Optimising gamification using constructive competition and videogames

FEATHERSTONE, Mark <http://orcid.org/0000-0001-6701-6056>

Optimising gamification using constructive competition and videogames

Mark Ashley Featherstone, PGCE, BSc (Hons), FHEA

A thesis submitted in partial fulfilment of the requirements of
Sheffield Hallam University
for the degree of Doctor of Philosophy

March 2022

Candidate Declaration

I hereby declare that:

1. I have not been enrolled for another award of the University, or other academic or professional organisation, whilst undertaking my research degree.

2. None of the material contained in the thesis has been used in any other submission for an academic award.

3. I am aware of and understand the University's policy on plagiarism and certify that this thesis is my own work. The use of all published or other sources of material consulted have been properly and fully acknowledged.

4. The work undertaken towards the thesis has been conducted in accordance with the SHU Principles of Integrity in Research and the SHU Research Ethics Policy.

5. The word count of the thesis is 61990.

Name	Mark Ashley Featherstone
Award	PhD
Date of Submission	March 2022
Faculty	Computing
Director(s) of Studies	Chris Roast

Abstract

This thesis is concerned with the use of gamification to make studying more fun. Games are designed to be compulsive and enjoyable, so if we can apply game design principles to studying then it might increase student engagement. Gamification is the name given to this concept and describes how some game design principles (like points, leaderboards, competition, rewards, etc.) can be applied generically to non-gaming, real-world activities, like studying.

Many commonly used game design principles, like those mentioned, are extrinsic motivators. For example, scoring points has nothing to do with learning times tables, but points can be used to motivate someone to learn maths. Extrinsic motivation like this can have negative side effects as people may feel pressure or stress, which can then reduce the inherent enjoyment of the activity. The joy of learning, the pleasure of practicing some skill, is known as intrinsic motivation.

Some activities do not rely on intrinsic motivation; consider a worker performing a task that requires no creativity or imagination, something that can be learnt by rote. However, many activities require inquisitiveness and creativity, a key feature of intrinsic motivation; consider a student learning a new subject in a school. In these situations, great care must be taken when using extrinsic motivation (a key part of gamification) such that it does not reduce someone's intrinsic motivation. Historically, this was not well understood and gamification was used inappropriately in environments such as schools where reductions in intrinsic motivation could not be tolerated (Deci, Koestner, & Ryan, 2001).

In an education setting, where there are concerns around intrinsic motivation, and a gamification approach could feel 'tacked on'; custom designed educational games are often preferred as they can capture the essence of the activity directly. Therefore they are usually seen as more beneficial and less prone to reducing intrinsic motivation, but are often expensive and inflexible (Egenfeldt-Nielsen, 2005). *Gamification can be cheaper, more flexible and easier to embed within existing learning activities* (Sebastian Deterding, Dixon, Khaled, & Nacke, 2011). *In these studies, gamification with constructive competition was used to engage students, without using extrinsic motivational levers (e.g. real-world reward and compulsory participation) that may reduce intrinsic motivation.*

This thesis provides a theoretical and empirical exploration of "constructive competition": design techniques that seek to minimise gamification's negative effect on intrinsic motivation. Two studies are described which detail the development of a new approach to gamification design based on constructive competition and its use in classes with computing students. A mobile gamification application called 'Unicraft' was developed to investigate these ideas, and the results of the studies suggest that it is possible to design for constructive competition and create positive gamification experiences. Full results and implications are presented, providing guidelines on gamification design best practice, development methodology and an example technical implementation using mobile devices.

Publications

Featherstone, M. (2019). Optimising gamification with constructive competition and videogames. The 9th Irish Conference on Games-Based Learning. http://www.igbl-conference.com/igbl2019-cork-city/

Featherstone, M., & Habgood, J. (2018). UniCraft: Exploring the impact of asynchronous multiplayer game elements in gamification. *International Journal of Human Computer Studies*. https://doi.org/10.1016/j.ijhcs.2018.05.006

Featherstone, M. (2018). *Designing Gamification for Constructive Competition*. *GAME-ON 2018* (Vol. 19). https://doi.org/978-9492859-04-4

Featherstone, M. (2017). A formative evaluation of a gamification app containing asynchronous multiplayer game elements. In *Proceedings of the 11th European Conference on Games Based Learning, ECGBL 2017*.

Featherstone, M. (2016). Using gamification to enhance self-directed, open learning in higher education. In *Proceedings of the European Conference on Games-based Learning* (Vol. 2016–January).

Commercial games

These are all commercial projects built by teams of programmers, producers, artists and designers at their respective companies.

Featherstone, M. (1997). Actua Soccer 2. PlayStation and Windows PC. Gremlin Interactive Limited. Role – programmer.

Featherstone, M. (2000). Actua Tennis. PlayStation, PSP, Windows PC. Gremlin Interactive Limited. Role – programmer.

Featherstone, M. (1998). Hard Core 4x4. PlayStation, Sega Saturn and Windows PC. Gremlin Interactive Limited. Role – programmer.

Featherstone, M. (2002). Gun Metal. Xbox and Windows PC. Rage Games. Role – lead programmer and designer.

Featherstone, M. (2002). Totaled! PlayStation and Xbox. Rage Games. Role – programmer.

Featherstone, M. (2003). Starscape. Windows PC. Moonpod Ltd. Role – designer and programmer.

Featherstone, M. (2007). Mr. Robot. Windows PC. Moonpod Ltd. Role – designer and programmer.

Featherstone, M. (2010). Word Pirate. Windows PC. Moonpod Ltd. Role – designer and programmer.

Acknowledgements

I'd like to thank everyone who helped me finish this thesis and I must start with my wife Holly and daughter Phoebe for supporting me even when this project took up so much of my time.

A special thank you goes to Chris Roast for mentoring, supervising, cajoling, reassuring and pushing me to do the best job I can, not forgetting Jacob Habgood, for his valuable feedback. I'd also like to thank Pascale Vacher, Pete Collingwood and David Moore for allowing me to run my experiments with their students and supporting me.

Contents

1 Introduction

Games have an educational potential that is evident in their ability to motivate individuals to spend time pursuing a learning-rich endeavour, voluntarily and often without real-world reward (Aldrich, 2004; Deci & Ryan, 2002; Gee, 2003; Royle, 2009). Game play can involve acquiring knowledge, developing skills and engaging in collaborative research, without any external coercion. Much of these learning activities are game specific, but some have the potential to transfer to the real world. This thesis is concerned with the way games can motivate people to learn and how educational experiences might be designed, such that the motivational power of games can be exploited in a positive and constructive way.

Educational games are often subject specific, which makes them costly to develop and hard to adapt (Egenfeldt-Nielsen, 2005). They usually lack the development budget of commercially successful videogames and are often judged harshly in comparison. Educational content can often compromise a 'fun' game design and feel 'tacked on' (Habgood & Ainsworth, 2011). There's also no guarantee that skills learnt within the game will transfer to the real world (Van Eck, 2006). It's possible that end users will simply improve their skills and knowledge regarding playing the game, rather than meeting the desired learning outcomes (Baker et al., 2009).

In contrast, gamification is a design methodology that has the potential to avoid many of the problems faced by educational games as it ‘wraps around’ the real-world activity or process it is attempting to optimise without altering it, see Figure 1. A game’s motivational appeal is often attributed to behaviouristic reward (Hopson, 2001), and many common game design principles can be understood in this way: leaderboards, points, achievements, virtual item rewards, etc.

Figure 1. Gamification wraps around existing processes (Featherstone, 2022)

Gamification applies these principles to non-gaming contexts and not just within educational settings, see Figure 2 for a non-educational example of gamification.

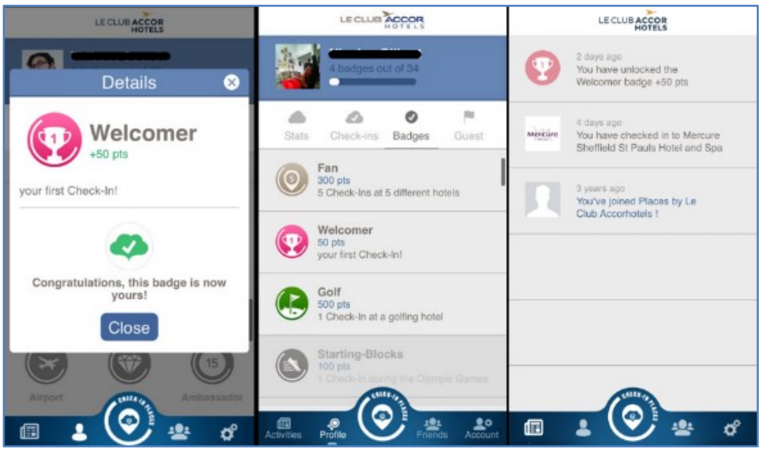


Figure 2. Accor hotels 'Le-Club' gamified customer app, left - after winning a 'badge', middle - progress screen, right - activity timeline (Accor, 2016)

In this example, the Accor hotels group wanted to enhance their loyalty program using gamification. Most people would not expect booking a hotel to be a fun experience, yet gamification can be applied to any real-world activity. Their goal was to increase customer awareness of their hotels, increase customer loyalty, increase how much was spent in their shops and restaurants, and encourage their users to attract new members. Hotel customers were automatically enrolled in the program and earned points when they booked a room, had a meal or bought something from a hotel shop (Accor, 2016). Accor created a Facebook and mobile app called 'Le-club', users would advance in rank and display 'badges' when certain requirements were met, see Figure 3. The points they were acquiring could then be used to subsidise hotel bills and therefore have real-world value.

Figure 3. Accor hotels 'A club' Facebook progress screen (Accor, 2016)

A similar approach to Accor has been used by many companies and institutions, there's nothing hotel specific within the design methodology. Contrast this with an educational game, like Assassin's Creed Discovery Tour (see Figure 4), a real time 3D exploration of ancient Egypt (Carmichael, 2018).

Figure 4. Assassin's Creed Discovery Tour (Carmichael, 2018)

It would not be practical to adapt this game for use in a history class about any other era or in a maths class. However, the type of gamification shown here provides a relatively reusable method of increasing end user engagement.

However, traditional gamification approaches (such as the Accor example) often use a small, simplified subset of game mechanics that may take too narrow a view of what makes games enjoyable, limiting the potential engagement. In the above example, the only game design features used were points, badges and leaderboards – the field of videogame design is far richer (Schell, 2008).

Gamification relies on extrinsic motivation; it adds games design principles onto a real-world task or process to try and make that task more fun and compelling. When it works, this makes people more engaged with the task, they perform it correctly, enjoy doing it, remain engaged longer or even do it faster. To achieve this, gamification often relies on competitive incentives such as financial rewards, prescriptive measurement of performance, public display and comparison of performance and compulsory participation (Sebastian Deterding, Dixon, et al., 2011). This can be stressful or perceived as controlling for users who may feel a loss of agency. Collectively, these potential negative impacts reduce intrinsic motivation, i.e. people feel that they have to do the task rather than wanting to do it.

This thesis provides a theoretical and empirical exploration of gamification design that follows a more constructive approach to competition, that is less likely to reduce intrinsic motivation. There is less reliance on stressful extrinsic motivators and greater use of videogame design principles. Both formative and summative evaluations are described. A set of guidelines are developed and tested which cover the design and development of gamification projects. A prototype gamification platform called Unicraft is developed and tested for mobile devices using these principles. An Agile development approach is taken and Unicraft is refined and tested over two versions.

1.1 Thesis structure

Chapter three provides a review of the educational literature that forms the theoretical basis for the motivational power of game-based learning, gamification and videogames. It explores the potential of games to motivate and why that hasn't been widely achieved through educational games. The empirical origins of gamification are explored, the ambition of practitioners to avoid the problems of educational games and the failure of gamification to realise that ambition.

Chapter three also focuses on intrinsic and extrinsic motivation, arguing that this is the key to realising gaming's educational promise. Competition is highlighted as a critical motivating strategy and an alternative design approach is described which attempts to optimise the constructive, positive potential of gamification while minimising the negative impact of its extrinsic motivators.

Chapter four describes the first design and development phase for Unicraft1: a mobile gamification platform designed to enhance the study experience of university students within the computing department. The game was conceived to test the hypothesis that successful gamification doesn't need to rely on as many extrinsic motivators if it more closely resembles a modern videogame in both form and substance. The design and development process is described, which resulted in the first prototype which was trialled with a small group of university students. Unicraft1 included many traditional gamification design principles (points, leaderboards, badges), but the key idea centred on a constructive competition implemented as a 3D fantasy battle. This part of Unicraft1 could be enabled or disabled remotely to examine its impact on engagement.

Chapter five describes the first empirical study to evaluate Unicraft1 (study 1) mentioned above, it used a mobile app gamification platform designed to closely resemble a 3D mobile videogame. The app was designed to promote engagement in lessons and the independent variable was constructive competition. The app was trialled with a group (n=26) of university students studying computer science. The cohort was split into two groups and a repeated measures design was followed. Student engagement with Unicraft1 dramatically increased, for both groups, when the battle game was enabled, a positive result. The study provided a range of insights into constructive competition, the logistics of using mobile apps in teaching and in how students engage. It became clear that monitoring levels of intrinsic motivation was very important. These factors led to the development of Unicraft2 and informed the design of a new study.

