they've done something worthwhile. In the example in **Figure 7**, the lecturer can find the student's profile photo, repeatedly tap to award fixed credit rewards and this is then relayed to the student's smart device to confirm the reward.

Figure 7. Ad-hoc in-class rewards

3.15 Review of shared work

Video games often have associated forums for players to share experiences of games, these often take the form of YouTube channels, store reviews (like iTunes), dedicated forums or Facebook groups. With students, a forum could be used for discussing their work. Involvement in these online spaces could be rewarded with credits, whether that means posting information, leaving comments, reviews, suggestions, ratings, etc.

3.16 Priorities

This section has covered a range of different game design principles, but it is not exhaustive and neither is it always appropriate to include all of them in all games. Certain principles may not be appropriate with a specific

game design or there may not be the time/budget to fully develop all of them. The following list arranges the principles in order of importance, practicality and relevance to the study with some initial justifications.

1. Attendance – there is clear correlation between regular attendance and student achievement.
2. In-class Q&A – if this activity can be rewarded it would map easily onto a traditional student activity.
3. Ad-hoc rewards – students know there is the potential of reward for any positive engagement.
4. Tutorials – rewarding progress through tutorials maps well to a student-university setting.
5. Avatars – a reward with zero real world value, it still has virtual value to the player.
6. Pets – a feature often implemented alongside avatars, they amplify virtual value.
7. Economy – items must have virtual costs requiring the player to perform work.
8. Virtual items – once we have an economy there must be something the player can buy.
9. Medals and achievements – it's useful to signpost significant learning outcomes or achievements.
10. Leader boards and competition – a way to encourage and promote higher performance.
11. Player matching – if we have a leader board then it's appropriate to segregate it into groups or ranks.
12. Chance – amplifies the compulsive nature of play and should increase 'stickiness'.
13. Ad-hoc meetings – it could promote peer bonding.
14. Clan home – using virtual housing to give players more things to buy and an excuse to band together.
15. Review of shared work – provides a way for students to reward each other.

3.17 System architecture

Students and teaching staff will access the system through their smart device, with progress also viewable through a browser. Unity3D will be used as the user facing technology as it supports deployment via a range of platforms (web, Windows, Android, iOS) and it is commonly used in 3D game development. All data will be stored in an online database. One potential configuration of the system is shown in **Figure 8**.