Chapter six describes the second phase of design and development that resulted in Unicraft2, a refinement of Unicraft1. The first study showed that removing compulsory participation and real-world reward to protect intrinsic motivation meant users were free to disengage over time as they became fatigued. Fun videogame design mechanics like constructive competition, avatars, points, leaderboards, etc., weren't enough on their own to maintain motivation and the gamification intervention would benefit from being fully embedded in the learning process. Unicraft2 includes multi-choice quiz activities that directly related to subject learning outcomes. This gave users another reason to use the app, to be reminded about the gamification project, to care about their progress and another way to earn virtual currency to spend on their avatars. The experimental methodology was also improved to include more rigorous measures of student motivation over the course of the study.

Chapter seven describes the second empirical study to evaluate Unicraft2 (study 2). Unicraft2 was used with 109 computing students over three different degree courses during a 10-week semester. The study was administered by a number of staff (helping to reduce the potential for experimenter bias), and also allowed the study to include the perspective of staff members who might ultimately be asked to use tools like Unicraft2 within their everyday practice. Metrics systems were used to gather usage information on Unicraft2 which showed that when constructive competition features were enabled there was a 193% increase in app activity. Following the guidelines that were developed, Unicraft2 used gamification to make studying more fun and compelling without reducing intrinsic motivation. As a result, attendance increased, average student attainment levels increased, and students reported an improved study experience.

Chapter eight presents a set of design guidelines for designing constructive gamification projects. It is hoped that following these guidelines will lead to gamification projects that are more likely to maintain levels of intrinsic motivation.

Chapter nine reviews and discusses the results of the studies in detail, reflecting on the guidelines that were developed and tested. It is argued that when following these guidelines, gamification can be implemented into an educational setting without relying on traditional extrinsic motivators (e.g. compulsory participation, linking to a student's final marks, real-world rewards, etc.). The guidelines suggest that by making the gamification project look and feel like a fun videogame, by using constructive forms of competition and by embedding learning activities in the application itself, students will engage and stay engaged longer, with a reduced risk of the negative side-effects common to gamification. When engaged with gamification effectively, in a positive and constructive manner, students had the expected benefits: increased satisfaction in lessons, higher marks and higher attendance.

1.2 Major aims and hypotheses

The major aims of this thesis have been to develop new guidelines for the design and implementation of gamification within settings where intrinsic motivation is important, such as higher education. Gamification is cheaper and more flexible than educational games, but it traditionally relies on powerful extrinsic motivators that are linked with reduced intrinsic motivation (Hanus & Fox, 2015). Reducing the intrinsic motivation of students (agency, independence, creativity and imagination) is an impediment to the widespread use of gamification in education. This thesis suggests that high risk extrinsic motivators can be avoided by using more game design principles than are traditionally used in gamification, so that the experience looks and feels like a videogame. It suggests that competition is powerful enough to motivate within such designs, but is less likely to have a negative impact if designed for constructive play.

Underpinning this approach to gamification are two aims:

Aim one: to explore how an increased use of videogame design principles can make gamification projects more fun and engaging.

The compelling nature of games comes from the fact they can be inherently fun to play. Using leaderboards, points and badges is merely scratching the surface of what makes a great game design. If we capture more of what makes games fun and apply that to real-world activities, then they might be more likely to be fun.

Aim two: to create gamification applications which look more like videogames, and explore their effect on engagement.

Videogames are ubiquitous in society (see chapter 2.3.1), and if gamification projects look and feel like a modern videogame then participants may find them more attractive, more likely to engage and then stay engaged.

Arising out of these core aims, this thesis forms and tests the following hypothesis about gamification:

Hypothesis: educational gamification projects that resemble videogames, use constructive extrinsic motivators and a wider range of videogame design principles are less likely to damage intrinsic motivation.

The traditional approaches to educational gamification had to compel participants to engage, this meant compulsory participation, real-world rewards (prizes) and linking engagement to final marks. This led to students feeling a loss of intrinsic motivation, stress, loss of agency and reduced creativity. Extrinsic motivators are necessary (points, leaderboards, badges, competition), but this can be implemented in a far more "light touch" approach, with more constructive forms of competition and still be compelling without forcing people to engage. Such an approach is more likely to be seen as positive and fun, with resulting higher engagement, attendance, satisfaction and grades.

1.3 Methodology and methods

The approach to the research reported is best understood by considering the professional experience of the researcher. Mark Featherstone has spent the last ten years working as a lecturer in videogame development at Sheffield Hallam University. Before this he spent 15 years working in the game industry. He has worked as a technical lead developer, game designer and indie games company owner. With commercially published videogames on PC, Xbox and PlayStation. Within this specific context a pragmatist research approach will be used. A longitudinal mixed methods study will be undertaken using a number of experiments. Primary quantitative data will be collected from custom software that the participants use, this will be complemented by primary qualitative data collected via interviews and surveys.

As already described, the research methods adopted are empirical in character but with an overarching familiarity with the skills and techniques of professional game design “Game design is a chaotic creative endeavour with no guaranteed best practice rules", see 1.4 Glossary. The game design process that can be considered to be the norm in professional practice is best characterised as iterative. As such the empirical studies provide objective data on and support an exploratory case study of game design and development. The conclusions and outcomes of the work are thus informed by both a tacit understanding of game design along with evidence based research. The resulting guidelines cannot be considered to be a methodology in themselves, but they are developed and tested by an empirically validated game design case study.

1.4 Glossary

Agile development	A software development approach that is iterative in nature. The developer cycles between specification, design, implementation and testing repeatedly over multiple versions, homing in on an ideal application.
Constructive competition	Friendly or healthy competition, where two or more people share measures of progress in a positive way to increase performance. Competitors tend to support each other, express good will and trust, even though there will still be winners and losers. Competing against the rules of the competition rather than each other.
Destructive competition	Unfriendly, stressful or combative competition. People competing against each other, in extreme cases opponents may become enemies. Sometimes referred to as 'cut-throat' or ruinous. Competitors feel uncomfortable, stressed, forced to go beyond normally acceptable behaviour to win at any cost.
Educational game	A game explicitly or incidentally designed with educational value. All games may be used in an educational setting, but educational games are usually designed to help people learn skills, learn about a subject, or reinforce learning.
Extrinsic motivation	The desire to perform some activity for reasons outside your own personal desires. For example, passing a maths exam because it is an employment requirement.

Game aesthetics	Imagery within the game that encourages a particular fantasy, for example, encouraging the player to imagine they are a fighter pilot. Design principles to encourage a player to feel appropriate emotions, for example, their plane being progressively more damaged by gunfire.
Game based learning	Any learning activity that is facilitated by a game of any kind, this links to the definition of 'educational game'.
Game design principles	Game design is a chaotic creative endeavour with no guaranteed best practice rules. Game design principles are generic ideas that have been repeatedly used in games with positive outcomes. For example, clearly communicate if a player action was positive or negative to facilitate progress within a game.
Game dynamics	Patterns of play or emergent behaviour resulting from collections of mechanics and the interaction of the player. For example, one game might include mechanics that support combat between players and also mechanics that support collaboration. Different players of the same game can then play in the way they prefer.
Game mechanics	Rules within a game that govern a player's actions, they specify how the game works. For example, if enemy characters are shot then points are earned.
Game metrics	Measuring the player's activities and progress within a game. Players can compare measures of their own progress together using points scores, for example, amount of currency earned, or the number of enemies killed. Measurement can also be used by a game designer to improve a game, for example, how long on average people play for after changes are made to a game. If that time increases then the change may be viewed as positive, if the time decreases the change could be undone.
Gamification	To take any activity that would not normally be seen as a game, then use game design principles to make that activity more fun. Rewarding the participant for performing the activity correctly, increasing their productivity or level of quality. Rewards can be virtual like points or real-world prizes. Competition is often used to increase motivation.
Gamified system or process	A process, system or activity that is not a game (e.g. cleaning hotel rooms or making mechanical components), but it has had game design elements applied to it. The aim being to make the activity more fun and improve participant performance (e.g.

	earning points for cleaning more hotel rooms or for reducing component fail rate).
Intrinsic motivation	The desire to perform some activity purely for innate enjoyment. For example, learning to play a musical instrument just because you’ve always wanted to.
Paper prototype	Game design is a creative process with no guaranteed correct formula or process. A prototype brings together game design ideas as quickly as possible so they can be tested through play. A paper prototype allows rapid brainstorming and testing. Game design principles, user interface layouts and visual themes can all be sketched out on paper and then play tested. Testing can involve actual players or just the designer thinking through a play session with the paper prototype being a prop to aid the process.
PvE	Player versus Environment – a competition where players compete with computer controlled avatars, where the competition is between the player and the rules of the game, not other players. For example, players fighting ever stronger computer controlled enemies, or players trying to avoid starving in a virtual wilderness.
PvP	Player versus Player – a competition where players compete against other players. For example, a battle game where players use weapons to kill each other’s avatars.
Simulation	A game can educate in an abstract sense, solving maths-like problems to destroy monsters. A simulation directly and virtually models the activity and may or may not contain game design principles. For example, a computer simulation of a building fire that is physically accurate and where the user identifies the correct extinguishers to use. An alternative implementation could allow users to compete in putting out the fire and earn points so there is a winner. Both are simulations of a real activity.
Virtual currency	Just as we use money in the real world to purchase items we need; within a game we can use real or virtual currency to purchase virtual items. Within a game, a player might find or win a new weapon, but they might also earn ‘coin’ through play and then be able to purchase that weapon instead.
Virtual reward	Within competitions rewards can be implicit – the inherent joy of winning, or it can be explicit, e.g. a cash prize in a gambling game or a student earning a gold star sticker. However, a reward can also be virtual, e.g. earning points that have no real-world

	relevance. Games often reward a player with virtual items like better armour, faster vehicles, more powerful weapons, in-game badges of achievement. None of those things exist outside the game.
Wagering	Making a bet. Risking something of value for the chance of a reward that is of greater value. Betting is a powerful motivator that can be addictive. For example, earning virtual currency through a time consuming in-game activity, but then making a wager using that currency which would rapidly increase its size or leave the player with nothing.

1.5 Selecting and referencing games

In addition to traditional academic research literature, any study of gamification must refer to significant and relevant games from within the gamification industry, the wider commercial game industry and the field of game design. Reference must also be made to the critical evaluation of games and the different genres of games. However, within the field of games, whether you consider commercial games, gamification or educational games, there is not an agreed method to select or even reference them (Gualeni, 2019). Games are occasionally analysed within scientific journals, such articles can then be selected and evaluated based on citation scores, the prestigiousness of the journal and whether or not they are peer reviewed. However, this is not the case for most games.

Within the game development industry there are a small number of publications aimed at professionals, such as Game Developer (Graft & McAloon, 1997) and Moby Games (Leonard, Hirt, & Berk, 1999), but most games are critically evaluated and analysed by professional reviewers within a wide variety of publications. Some publications are non-commercial independents, and some are long established and prestigious. In the past these were distributed as magazines, but now the majority of games analysis and review is online. A small number are maintained by volunteer contributions in a similar way to Wikipedia, most notably Moby Games. It is possible to rate these publications on their longevity and popularity (see Table 1):

Title and description	Details	Reference
IGN.com	• 24 million visitors • Started in 2003	(Amini, 2003)
Gamespot.com	• 14 million visitors • Started in 1996	(Deemer, Broady, & Epstein, 1996)
Kotaku.com	• 13 million visitors • Started in 2004	(Crecente, 2004)
Polygon.com	• 11 million visitors • Started in 2012	(Plante & McElroy, 2012)
Pcgamer.com	• 8 million visitors • Started in 1993	(Firme & Lahti, 1993)

Table 1. Most popular and longest-lived game review publications (Featherstone, 2022)

This analysis is aggregated by the long running web publication, Metacritic (Dietz, Doyle, & Doyle-Roberts, 1999). It combines and aggregates all game review articles relating to specific games, ordered by review score. This averages out any possible aberrations with one particular reviewer. Most critics give games a summary score, usually out of 100, and Metacritic uses this to sort different games within genres. This is not a standardised metric, each reviewer awarding a score based on varying value judgements, for example, there is no agreement as to the definition or measurement of fun. However, while this is a flawed non-standardised evaluation, it is the only one available. Gamification software is rarely reviewed by these publications or any others, as it is often aimed at industrial or educational users rather than high street customers. However, as it features the same game design principles we can draw comparisons to commercial videogames and base references on gamification projects with high numbers of users, the author's personal experience or published reviews - where that information is available (see 2.11 Case studies and experience).

2 Literature review

This chapter reviews the literature within learning, educational games, videogames and gamification, alongside a review of actual key videogames themselves, with a focus upon the use of gamification to increase engagement in educational environments. This chapter argues that games have an educational potential that is evident in their ability to motivate individuals to spend time pursuing a learning-rich endeavour, voluntarily and often without real-world reward (Royle, 2009). Game play can involve acquiring knowledge, developing skills and engaging in collaborative research, without any external coercion. Much of these learning activities are game specific, but some have the potential to transfer to the real world (Habgood, Ainsworth, & Benford, 2005).

2.1 Learning

The goal of this study is to intervene positively within a real-world higher education learning process and improve the experience and performance of participants. Therefore, it’s important to define what learning actually is and how people do it.

Learning involves the acquisition of new skills, knowledge, understanding, values and behaviours. More broadly, it is “the process by which relatively permanent changes occur in behavioural potential as a result of past experience” (Anderson, 1995). This dissertation is focused on interventions in higher education settings so the focus here is on educational learning theory.

2.1.1 Educational learning theories

There are three key educational concepts defining the relationship between a teacher and a student:

- Pedagogy – a commonly used term, but one that is hard to define, it is the science and craft of teaching or more generally, any activity by one person designed to enhance learning in another (Mortimore, 2012). Teacher centred and originally focused on children.
- Andragogy – an easier term to define, but only in its relationship to pedagogy, it refers to the method and practice of teaching adult learners (Krajnc, 1989). As students are more mature there can be a more learner centred approach.
- Heutagogy – often linked to andragogy as it usually involves more mature students, it refers to the empowerment of the student to take control of their own learning, making them more autonomous and self-determined (Blaschke, 2012). Learner led.

A number of core educational theories relate to the above three concepts (Lockey, Conaghan, Bland, & Astin, 2021):

- Behaviourism – originally described by Skinner, the process of rewarding good behaviour, a key part of pedagogy focused on the teacher. Lectures, rote learning and tutor led tutorials are part of this approach to learning.
- Cognitivism – here thinking is said to be separate from behaviour, cognitivism involves acquiring, storing and retrieving information. More related to the andragogical approach, it is student centred and often involves student reflection, problem solving, memory and thinking skills.

- Connectivism – a more heutagogical approach that defines learning as involving a variety of sources of opinion, with the student seeking them out for themselves. This can involve traditional teaching methods, but also technological resources such as the internet, with the student having agency of which sources to use when.
- Constructivism – an andragogical/heutagogical approach where students experience new concepts and skills, then reflect upon those experiences. Students explore topics without direct instruction and reflect on the experience through a process of guided discovery.
- Humanism – a heutagogical approach that focuses on the learner and their self-confidence, self-esteem and wellbeing. The student has great control over their own learning and involves the entire human perspective: knowledge, practical skills, art, the wider society, teamworking and social skills. It aims to help the learner move towards full autonomy, setting and achieving their own goals.

2.1.2 Learning in practice

People do not generally learn by listening to or reading facts alone, they learn by undertaking a hands-on journey into the subject to be learnt. Aldrich defines this process as, “full cycle learning” (Aldrich, 2004), see Figure 5.

Figure 5. Full cycle learning (Aldrich, 2004)

1. Initially a person has an incomplete understanding of some system, e.g. basic knowledge of numbers.
2. From this understanding, a goal forms, either by the student directly or from an outside influence, such as a teacher, e.g. to increase understanding of numbers by learning to multiply by ten.
3. A plan is then created, again, either by the student directly or with the help an outside influence, the teacher, e.g. memorising times tables, practicing answering questions, memorising algorithms such as shifting digits left, etc.
4. Execute the plan:
    a. Do work from the plan, e.g. writing out times tables, answering questions.
    b. Get feedback on what’s been done, e.g. a teacher checks answers and discusses the technique used.

c. Reflect on the feedback and update understanding.

d. Repeat execution until the desired level of understanding is reached, fatigue sets in or reflection suggests altering the plan (in which case return to step 1).

2.1.3 Gamification and learning

Gamification wraps around real-world processes and so can be used within any of the theories discussed, but the learning approach has an impact on gamification design decisions. For example, traditionally, gamification would use rewards for specific behaviours and goals, a clearly behaviouristic approach. However, it can also be designed more flexibly to signpost and record generally positive activities, like asking a question, a more heutagogical and constructivist approach that aids student planning and reflection.

2.2 Theories of fun

What does it mean when someone says a game is fun or that they had fun playing it and how does that relate to learning? Fun is the satisfaction that arises from learning how to play well, Crawford describes fun in games as “the emotional response to learning” (Crawford, 2003). Koster goes further with his definition of fun, “it arises out of mastery. It arises out of comprehension. It is the act of solving puzzles that makes games fun. With games, learning is the drug.” (Koster, 2013).

People and even many animals are predisposed to want to play games (Smith, 1982). To play games is a recognised indicator of intelligence. Playing games emerges from a series of important inherited survival traits:

- Practice important real-world skills safely before actually attempting to use them in earnest (both mental and physical).
- Allow groups of individuals to practice co-ordinating themselves as teams to solve problems.
- Reinforce social bonds in groups.
- Pass on skills from expert to novice in a safe environment where mistakes are not critical.
- Establish social hierarchies in a way that prevents violence.

Exercising, improving and refining our physical and mental skills is so satisfying that people began to create more and more abstract activities, often unconnected from any obvious real-world benefit, to allow them to simply play (DeKoven, 2002).

Thinking, memory and learning are all linked in the way that we identify or create patterns and map them back to reality to allow us to cope in the world and achieve our desires. Games help us learn patterns safely, to practice and gain mastery, fun is a pleasurable neurochemical response (dopamine) which helps us to keep trying. Leach said, “for a small child, there is no division between playing and learning” (Leach, 1994), while Oppenhein says, “play is by its very nature educational” (Oppenheim, 1984).

There are four core mechanics used in all games, each with the capacity to be fun (Caillois & Barash, 2001):

- Agon - competition, either against a hard problem or a person. For example, gaining the highest score in Counter-Strike, a multiplayer game of warfare (Valve, 2012).
- Mimicry - roleplay and make believe, learning successful patterns in often fantastical situations. For example, becoming a wizard and using spells effectively in Skyrim, a fantasy adventure game (Bethesda, 2011).
- Ilinx - mastering physical reactions, activities requiring physical skill, hand/eye coordination. For example, avoiding death in Super Mario by making accurate jumps across platforms (Nintendo, 2016).
- Alea - chance, gambling, risk. For example, paying to play the national lottery has an extremely low chance of success, but many choose to do so regardless for the thrill of the draw. For example, repeatedly collecting rat pelts to use in a spell that has a low probability of success in World of Warcraft, a massively multiplayer online role playing game containing probability driven rewards (Blizzard Entertainment, 2004). The activity seems monotonous, the chance of success low, but thousands of players engage just for the chance of success.

One or more of these mechanics, designed along best-practice principles and implemented within a game, are good indicators of a potentially fun experience. Games feature recurring common themes and design principles that appeal to a wide range of people:

- Fantastical situations or stories.
- Physical skills and the exercise of reflexes.
- Mental skills, strategy, tactics, planning and problem solving.

- Facilitating the player to act out the role of hero or villain.
- Competing either against other players or against the rules of the game.
- Working with other players to achieve a common goal.
- Learning how to interact with some system such that you make progress, receiving rewards and feedback on correct and incorrect choices.
- Taking what appear to be risks, but without real-world repercussions.
- Displaying your progress to other players.

In terms of gamification within an educational environment, it's desirable for students to memorise, discuss, think, practice and learn about their particular subject and when performed successfully this should be intrinsically fun assuming the student is interested in the subject. However, when performed incorrectly, inefficiently or poorly or by force, then it is not fun, therefore, if gamification can reinforce and remind students of appropriate learning behaviours, as defined by their teachers, then it should encourage more students to have fun more of the time. If the gamification design itself resembles a game more closely then even better.

2.3 Videogames

Game definitions vary, Koster says games are puzzles to be solved and provide lessons to be learned (Koster, 2013). Schell says games are problem solving activities approached with a playful attitude (Schell, 2008). Costikyan says a game is a form of art in which participants, termed players, make decisions in order to manage resources through game tokens in the pursuit of a goal (Mäyrä

& Costikyan, 2002). Zimmerman defines a game as an activity with some rules that players engage in for a quantifiable outcome (Salen & Zimmerman, 2003). For the purpose of this research the author defines a game as players taking part in playful problem solving activities, defined by rules, with a quantifiable outcome, often involving friendly competition.

Play was initially commercialised through sports games like boxing and in the home via board games. One of the most famous and commercially successful board games is Monopoly, developed and patented by Lizzy Magie in 1903, at the time it was called the “Landlord’s Game” see Figure 6. The game was meant to be fun to play, but also teach an important lesson about the inequalities and exploitation inherent in capitalism (and therefore also crosses over into section 2.4 as an example of an educational game). Over the years this lesson has often failed to transition from the game to the real world and many players are not aware of Magie’s underlying aim in developing the game.

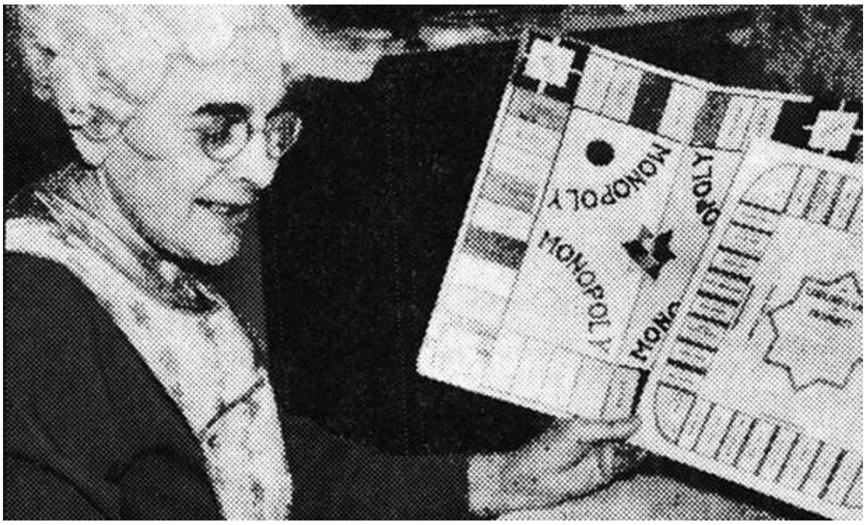
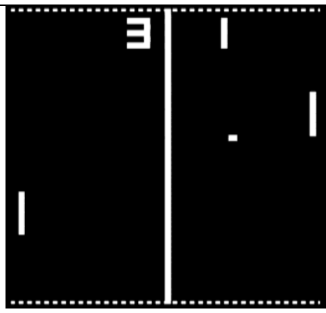


Figure 6. Lizzy Magie's "Landlord's Game", (Anspach Archives, 1936)

Electronic games, known as videogames, began to appear in the 1970s and quickly became very popular. A videogame refers to any game that is accessed through an electronic device such as a PC, television, mobile phone/tablet, dedicated console hardware or arcade machine (see Table 2).

Hardware	Example screenshot	Description
		**Pong Arcade machine** Manufactured by Atari in 1972, a simulation based on table tennis. Arcade cabinets played a single game, were coin operated and could be found in the high street. (C.C.H, 2020)
		**Atari VCS 2600** Manufactured by Atari in 1977, capable of playing multiple games sold on cartridges. Example shown is 'Sky Diver' from 1979. One of the first home consoles using a normal television. (Atari, 1995)
		**Super Mario Brothers Game Watch** By Nintendo and released in 1989, based on the popular Super Mario franchise. (Pad and Pixel, 2020)
		**Snake** By Nokia, came preinstalled on the Nokia 6610 mobile phone in 1997. (Wright C, 2016)

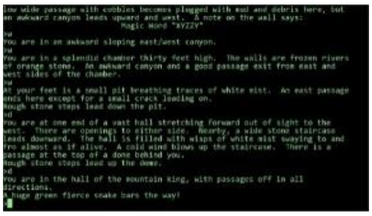
		**Colossal Cave Adventure** A text-based adventure game, released in 1975 by Will Crowther for Dec PDP-10, then widely distributed as a browser based web game. (Bartle R, 2002)
		**Maze War** An early multi-player online networked game released in 1974 on the Imlacs PDS-1. (DigiBarn Games, 2004)

Table 2. Early examples of videogames (Featherstone, 2022)

User demands for improved graphical fidelity have driven rapid advances in processing power in videogames, often based on ever more realistic visuals (see Table 3).

Hardware	**Examples screenshot**	**Description**
		**Dance Dance Revolution A20** An arcade game made by Konami and released in 2019. A physical game based on rhythm. (DDRCommunity, 2020)
		**PlayStation 5 home console** Manufactured by Sony in 2020. Can play multiple games distributed either by disc or online download (Sony, 2020). Example game, Assassin's Creed Valhalla by Ubisoft 2020.
		**PUBG** Player Unknown's Battlegrounds or PUBG is a mobile 'battle royale' style game (Jagneaux D, 2018). Phone shown is the powerful Samsung S20 Ultra released in 2021.

		**Minecraft: Pocket Edition** Minecraft is a hugely popular 'open world' game involving construction (Fulton M, 2021). It was released on a variety of hardware and is shown here on a Samsung Galaxy TabS7FE Android tablet.
		**Fortnight** An online multiplayer game by Epic released in 2017 (Metacritic, 2017). The hardware shown is a home PC with exponentially more processing power than the PCs shown in the previous table at a fraction of the price.

Table 3. Recent examples of videogames (Featherstone, 2022)

2.3.1 Videogames are ubiquitous in society

Videogames are extremely popular throughout the world and have now become ubiquitous in society (Yanev, 2022).

- 2.5 billion people are estimated to play videogames.
- 64% of US adults and 70% of those under 18 play videogames regularly.
- 41% of US gamers are women.
- In a survey of internet users from 43 countries, on average 83% admitted to playing videogames (Clement, 2022).

2.4 Educational games

For centuries there has been a fascination in using analogue games for purposes beyond purely abstract play, due to their appeal to both young and old. Chess is perhaps the most famous example, an abstract battle strategy game, used by the military as far back as 600 A.D. and still studied today within some military colleges (György Kende, Bjkmk, & Kmdi, Seres Zmne, 2006). Schools have used analogue games within teaching as far back as Friedrich Fröbel in 1840 (Powell, 2012) with his simple educational toys (Pound, 2008) and continue to use a wide range of analogue educational game genres in the classroom, including Fröbel's originals (see Figure 7).