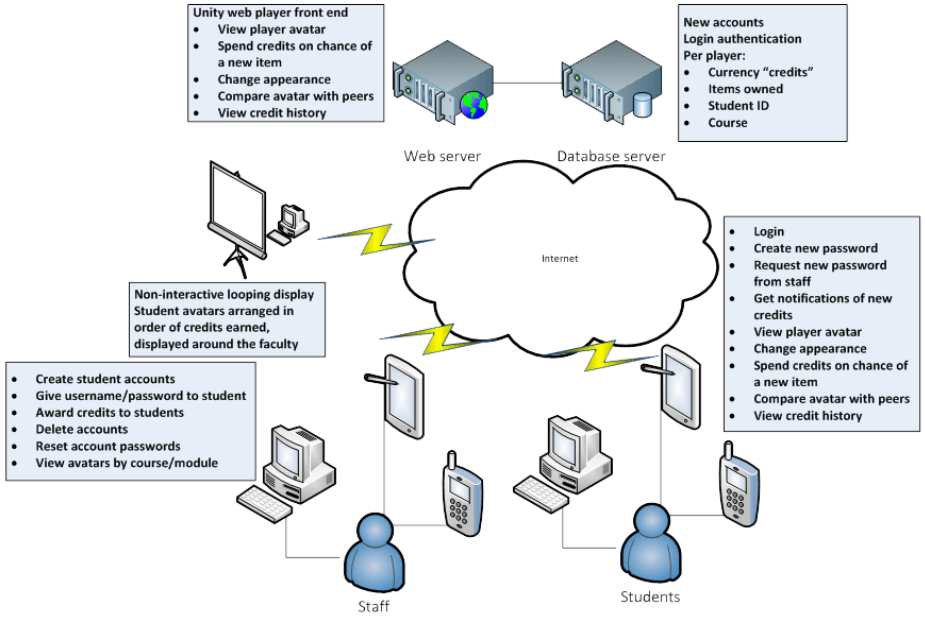

Figure 8. System architecture

Research design

A longitudinal crossover study will be undertaken to achieve the objectives outlined above. Two groups of computing students will be identified within the university to be the subject of the study, running over two semesters. The students will provide informed consent, their data will be protected and anonymised, and those who opt not to be involved will not be disadvantaged in their studies. One of the students' modules will be selected for the study. The control group will receive the traditional teaching approach, while the treatment group will use 'gamification' software. In semester2 the control and treatment groups will swap. Dependant variables that can be recorded include: attendance, dropout rate, formative and summative assessment results, with questionnaires used to assess qualitative effects such as motivation, enjoyment and belonging.
The software for the proposed study will include a client-server infrastructure to manage data. Deployment will be via desktop PC, web, tablet and smart phone. Lecturers will reward selected activities or achievements

with 'game credits'. These will be used to create video game-like avatars and fuel an achievement system with virtual ‘medals’. These avatars may then be ranked against others or joined into ‘clans’ of students. Figure 9 shows how the interface to the software might look. Key questions are: does gamification have an impact on attendance, dropout rate, satisfaction, creativity, motivation, lecturer workload and adaptability, student socialisation and attainment, plus how do students approach self-assessment (is there cheating).

Figure 9. Interface mock up

The smart learning platforms, mentioned previously, highlight a potential threat to this study’s validity, as the proposed software features similar functionality. If there is an impact on the student experience, then it will be difficult to isolate the exact cause between:

- novelty of using a smart device and being involved in an experiment
- instant feedback and ranking offered by both smart learning software and the proposed software
- game design principles unique to the proposed software platform - the point of the study

3.18 Quantitative data

These are activities where data can be measured by the software and pre-existing data exists for comparison to control groups.

- Attendance - improves course identity, socialisation and attainment, rewarded with game credits.
- Dropout rate - students who study/socialise together are less likely to feel isolated and disengaged.
- Formative assessment - in class tests, Q&A sessions, with instant credit rewards.
- Summative assessment - assignment scores could generate a proportional amount of game credits.
- Educational games - where practical, scores could be linked to meta-game credit rewards.

3.19 Qualitative data

With some activities the software can make direct measurements, but the control group can only provide a qualitative data source. With others there is no practical way to make direct measurements.

- Visiting the library - students using the software could get game credits for visiting the library. For comparison, students in a control group would be questioned as to how often they use the library.
- Cheating - anonymous survey could identify if students were cheating on self-assessment activities.

4. Conclusion

Experimenting with video games in and out of the classroom to enhance attainment and engagement has had an impact on the field of education in general and educational games specifically (McClarty et al., 2012). Avoiding creating specific educational games for specific subjects reduces the time and expense of ‘gamifying’ education (Deterding, et al., 2011) and increases the lifetime of software within a rapidly changing curriculum.

The underlying hypothesis to this work is that; gamified systems using a wide range of game design principles may increase engagement and attainment in some students without compromising creativity. Making aspects of the whole education experience more fun, compulsive and competitive could contribute to improving students' grades and helping them retain more information from their studies (Behm-Morawitz, 2013).

This PhD work is only in its first year, questions that still need to be addressed:

- If specific game design features are responsible for an observed difference in engagement or attainment, how will they be identified?
- If there is an impact on the student experience, will it be possible to identify how and why?
- Is it possible to isolate and measure the impact of the software's unique features?

- Is novelty the main motivating factor in any impact on student experience?
- How reliable are any results when the software is used by someone other than the author?
- How can any impact on student creativity be measured?

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