Figure 7. Froebel's Gifts, some of the first sets of wooden blocks for creative play (Powell, 2012)

In the early 1970s, cheap mass-produced home computers were introduced to the public and entertainment videogames transitioned from the arcades to the home. Starting in 1972, iconic franchises like Pong became commercial hits (C.C.H, 2020). As analogue games had been used in education for decades it was natural for the development of educational videogames to follow closely behind the commercial success of entertainment videogames.

Example: The Oregon Trail

One of the first examples is the now famous 'Oregon Trail' from 1971 (see Figure 8), which became so popular the developer created numerous iterations of the game under the same brand over the following years (Mott, 2013). It was widely used in American elementary schools up until the early 2000s.

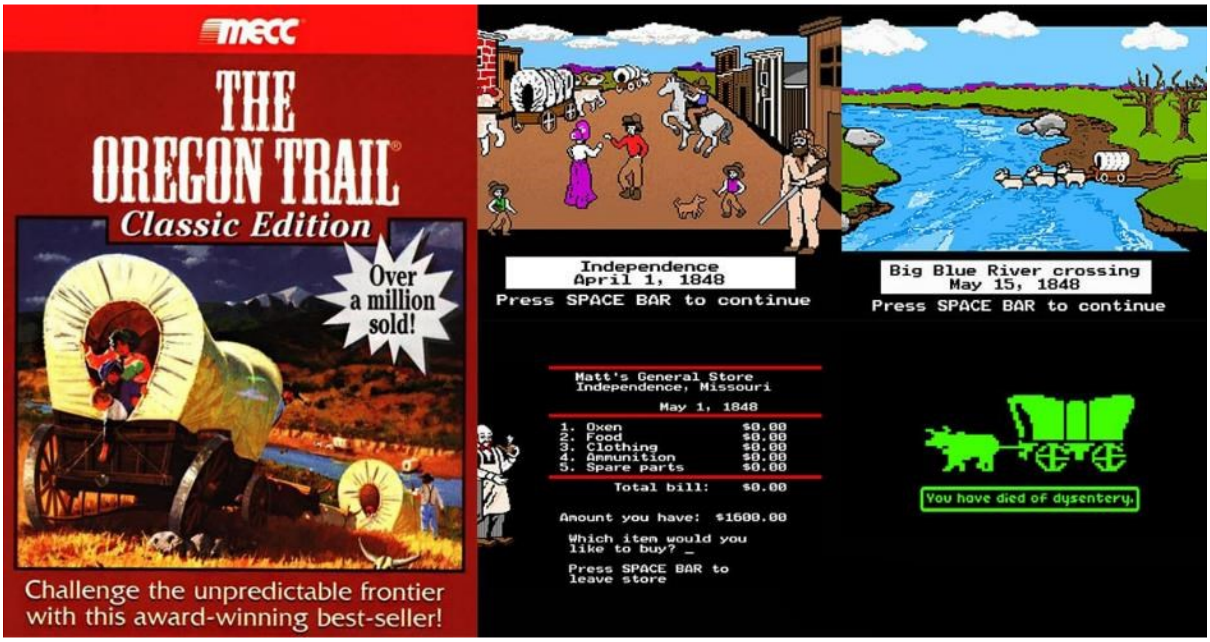


Figure 8. The Oregon Trail – left game box cover art, centre top a town along the trail, centre bottom purchasing supplies, right top a potential danger point on the trail, right bottom a famous negative outcome (Mott, 2013)

The game was designed as an engaging way for students to learn about American history, specifically about early pioneer experiences on the Oregon Trail. Initially it was text only, later graphics were added to keep pace with growing consumer expectations regarding graphical fidelity in videogames. In the game, students are asked questions that might have faced the early pioneers and the students' responses influence whether they survive to the end of the trail. An element of randomness is used to ensure the experience is somewhat different for each player. Challenges such as storms, violent attacks and hunger test the decisions the player has made regarding the route, supplies and equipment taken. Compared to reading about the challenges the pioneers faced in a traditional history lesson, this game immerses students in the world of the pioneer. For example, if the student fails to take enough food a virtual family member might starve, take the wrong clothing and they might freeze. This visceral experience is very compelling.

Example: Number Munchers

Educational games don't have to be realistic to still be compelling, the videogame 'Number Munchers' was introduced in the 1980s (see Figure 9), after a commercially successful release the developer created a variety of similar games over the following years that were popular with American schools (Mecc, 1990). These games covered parts of the maths curriculum directly within the rules of the game. In Figure 9, an early version of the game, the player moves around the board and 'eats' numbers:

- Factors – given a number, eat its factors
- Multiples – given a number, eat its multiples
- Primes – eat prime numbers
- Equality and inequality – find equations that do or don't equate to the given value

Figure 9. Number munchers – left multiples of 2 game mode, middle multiple of 5 game mode, right game box cover art (Mecc, 1990)

Like ‘The Oregon Trail’, this game embedded learning outcomes directly, the only way to be successful in the game was to understand the mathematical concepts it was designed to use.

Summary

Educational games are designed to embed specific educational content within an engaging and compulsive game. Consequently, they tend to be subject specific, designed to enhance engagement and scaffold learning in a single subject, set of learning outcomes or curriculum (Egenfeldt-Nielsen, 2005). Creating bespoke games for explicit learning outcomes is costly and potentially limits the usefulness of the game outside of the specific context for which it was created and makes it hard to adapt to changes in curriculum content (Clark, 2007).

Games like ‘The Oregon Trail’ and ‘Number Munchers’ were technically very simple and therefore easy to develop. However, the complexity and graphical fidelity of videogames has always risen as technology improves, so player expectations are constantly increasing and new, more sophisticated versions of games must be produced regularly. As graphical fidelity and complexity increase so does development time and cost. There is a balance to be maintained, educational games can be very powerful when designed around specific learning outcomes, but that power comes at great cost. Educational experts and videogame design experts are required, development time is long and the resulting app is often inflexible when the curriculum changes and not applicable to other subjects. Where educational games lack the resources of commercial videogames, students may see them as poor quality (Bruckman, 1999). A game with the same production values as “The Oregon Trail” or “Number Munchers” would not be acceptable to many current students.

2.4.1 Intrinsic Motivation for Learning

What is it that motivates someone to learn a new skill? Sometimes people have an inherent compulsion and enjoyment in learning a new skill, this is intrinsic motivation. Sometimes they are compelled by external factors to learn, for example, because they see their peers performing the task or they are offered a reward by a teacher. Within the same class, one person may be immediately intrinsically motivated, while another will require some external motivation (the offer of a reward perhaps) before they engage. Over time, one student may begin to focus more on the inherent pleasure of learning and less on the reward, while for another it might be the opposite. Educational environments and their students are very complex and fluid.

What is it that demotivates someone? A student may be enjoying learning a new skill, but then they find progress slows and the next step is too hard. Perhaps they become bored, the task becoming too easy and they see learning as repetitive or they fail to make progress at the same pace as their peers. They may feel the teacher is forcing them to learn and they lose interest.

Intrinsic motivation describes that inherent interest, the joy people often feel learning a new skill, the desire to do something without any external pressure or reward, just for the fun of it. Schools aim to create environments where students’ imaginations are nurtured and there is a natural desire to learn. Within a school, where there is a set curriculum, compulsory testing, punishments and prescribed learning outcomes, problems can arise when a student's natural curiosity and will to learn are not engaged. Where learning is only achievable by rote practice, engagement will be limited. Learning environments should be designed to nurture and amplify people's intrinsic motivation without obvious rewards (Malone & Lepper, 1987).

It was around the time of Lepper and Malone's seminal paper on motivation that we began to see mass market games consoles both in the home and in schools and the development of and research into educational videogames. More recently, Koster (2013) described how a well-designed game can be inherently (intrinsically) fun and engaging to play for millions of players even though it uses many extrinsically motivating design principles (points, leaderboards, competition, etc.). This is what makes game design, and therefore gamification, a complex creative process requiring a skilled and experienced designer.

Games require players to engage in ways which are common to educational settings:

- Learn a set of rules so the player understands how the game is played.
- Understand the setting of the game and how that setting interacts with the rules.
- Practice over time to apply those rules and make progress in the game.
- Get rewarded for doing something correctly – as defined by the rules.
- Feel motivated, either extrinsically or intrinsically to keep persevering until mastery is achieved.

Usually, players are not forced to play games, yet they choose to do so in their millions and spend hundreds or even thousands of hours playing them. Games use extrinsic motivators like competition and points, yet when done well, players are still intrinsically motivated to play.

Education can be perceived by some students as work and not enjoyable (Egenfeldt-Nielsen, 2005). If education could be more like a game then students might therefore be more motivated to engage with learning. In the 'Number Munchers' example shown previously, note how some of the game rules (e.g. eat prime numbers, etc.) matched an educational learning outcome. So simply playing the game reinforced desired learning.

2.4.2 Gamification or educational game?

Gamification has the potential to avoid some of the problems faced by educational games. A game's motivational appeal is often attributed to behaviouristic reward (Hopson, 2001), common gaming activities can be understood in this way: acquiring items for a virtual avatar, unlocking a new location, virtual badges, enhancing peer recognition, increasing points scores, acquiring higher rank, unlocking new skills, etc. Gamification applies these features to non-gaming contexts, 'wrapping' around an existing task or process. For example, the United States army created 3D simulations of combat to train new recruits (see Figure 10).

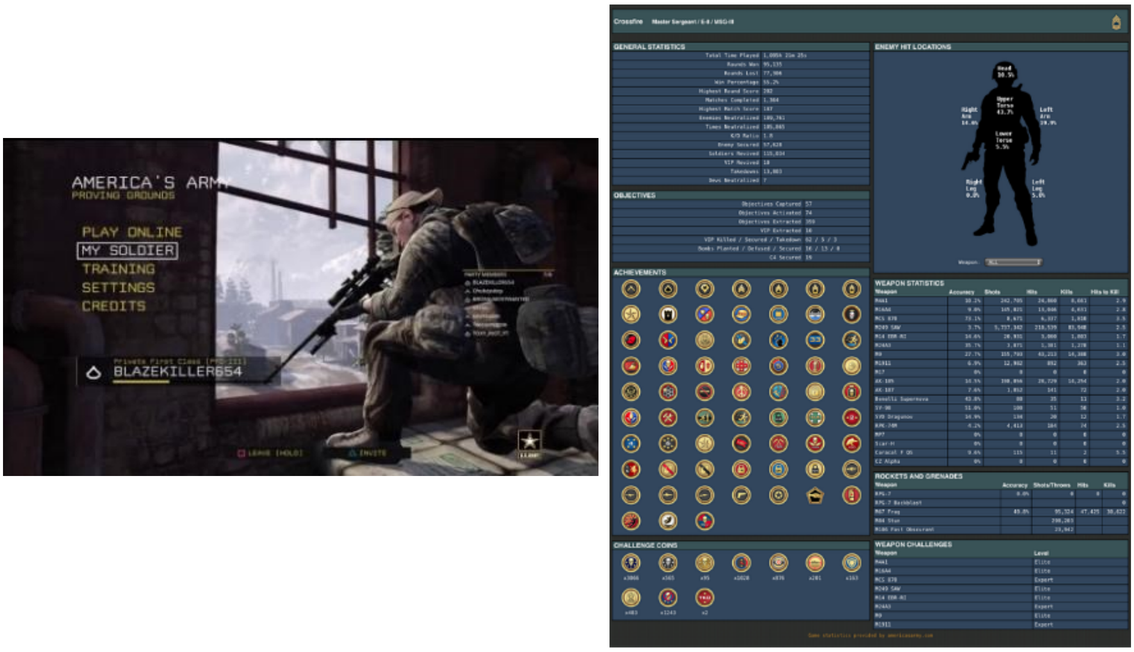


Figure 10. America's Army: Proving Grounds - left a screenshot from the game, right one of the gamified ranking screens (United States Army, 2020)

To make the simulation more fun and to encourage participants to improve their performance they added gaming features to the training simulation such as points and leaderboards. A modified version of the training simulation was released to the public under the name 'Proving Grounds' as a recruitment tool, with gamification features such as player ranking leaderboards used to increase its popularity and levels of engagement without requiring significant changes to the simulation (United States Army, 2020). Unlike educational games, gamification projects can be more general in nature, applicable to a range of activities. This makes them easier to develop, more reusable, more flexible and faster to implement than an educational game.

However, traditional gamification approaches often fail to capture the full spectrum of game design principles, potentially taking too narrow a view of what makes a game enjoyable by only focusing on what makes them extrinsically motivating from a behaviouristic perspective (Skinner, 1963). Skinner found rewards and random chance to be particularly motivating and compelling, in extremes this even led to negative destructive behaviour reminiscent of addiction. Gamification often relies on incentives such as monetary rewards, but it isn't a binary outcome where rewards are always positive or always negative. It depends on the environment and how the rewards are chosen and implemented. When a person focuses too much on the reward instead of the task, intrinsic motivation falls, the task feels like work to complete before the next reward.

When people feel like they must complete a task simply to get to the next reward or 'progress badge', when they feel they have no control over the task itself, they lose agency or independence. Agency is a critical element for fostering intrinsic motivation, considered by many to be an extremely important feature of productive learning environments (Cerasoli, Nicklin, & Ford, 2014; Danner &

Lonky, 1981; Deci & Ryan, 2002). When someone has agency, they have control over when a task is performed, how it is performed and when to stop.

Where people exhibit high levels of intrinsic motivation they are said to be in an optimal learning condition (or flow state), where the pace of learning is rapid and creativity is high (Csikszentmihalyi, 2014). Chen describes flow as a situation where someone feels totally immersed within a task (Chen, 2007). Something they find challenging, but not too hard, where they receive regular feedback, are compelled to continue and make steady progress (see Figure 11).

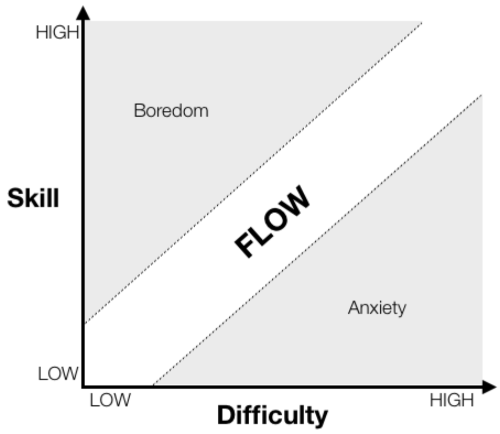


Figure 11. the ideal learning state of flow (Chen, 2007)

When in a flow state people are often unaware of what is happening outside the task and feel like time is passing quickly. They may be enjoying the task or just determined to complete it. Although behaviourist approaches may have the potential to limit intrinsic motivation and flow, modern theories of game design draw upon a much wider range of motivational design principles than just behaviourism and seek to maintain flow states for longer (Koster, 2013; Schell, 2008).

People generally find competition and reward compulsive and engaging, it can be used to encourage and maintain a flow state within games; hence it takes a central role in the design of many gamification environments, but competition and reward can be problematic. Early research into the motivational potential of games was quick to identify the potential of competition to both increase and decrease motivation (Lepper & Malone, 1987). More recent studies have found negative effects of competition for gamification in educational settings where social comparison is a significant affective driver (Hanus & Fox, 2015). The role of competition in the classroom has also been questioned more generally (Reeve & Deci, 1996). Within the field of psychology it has been shown that rewards tend to reduce intrinsic motivation and lower performance (Deci & Ryan, 2000). Both competition and rewards are seen as core levers within gamification to make a task compulsive and engaging, but often these design principles have negative side-effects.

If gamification results in lower intrinsic motivation for some users, then its educational value is questionable. Yet it would be confounding if this were true as there are so many videogames that use competition and rewards while being undeniably intrinsically motivating (Koster, 2013). There is relatively little research which has considered whether gamification projects are capturing the most appropriate game design principles.

2.5 Features of Gamification

Gamification refers to the "use of design elements characteristic for games in non-gaming contexts" (Sebastian Deterding, Dixon, et al., 2011). It is a recent term with differing opinions as to its origin: Jakubowski claims it originates with Nick Pelling in 2002 (Jakubowski, 2014), but Deterding claims other origins in 2008. Gamification can be found in education (A. Cohen, 2011), corporations and government programs (Sebastian Deterding, Sicart, Nacke, O'Hara, & Dixon, 2011), but its popularity and application to diverse processes means definitions need continually updating (Raftopoulos, Walz, & Greuter, 2015). There are even reusable gamification toolkits designed to allow the user to quickly gamify any industrial or commercial process that uses a website, such as Badgeville's "Social Fabric" tech (Laird, 2017; Rigsby, 2012), see Figure 12.

Figure 12. Badgeville's "widget studio" (Rigsby, 2012)

Note: 'Widget Studio' allows any website to reuse common gamification technology such as leaderboards, ranking and badges with plug-in customisable widgets.

Gamification can make products and processes more compelling, see section '2.11.1 Successful gamification case studies', but success is by no means guaranteed due to the complexity and unpredictability of the design process (Kleinberg, 2012). Gamification attempts to map the underlying game design principles of fun and compulsive games to real-world activities like education, commercial industrial processes and everyday activities, see Figure 13.

Figure 13. Gamifying activities and processes (Featherstone, 2022)

Industrial • Building widgets • Cleaning room	Examples of industrial processes that might benefit from increased quality, productivity or adherence to a specific process. All things that gamification can focus on improving.
Educational • Learning multiplication • Creative writing	Examples of educational topics or learning outcomes that might benefit from higher student engagement. Something gamification might improve.
Real world • Exercising • Booking a hotel	Examples of real world activities where measurement is possible and therefore gamification might be applied.

Care must be taken to avoid confusing gamification with the idea of transforming an activity into a game, for example, Grand Theft Auto (Rockstar Games, 2013) contains a realistic simulation of driving (see Figure 14), but this is not gamification. The driving game they built cannot be applied in a generic way to gamify other real-world processes, it is specific to driving. Although it appears realistic, it’s designed purely for fun, not to teach the player how to drive appropriately in the real world.

Figure 14. Grand Theft Auto 5 driving sim (Rockstar Games, 2013)

This thesis is concerned with the application of game design principles which go beyond the typical features applied to many gamification projects. As an emerging field, gamification does not yet have one defining design framework to guide development, but Mora et al found that psychological aspects, specifically intrinsic motivation were given great importance (2015). Deterding's 'lens of intrinsic skill atoms' (2015), for example, extends Schell's seminal game design work, 'A book of lenses' (2008) into the field of gamification and embraces an

Agile-like iterative approach (Keith, 2010). However, these lenses are framed in terms of questions rather than specific guidelines or feature sets.

Deterding's earlier definition of gamification (Sebastian Deterding, Dixon, et al., 2011) suggested that badges, leaderboards and levels were all design patterns characteristic to gamification (see Figure 15). However, other authors have argued that basing definitions of gamification on a set of game elements is problematic (Fuchs, Fizek, Ruffino, & Schrape, 2014) and some have suggested that game design is too complex an activity to be reduced to formal methods at all (Crawford, 1984).

Figure 15. Entegy's conference gamification platform (Entegy, 2019)

Note: Gamification has wide application, Entegy's conference management platform features a mobile app gamification system customisable to any conference, with the novel idea of improving engagement of conference visitors by turning their engagement into a game. It is, however, a very straightforward system of points, badges and leaderboards.

Nonetheless, Petty and Van der Meulen assert that, "Poor game design is one of the key failings of many gamified applications today" and went on to predict that 80% of current gamified applications would fail to meet business objectives as a result (2012). As such it is clearly useful to have some guidelines to inform the effective design of gamification. One solution suggested by Deterding (2011) is "to treat game elements as a set of building blocks or features shared by games, comparable to Wittgensteinian family resemblances". In line with this perspective we have sought to examine specific examples of gamification projects to establish a set of characteristic features and design patterns, see Table 4.

In line with Deterding (2011), we see from Table 4, that leaderboards, points and rewards are a reoccurring design pattern within these examples, as to a lesser extent are videogame imagery, competition, automated testing, real-world rewards, badges and reward schedules. In all of these examples, gamification does not make the core activity more game-like, it wraps concepts from game design (particularly points and leaderboards) around the activity to make it more enjoyable and/or competitive (Sebastian Deterding, Dixon, et al., 2011). This encourages the user to perform the activity correctly or to a higher level of quality or with improved efficiency. A common implementation technique in gamification is the use of metrics to assess progress, these metrics result in richer feedback to the participant and the underlying process becomes more measurable and transparent. It becomes easier to make comparisons between 'players' and reward progress, creating a highly motivational framework to apply to any activity (Duggan & Shoup, 2013).

So, while proliferation in gamification projects makes generalisations difficult, the 'family resemblances' of gamification projects could be characterised as applying leaderboards, rewards, videogame imagery and badges to:

- Scaffolding a desired process or behaviour, by providing points and feedback to reward those that follow it correctly (based on measurements of the process or behaviour).
- Rewarding those that complete set tasks with greater efficiency and/or higher quality than their peers, or their own previous attempts at the task.
- Make an activity more enjoyable without altering the core activities behind the original process or behaviour.

Example	Description	Design patterns
Barr et al., 2016	Library Tree is a web app designed to increase student engagement with a university library. It links to the student's library account and points can be earned for borrowing books, entering the library and engaging with the less utilised aspects of the library service.	Points, leaderboards, badges and progress recording.
Kuchinskas, 2013	Telemetric apps that gamify fuel efficient or safer driving for insurance and delivery companies.	Points, leaderboards, ranks, real-world rewards.
Delta air lines, 2017	Frequent flyer miles which allow loyal customers to earn points that can be turned into real-world rewards.	Points, leaderboards, ranks, real-world rewards.
Zichermann and Linder, n.d.	Supermarket loyalty cards which allow shoppers to earn points they can spend on physical goods. These often encourage shoppers to 'game the system' with special offers on items they might not particularly need, but buy anyway to take advantage of temporary points boosts.	Variable ratio reward schedules.
Whitson, 2013	Nike+ collects data on daily exercise, tracking distance, time, location, speed and creating a historical record with rewards for progress.	Badges, progress recording.
Lithium, 2017	Mobile phone network provider, Giff-Gaff's rewarding customer-led company promotion activities such as answering other customer questions, recruiting new customers or promoting the company on social media.	Tracking and rewarding diverse real-world activities.
Fuller, 2017	The Google Maps badge scheme where users are encouraged to provide reviews, images and answer customer questions for points.	Videogame imagery, social media display of rank.
Herger, 2012	Staff training programmes such as the 'Road Warrior' marketing training app by technology company SAP. It uses a quiz style game to rate the performance of staff.	Automated evaluation using multiple choice tests and competition.
Duolingo, 2011	Language learning program that uses a variety of quiz style games to encourage users to practice their language skills.	Social media display of rank, mobile app, daily reminders, leader boards, quiz, badges, competition.
Entegy, 2019	Mobile app to increase engagement in conferences, sold as part of a customizable platform. Conference goers can earn points by increasing engagement in the event.	Leaderboards, points and badges.

Table 4. Examples of gamification (Featherstone, 2022)

2.5.1 The challenge of Intrinsic Integration

Videogames, as opposed to simulations, often use fantastic themes and settings to evoke the interest and curiosity of the player. In an educational game these fantasies can be extrinsic or intrinsic to the learning outcomes. For example, a science fiction story about a spaceship racing to the moon before the crew run out of oxygen, the player might solve maths questions with a right answer advancing the ship and a wrong answer retarding it. This would be an example of an extrinsic fantasy, as the learning activity (answering maths questions) has nothing to do with the fantasy of the game (piloting a spaceship). Intrinsic fantasy involves the theme, setting, story and play activity being directly blended with the learning outcomes. Take our spaceship example, if the player had to use mathematical formulas to control the production of oxygen, playing the role of science officer perhaps, then the maths learning outcomes would be intrinsic to the fantasy of the game. Intrinsic fantasy is generally more interesting and with higher educational potential (Malone & Lepper, 1987).

However, more recent work has highlighted how intrinsic fantasy creates its own practical problems in terms of connecting the fantasy to the desired learning outcomes and then resulting in an artefact that is so tightly connected to specific learning outcomes that it becomes difficult to adapt if those learning outcomes change (Habgood & Ainsworth, 2011; Kafai, 1995).

In both ‘Number Munchers’ and ‘The Oregon Trail’ the educational content or learning outcomes are embedded directly within the rules of the game. A student who enjoys playing the game is intrinsically motivated to master the skills and knowledge needed to play well. By definition this means the game is designed with those learning outcomes in mind and this means such games cannot be used to teach other learning outcomes without significant modification.

The advantages of a non-integrated approach are that it is possible to separate the game from the learning, which makes the game easier, cheaper and faster to adapt to new learning outcomes. One of the most common non-integrated approaches is the simple quiz, Kahoot is a very popular example using mobile phones as response clickers (see ‘4.1.6 Smart devices in education’). Here the fun part (e.g. earning more points in a quiz, killing the next monster, etc.) is predicated on the student correctly answering a question (e.g. entering the answer to a maths problem). The student is now extrinsically motivated to learn, i.e. they want to make progress and the questions are an obstacle to that progress and not actually embedded within it. The educational content is something they must endure to make progress in the game and is separate from the game. In Unicraft1, experimental gamification software created for this study, players’ avatars battle undead monsters, this has nothing to do with the learning activity, but the virtual currency needed to ‘power up’ your avatar comes from making progress in class (asking questions, completing assignments, regular attendance, etc.).

Such separation makes a game more flexible and applicable to almost any learning outcome. Making a new set of questions for a Kahoot quiz, regardless of subject, is very straightforward. However, where we rely on non-integrated extrinsic motivation, like a quiz, there is a greater risk of reducing intrinsic motivation and the activity is more likely to be perceived negatively (Deci & Ryan, 1985; Habgood & Ainsworth, 2011). This is because a non-integrated approach, if not designed very carefully, can be seen as external or separate, bolted on, an obstacle to performing the task. There is a subtle balance to be struck, the more use that is made of extrinsic motivational techniques, the more likely the user is to feel compelled to participate for longer periods, this is important. However, the more we rely on extrinsic motivation the more likely it is that levels of intrinsic motivation will fall. The risk being that the user will become solely focused on the gamification techniques being used and lose interest in the underlying real-world task e.g. the person is focused on being top of the leaderboard rather than learning their multiplication tables.

When someone plays a game, they are usually interested in having fun, but that is a difficult state to define. It can feature elements common to optimal learning: making progress, exploring possibilities, understanding how something works, overcoming obstacles and gaining mastery (Schell, 2008), engagement and total immersion or flow (Chen, 2007). To do this the player has to understand the rules of the game and make informed decisions, often applying tactics and strategy to plan for success. Games usually get more challenging over time, requiring the player to practice and perfect their skills and knowledge to keep making progress (DeKoven, 2002). Some games are extremely complex, challenging and require hundreds of hours of practice to complete. This demonstrates players are learning, they are deciphering winning strategies, understanding and remembering the rules, perfecting skills, creating mental models, predicting the outcome of decisions, making decisions, experimenting and planning (Kiili, 2005).

In many games the player has simply learnt to play the game well and the skills and knowledge they have acquired have no application outside the game. As a piece of entertainment, that is perfectly acceptable. Educational games are designed to be fun, engaging and teach the player skills and knowledge that transfer into the real world. This is problematic as learning is less predictable during play than in a traditional taught lesson; it is difficult to embed educational content within a game without compromising a 'fun' design, and the educational aspects can easily end up feeling 'tacked on' as they sometimes can in a non-integrated approach (Habgood & Ainsworth, 2011).

Unless a game is designed very carefully there may be shortcuts or strategies that enable progress without actually learning anything transferable (Baker et al., 2009; Guillén-Nieto & Aleson-Carbonell, 2012). For example, in ‘Number Munchers’, if the questions weren’t random then the player could memorize the answers and play just for the fun of seeing their character move and earn points. In ‘The Oregon Trail’, if the calamities befalling the player were small in number, the player might just memorise the appropriate button to press with no understanding of what it meant outside the context of making progress in a game.

Educational games attempt to avoid problems that would limit knowledge transfer by exhaustive testing, but clearly there may be other ‘cheats’, shortcuts or dominant strategies not discovered during testing. People are inventive and unpredictable, testing for learning is complex, so it can take experimentation and a lot of time to be confident the students are actually learning something that has application to the real world (Van Eck, 2006).

Gamification can reduce intrinsic motivation when students perceive it to be an obstacle to the learning activity, something that isn’t integrated (Ryan, Rigby, & Przybylski, 2006). Educational software, custom designed to the learning activity, with integrated learning activities blended into the rules of the game, is often seen as a more ideal solution.

However, when considering the difficulty in achieving actual knowledge transfer to the real world, the long development time and the inflexibility of the software (tied very specifically to certain learning outcomes) it is not so clear cut (see Table 5). Well-designed gamification does not interfere with the actual learning activity, it wraps game design principles around it. Well-designed gamification is not an obstacle to learning, but an enjoyable related activity. Gamification design, like game design in general, is a creative process requiring the input of an experienced designer with no guarantee of an optimal output. Educational games are similarly problematic, but less flexible.

	Educational game	Gamification application
Can learning outcomes be integrated?	Yes, consider a virtual darts game, the player must perform certain maths calculations when deciding where to throw the next virtual dart.	No, consider a quiz where the player earns points for answering questions correctly relating to the lesson's learning outcomes.
Is knowledge transfer guaranteed?	No, the game may incorrectly integrate learning outcomes such that the player simply learns to play the game better.	Yes, the underlying learning activity should not be changed by gamification.
What is the potential for learning impact?	Very high, a well-designed educational game integrates learning directly into a compelling fantasy.	High, gamification can make learning more fun, but it doesn't have the same potential as a well-designed educational game.
How flexible is the application likely to be?	Low, an educational game's power comes from it being designed to integrate learning in a specific topic.	High, gamification can use generic game design principles without being specific to a particular topic.

Table 5. Comparison of educational games and gamification (Featherstone, 2022)

2.6 Gamification design frameworks

Many authors have attempted to capture best practice in the design of gamification interventions. Some of these gamification design frameworks provide a high level definition of gamification design, which follows an Agile approach (Marczewski, 2017), but doesn't capture enough practical detail, see Figure 16.

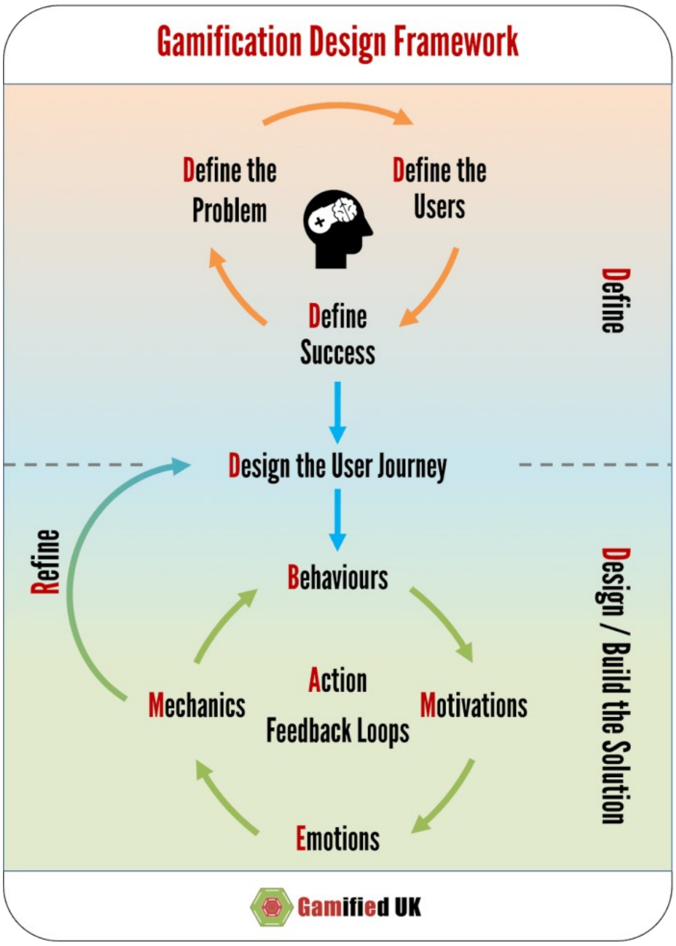


Figure 16. Gamification design framework (Marczewski, 2017)

Others are more detailed and some of these will be briefly summarised.

2.6.1 A framework for increasing the sustainability of gamification impact

A user centred agile process, the framework suggests a focus on intrinsic motivation and elimination of extrinsic reward (Almarshedi, Wanick, Wills, & Ranchhod, 2015). The author envisages gamification applications that identify a student's specific needs and provide feedback and encouragement in a context sensitive manner, see Figure 17.

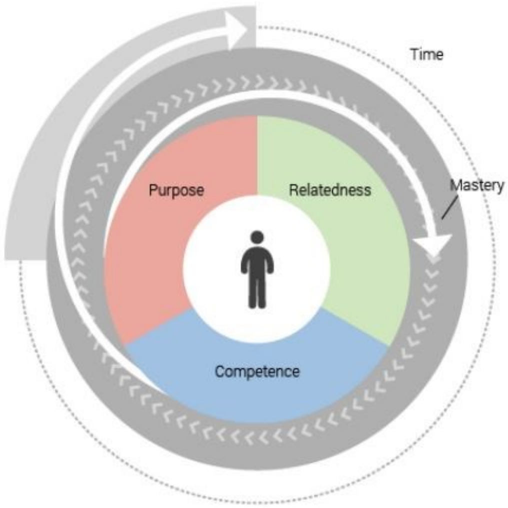


Figure 17. Sustainable gamification design
(Almarshedi, Wanick, Wills & Ranchhod 2015)

The framework lacks practical game design information, but it stresses the importance of intrinsic motivation in learning environments and the need for context sensitive and student specific feedback. For example, allowing the student the freedom to work on any of a range of activities, in any order, while providing specific and personal feedback.

2.6.2 A social gamification framework for a K6 learning platform

Here the focus is a classroom as a "social learning environment" with gamification defined in a basic sense as a collection of game elements: points, badges, leaderboards, virtual gifts (Simões, Redondo, & Vilas, 2013). These are based on social games, but used in a class environment to reward the student's progress, see Figure 18.

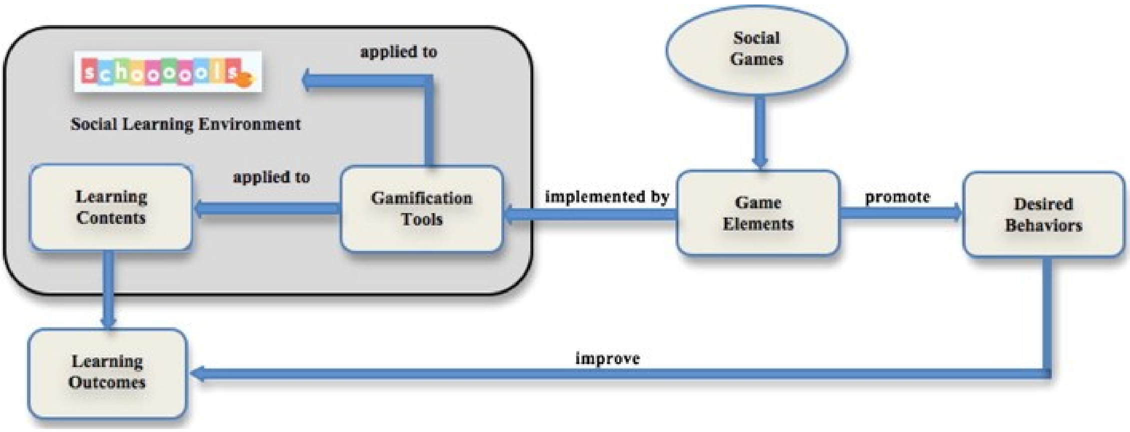


Figure 18. Social gamification (Simões, Redondo & Vilas, 2012)

There's a reliance on the teacher to actually design the learning activity to include social gaming elements, but this is not explained in sufficient detail.

2.6.3 Gamification of education using computer games

This framework is split into three parts (Nah, Telaprolu, Rallapalli, & Venkata, 2013):

- High level definition of gamification - setting goals, achieving them, reinforcing appropriate behaviour, competition and fun.
- System design elements - a low level breakdown of common game design elements like points, leaderboards and badges.
- Engagement and cognitive absorption – a state of flow where the student is deeply engrossed in the subject, the framework gives examples of how this might be measured.

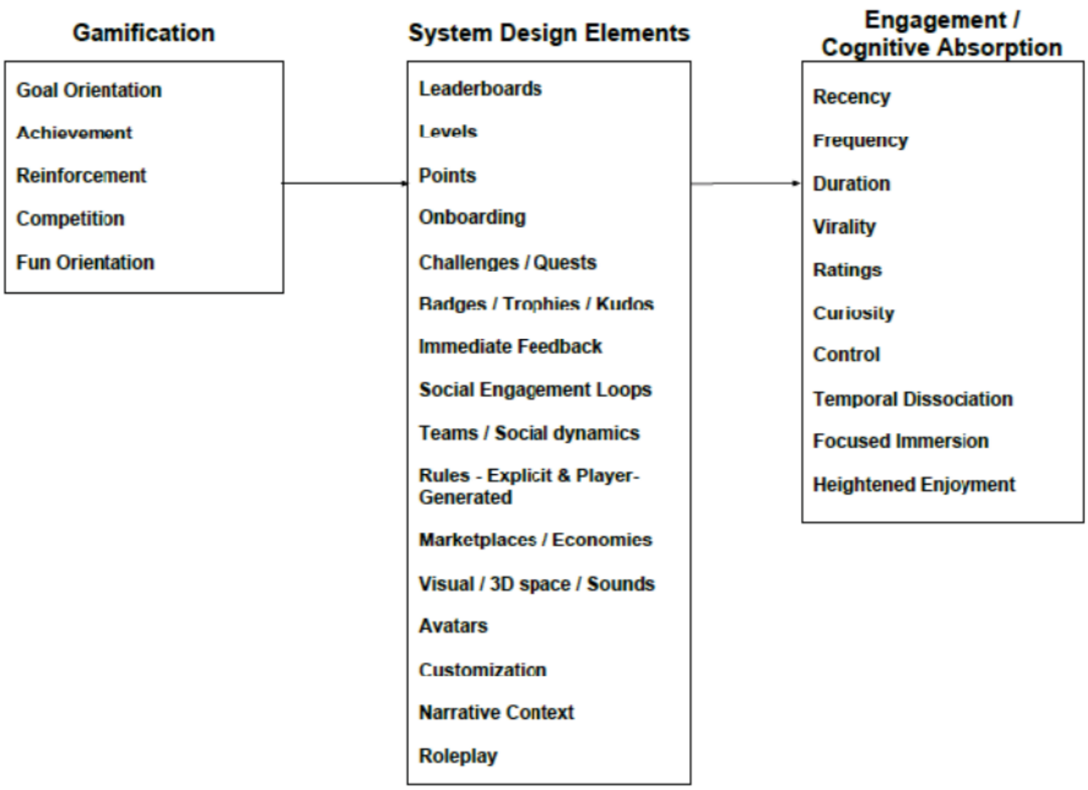


Figure 19. Gamification of education using computer games (Nah, Telaprolu, Rallapalli, & Venkata, 2013)

The novel element to this framework is not to focus on learning as such, but on what the authors call "cognitive absorption", which is known more commonly as flow (Chen, 2007). The framework suggests that learning is a side effect of the student being within a state of flow and therefore gamification should be designed to nurture flow, see Figure 19.

2.6.4 Gamification framework model based on social engagement in eLearning 2.0

This framework emphasises the importance of social features such as chat, discussion, social networks and user developed learning materials, while mixing in traditional gamification features such as badges, points and leaderboards. The process can be summarised as:

1. Analysis – the focus is on where gamification features can be used and delivered using web2.0 technology, for example, self-assessment, group discussion, blogs, message boards, chat, etc.
2. Design – blend gamification, eLearning and web2.0 together into a plan.
3. Development – implement as an online or app based system.
4. Implementation – favour extending existing online tools such as Moodle to support the plan.
5. Evaluation – measure the impact with metrics, are the students using all the features. Assess the impact on motivation.

Once again there is not much detail on how the gamification aspect would work other than the usual mention of leaderboards, competition, badges and points. What's interesting is the idea that the whole learning environment should be integrated into some form of online platform.

2.6.5 FRAGGLE: Framework for Agile Gamification of Learning Experiences

This is one of the more in depth frameworks, with an emphasis on metrics and monitoring of outcomes (Alberto Mora, Zaharias, González, & Arnedo-Moreno, 2016). However, there is still little said about the design of the gamification process itself other than the traditional elements of points, leaderboards and badges.

Summary of each phase, see Figure 20:

- Declaration – identify problems in learning and their causes, create stories describing how those problems might be solved e.g. poor attendance or low submission of assignment. Tests are then defined which could measure the problem.
- Creation – identify player types and their possible motivations, then consider gamification mechanics that might be appropriate and how they might fit into the overall game. Finally define the desired student actions and system triggers, for example, submitting an assignment triggers a virtual credit reward.
- Execution – players perform the desired actions and their interactions are recorded to quantify effectiveness.
- Learning – analysis of behaviours, is learning occurring efficiently, are the tests being met, does the design need modification?

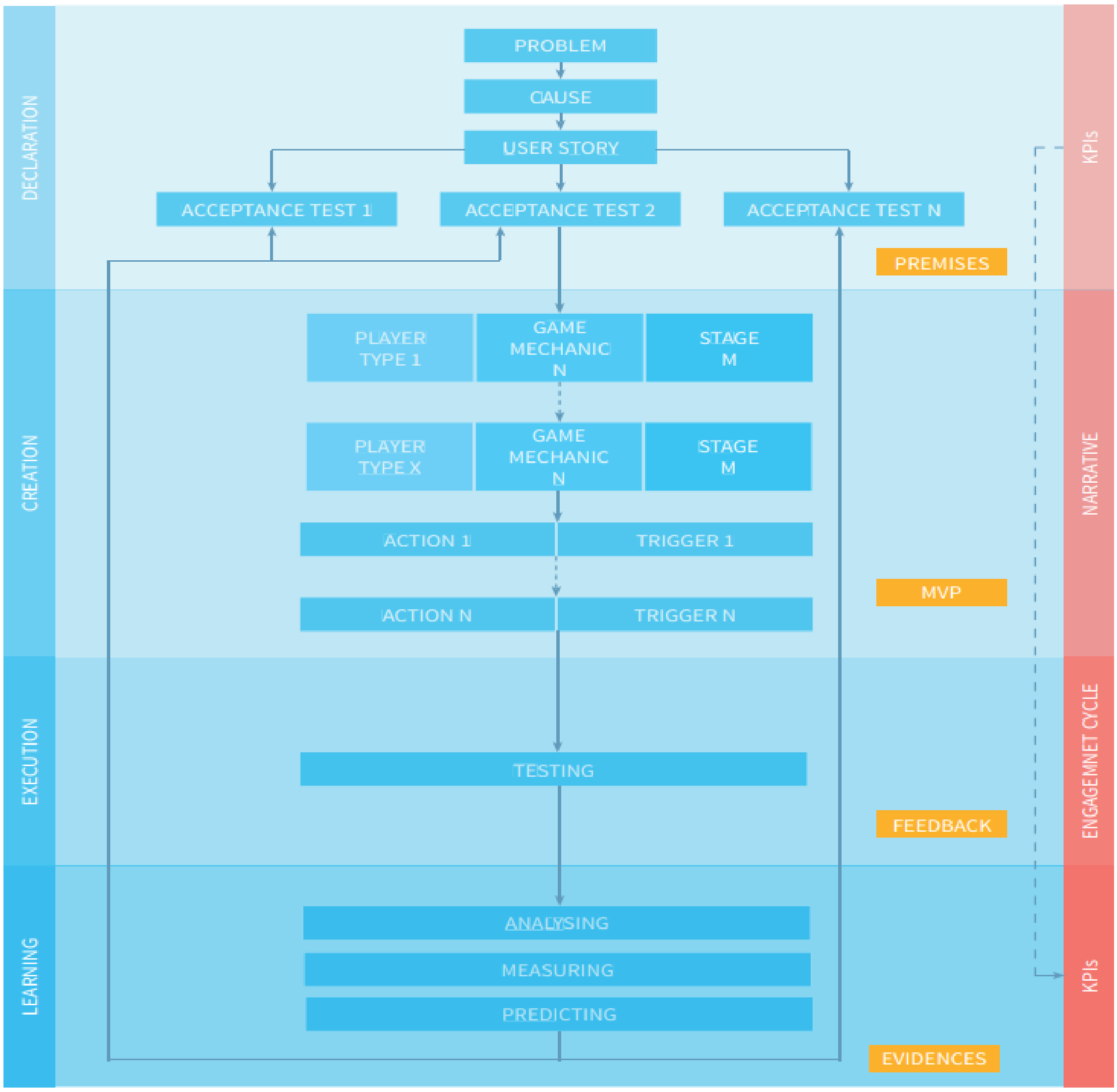


Figure 20. Framework for agile gamification of learning experiences (Alberto Mora, Zaharias, González, & Arnedo-Moreno, 2016)

2.6.6 Implementing gamification

In this framework they are explicit that gamification can be understood as a software development process and their method resembles the others summarised here (Herzig, Ameling, Wolf, & Schill, 2015).

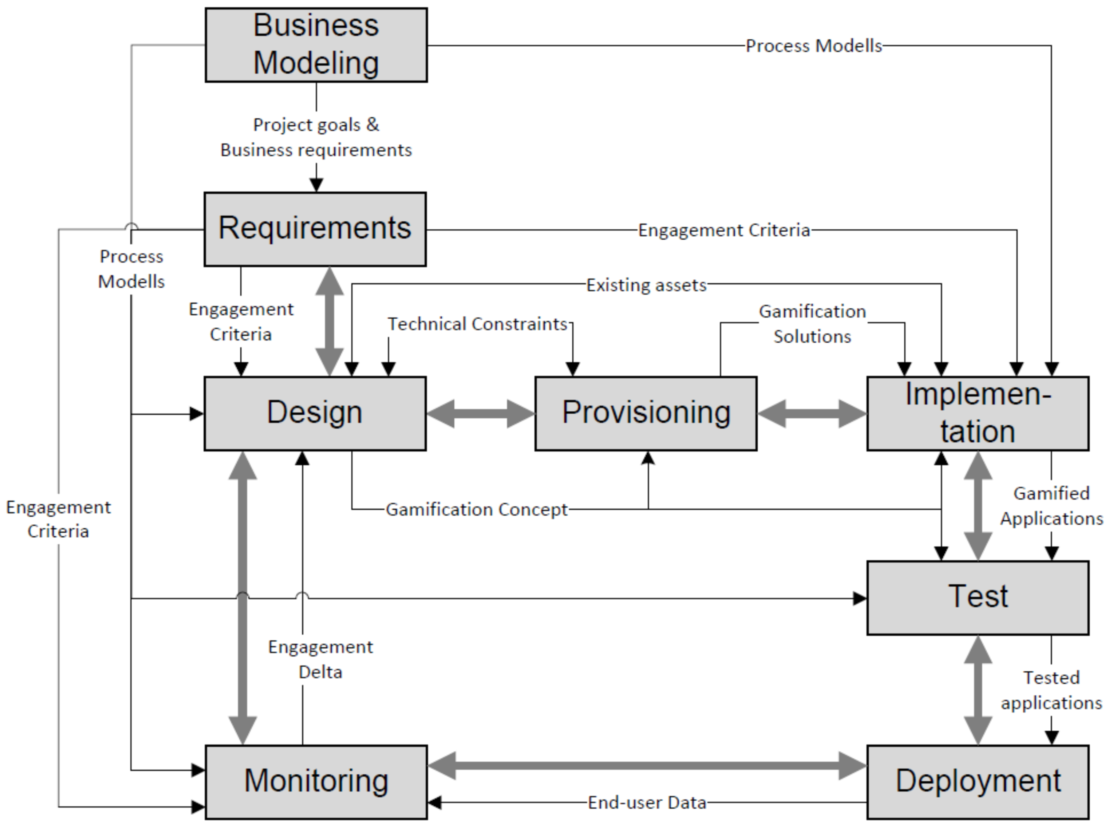


Figure 21. Implementing gamification framework (Herzig, Ameling, Wolf & Schill, 2015)

Much of the framework (see Figure 21) restates Agile software development methodology, but there is a list of common gamification tropes (points, leaderboards, badges, etc.) which are then used within a design process:

1. Identify basic concepts – points, leaderboards, badges, etc.
2. Develop a game design using those basic concepts, defined as a set of rules used to play.
3. Requirements
    a. Create a set of functional requirements – how will the game work.
    b. Create a set of non-functional requirements – how will the system be managed and adapted to new contexts.

4. Gamification solutions – a database driven approach for implementing the gamification application using an achievement system. The suggestion is this could be quickly refactored to apply to different gamification problems.
5. Requirements mapping – ensuring the solution meets all the requirements.
6. Application – build and test the software.

The framework mentions the changing nature of real-world processes and suggests a server backed application platform designed to be quickly adapted to new learning environment constraints. It can be argued that gamification is actually a games design process and that the focus on Agile methods ignores this important aspect of game design.

2.6.7 Summary

Existing gamification frameworks draw strong comparisons to agile software development methods, which is appropriate, but there is little said about the complex craft of game design that by extension defines gamification design. The process of defining the learning problems, gathering requirements, developing a flexible metrics driven server based application platform, measuring impact, these are all important points. However, the game design supported by such technical implementations is likely to be just as important.

The guidelines presented in section 8 of this research, while similar to and overlapping with aspects of the guidelines above, provide more practical detail and focus on the game design process rather than considering gamification as a more of a software development process. The guidelines in section 8 emphasise the importance of a more holistic game designer led approach.

The framework in section 2.6.1 does suggest focusing on intrinsic motivation as do the guidelines developed in this research, but it assumes a basic gamification design of points, badges and leaderboards is enough. In section 2.6.2 the social gamification framework emphasises the importance of group activity and social interaction, as do the guidelines in this research. However, the social gamification framework in 2.6.2 doesn't provide detailed guidance on how the teacher would design such social game-like educational activities.

The framework for gamification of education using computers in section 2.6.3 does talk in some detail about game design strategies to nurture states of flow in learners, as do the guidelines in this research, but it lacks practical guidance on how to implement it. The eLearning 2.0 framework in section 2.6.4 suggests using online technology to enhance delivery, as do the guidelines in this research, but it presents gamification simplistically as points, leaderboards and badges. The framework FRAGGLE in section 2.6.5 goes into great detail about how metrics can be used to understand learners and measure the success or otherwise of the gamification process, as does the guidance developed in this research. However, like many existing frameworks, it has little detail on gamification other than the superficial use of points, leaderboards and badges. Finally, section 2.6.6 is focused on implementation issues, and like the guidelines developed in this research, it suggests live metrics should be used to monitor learners' progress and the function of the software. However, gamification can not solely be viewed as a software development process, a game design process must come first.

2.7 Cheating

Any competitive activity (especially those with a high value reward) brings the risk that participants will attempt to cheat as an easier or faster path to that reward (Fülöp, 2009). Videogames in particular have a long history of well publicised and wide ranging problems with cheating: 3rd party game guides, exploits, game hacks and cash for in-game advantage (Consalvo, 2009). Even if no cheating is occurring, the suspicion of cheating can be enough to damage faith in the game and nullify any expected incentives of competition (something that was mentioned by participants in this study, see '7.8.2 Student interview').

Automatic validation

Manually checking the activity of individuals participating in a game or in a gamified real-world activity is time consuming. In an educational setting a teacher should not be spending time monitoring gamification systems, they need to be focused on learning. Automated validation can help, for example, students might earn points for regular attendance, this could be achieved by the tutor manually registering attending students (time consuming) or by performing an automated GPS check to see if the students are close to the tutor at the time of the lesson.

Some commercial games provide anti-cheating systems that go much further in monitoring player behaviour. Such systems are designed to reassure all competitors that the competition is fair, usually performing validation of each player's software and their game-server communications. One of the most famous implementations being Valve Anti Cheat (VAC) which is used on the enormously popular Steam platform (Valve, 2017) to increase player confidence in competitions. However, these systems are complex and time consuming to develop.

Fairness

People are less likely to cheat or seek ways to cheat when a shared activity is perceived as fair by all participants. The more complex any game becomes, the greater the risk that there will be exploits or opportunities to cheat. Most players, especially where they know one another and are not unduly extrinsically motivated, will initially play within the 'spirit of the rules' to help ensure a fair game that results in a positive experience (DeKoven, 2002).

There are many situations where players might lose faith in the game and be more inclined to cheat or use exploits to make progress:

- A player believes that another player is cheating (even if that is not true).
- A player feels they have no realistic chance of catching up with a competitor.
- Gamification has added game design principles that players find frustrating and an obstacle to progress.
- Gamification is using rewards that players find particularly valuable and desirable.
- The player discovers an exploit, some behaviour that is allowed by the game, but not anticipated by the designer and therefore facilitates faster progress than is appropriate.
- The player discovers a mistake or bug that facilitates progress without actually performing the desired task.

Where these situations occur, even if players do not cheat, it is highly likely that intrinsic motivation will be reduced, because the activity is seen as unfair.

To avoid cheating, a game and its rules must be well defined, with outcomes judged by a human arbiter or outcomes that lend themselves to automated fair assessment (Kiili, 2005). If those judgements are to maintain participant confidence then the assessment must be carefully specified. Where computational validation is not possible or practical, special care needs to be taken in the design process to ensure that rewards are perceived as fair, not too time consuming to validate and the criteria for measuring progress unambiguous.

2.8 Player typologies

Within gamification we are attempting to make some real-world activity more fun and increase user engagement: either to spend more time with the activity, increase quality of work or to do the work faster. However, the participant should see themselves, at least partially, as a player within a fun game-like activity, even though they may actually be a student attempting to learn computer programming, for example. Therefore they will have pre-conceptions based on their previous experiences of playing games. People enjoy different recurring aspects of games and tend to play different games in similar ways or be attracted to certain styles of game. People can be grouped into categories based on their common behaviours and wants, there are a number of typologies that have been developed.

2.8.1 Bartle's taxonomy

Bartle's taxonomy of players is one attempt to categorise these types and it can be a useful design aid (Bartle, 1996) and can be summarised in Figure 22.

Figure 22. Bartle's taxonomy of players (Bartle, 1996)

- **Horizontal axis** – left implies a desire to interact with other players, right a desire to interact with the world (the rules of the game).
- **Vertical axis** – up implies a desire to act upon the game, make changes, examine the rules and use or exploit them to achieve goals.
- **Killer** – highly competitive, wants to interact with people, will exploit the rules to gain advantage in competition. Motivated by winning, they want to be the best and look for exploits. Are happy to see others lose if it means they are winning. They want to have a higher score than their peers and have better equipment. Tends to be a small number of players and can be the most susceptible to the temptation to cheat.

- **Achiever** – likes to finish the game, have the most points and show their peers how much progress they've made. They like to collect items and display them to others. They are naturally the most responsive to gamification's points, leaderboards and badges. They are the most likely to boast about shortcuts and exploits to maximise progress. Tends to be a fairly small number of players and can be quite susceptible to the temptation to cheat.
- **Explorer** – likes to see everything the game has to offer, explore all the rules, unlock all aspects of the game, find any hidden areas. Motivated to discover new things, not concerned with points and leaderboards. Will take part in repetitive tasks, but only if they lead to discovering something new or accessing a new part of the game or new equipment. Discovery gives them satisfaction and they will often play alone. Tends to be a fairly small number of players and they are less likely to want to cheat.
- **Socialiser** – enjoys playing games either because they are playing with other people, or they know other people who play and want to discuss the experience with them. They are happy to collaborate and even help competitors, especially if they can play as a team in the game. Even if they cannot play as a team they will discuss the game with friends and help others make progress. They will not enjoy player on player competition. Tends to be the largest proportion of players and they are less likely to want to cheat.

2.8.2 Extended Bartle

This typology extends Bartle with a finer separation of player behaviours, adding to the four types with the following (Ferro, Walz, & Greuter, 2013):

- Competitor – bests other players
- Collector – collecting items
- Achiever – high scores
- Joker – plays purely for fun
- Artist – for the appreciation of design
- Director – loves to be in charge
- Storyteller – loves fantasy worlds
- Performer – putting on a show for other players
- Craftsman – building things

However, these are just examples within wider categories, as seen in Figure 23.

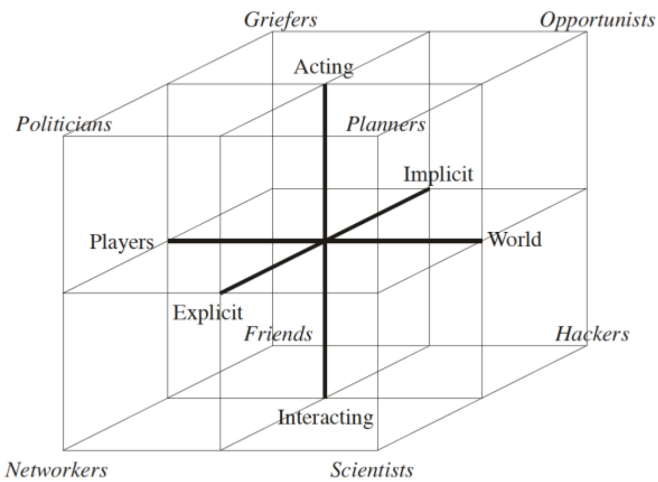


Figure 23. Personalised gamified systems player topology (Ferro, Walz & Greuter, 2013)

2.8.3 Myers-Briggs personality types

One of the most famous attempts to categorise people based on similar behaviours and needs was developed by Myers and Briggs and is not specifically describing game players (Myers, 2014). It defined four letter codes to describe peoples' behavioural type:

- E – extraversion.
- I – introversion.
- S – sensing.
- N – intuition.
- T – thinking.
- F – feeling.
- J – judging.
- P – perceiving.

It then segregated people into sixteen different types, each assign four of the code letters above:

- Inspector (ISTJ) – planners, law abiding, order, responsible, realistic.
- Crafter (ISTP) – looks for solutions, thrill seekers, objective, quiet, insensitive.
- Protector (ISFJ) – observant, supress emotions, practical, ordered, practical, sensitive.
- Artist (ISFP) – practical, hands-on, loyal, quiet, needs personal space, dislikes the abstract.
- Advocate (INFJ) – sensitive, reserved, idealistic, stubborn, high expectations.

- Mediator (INFP) – caring, works alone, idealistic, takes everything personally, overlooks details.
- Architect (INTJ) – enjoys the theoretical, good listener, self-confident, overly analytical, perfectionist, insensitive.
- Thinker (INTP) – reserved, thoughtful, logical, independent, self-doubt, rule breaker.
- Persuader (ESTP) – gregarious, funny, observant, resourceful, competitive, easily bored.
- Director (ESTJ) – realistic, dependable, traditional, leadership, inflexible, bossy, argumentative.
- Performer (ESFP) – socialiser, spontaneous, practical, easily bored, does not plan, impulsive.
- Caregiver (ESFJ) – kind, loyal, organised, enjoys helping others, conscientious, controlling, needy.
- Champion (ENFP) – warm, enthusiastic, empathetic, good communicator, creative, disorganised, stressed.
- Giver (ENFJ) – warm hearted, empathetic, affectionate, persuasive, manipulative, self-sacrificing.
- Debater (ENTP) – creative, conversationalist, debater, values knowledge, unfocused, argumentative, dislike routines.
- Commander (ENTJ) – strong leader, self-assured, well-organised, assertive, outspoken, aggressive, intolerant, stubborn.

2.8.4 Player typology in theory and practice

This typology (see Table 6) was based on surveys of players more generally and was designed as a result of the criticism of Bartle as a typology only applicable to players of massively multiplayer games (Bateman, Lowenhaupt, & Lennart, 2011).

Player archetype	Drawn to…	Behaves with…	Tolerant of…
Logistical	Optimisation, planning, trading	Caution, meticulousness	Repetition, rules, procedures
Tactical	Improvisation, operation, controlling single characters, thinking on the spot	Impulsiveness, competence	Risk, speed, variation
Strategic	Solving, hypothesizing, controlling multiple units, thinking ahead	Logic, perfectionism	Complexity
Diplomatic	Harmonising, imagining, cooperation	Empathy, morality	Impressionism

Table 6. Player typology in theory and practice (Bateman, Lowenhaupt & Lennart, 2011)

The surveys used psychometric type theory and trait theory to identify common characteristics in players.

2.8.5 Player types: a meta synthesis

This study was based on a comprehensive analysis of previous literature on the subject and results in a combination of previous typologies combined into one (Hamari & Tuunanen, 2014).

- Gaming intensity and skill – hardcore, aggressive, casual.
- Achievement – progress, provocation, power, casual, single player games.
- Exploration – problem solver, explorer, aggressive, socialiser, immersion, fantasy and story.
- Sociability – community oriented, socialiser, idealist, helper, friend.
- Domination – killer, aggressive, artisan, power, domination, casual.
- Immersion – committed, explorer, fantasy, story, escapism, hardcore.
- In-game demographics – avatars, professional, guilds, server type.

It shows there is common terminology within many typologies and concludes most are based on Bartle's.

2.8.6 Summary

A gamification designer must be aware of player likes and dislikes, to try and cater to as many as possible within the game design. Based on the author's experience working as a game developer and the popularity of Bartle's taxonomy within that industry, this is the player categorisation system that was chosen. Players don't rigidly fit into one of these types, they tend towards some part of the graph and that tendency may change over time and be affected by the design of the game. Killers will be drawn towards games that are clearly identified as having a focus on competition, but they may still play other types of games as well. A killer playing a game that doesn't contain direct competition may become frustrated and stop playing, but if the game is well designed and promotes socialisation, then the killer may shift their behaviour to maximise their enjoyment.

A gamification designer therefore needs to understand the nature of those who are participating and design accordingly. For example, applying gamification to a high-pressure sales environment might lead the designer to focus more on direct competition, giving more stimulus to killer type players. In the case of an educational environment, where it's likely to be a complete mix of player types, the game should be designed with elements that appeal to all types but favouring the expected majority of socialisers. Also, it would be important to limit the behaviour of player types that tend to act upon the game and its players directly: killers and achievers. Socialisers and explorers won't appreciate being excessively interfered with by killers or the boasts of achievers. It's not clear how well these classifications map to gamification, which attempts to promote a game-like experience, but applied to some real-world activity.

2.9 The long tail

Why do players lose interest over time with all games and most activities they are not compelled to undertake? The long tail (Brynjolfsson, Hu, & Smith, 2006) is a name used to describe an exponential decay relationship that is seen in many aspects of human life and society in general.

1. Videogame sales are very high on launch day, but fall over time.
2. Attendance at university is high at the start of a semester and then falls over time.

3. Engagement with a software application can be initially high, but will fall as novelty fades.

Items (2) and (3) are key issues for Unicraft1, experimental software used to test the ideas developed in this study, will it be possible to maintain student interest with the application for an entire course? The long tail describes this initial high level of activity that then usually decays with time and is often unavoidable without some form of extrinsic motivation (e.g. compulsory participation).

There are two key factors in the long tail:

- Motivation - it is human nature that motivation will fall as a result of the participant becoming tired, distracted, bored, loss of novelty, etc. However, the design of the activity can affect the shape and rate of decline.
- Availability - if access and engagement with an activity is facilitated via multiple channels, a user's time will tend to be split between them. For example, within the subject chosen for the study, a university computing course, there are a number of 'channels' to choose from to access learning:
    - Lectures
    - Tutorials
    - YouTube videos
    - Books
    - Websites and forums
    - Game jams
    - Library - 24hr access to computer equipment

Therefore, amongst other goals, a gamification project in the area of higher education should be designed to:

- Combat the inevitable decline in use of the app itself as its novelty wanes e.g. introducing new features over time.
- Compete for students' time alongside other learning channels and where possible integrate with them.
- Avoid taking too much student time and starving other learning channels.

2.10 Attendance

Attending lectures and tutorials regularly, plus completing all the work set, has been shown to produce optimal outcomes for students (Paisey & Nicholas, 2004). Within the author's institution there is primary data supporting this (see Figure 24), the graph shows that students who do not progress from one semester to the next are more likely to have poor attendance.

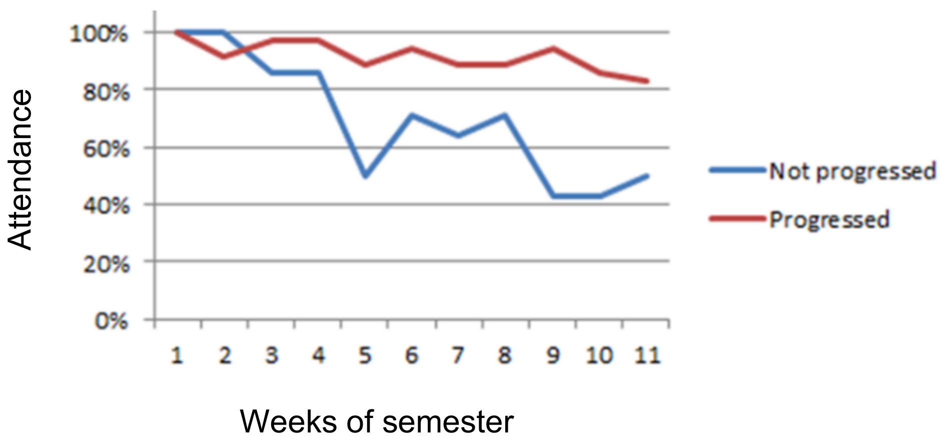


Figure 24. Relationship between attendance and progression (Featherstone, 2022)

Students who meet progression targets tend to use a range of learning channels on the list in section 2.9, not just good attendance at lectures and tutorials, but students have problems when they aren't motivated by any learning channels or focus on one or two that don't include regular attendance. Therefore, amongst other goals, a gamification project in the area of higher education should be designed to:

- Encourage attendance at lectures.
- Encourage engagement with tutorials.
- Encourage completion of assessed work.

2.11 Case studies and experience

There is much to be learned from successful and unsuccessful gamification projects, but how are such projects selected and how can success or failure be assessed? Whereas a scientific paper can be assessed based on the quality of the journal it is published in and the number of citations, there is no similar measure for gamification. Videogames are usually judged by their commercial sales numbers and by aggregation of review scores (Red Ventures, 2021) alongside videogame curation databases (Blue Flame Labs, 2021). Gamification projects are not widely reviewed and often their sales numbers are commercially sensitive, especially when sold to groups of schools or industry. Selection will therefore be done based on sales numbers and reviews, where they are available, but also evaluation by the author based on games industry experience. Author’s selection process overview:

- Are reviews or articles available?
    - Is the author reputable?
- Are user numbers available, is this software widely used?
- Can the software be downloaded for evaluation?
- Does the software appear to be of high quality?

- What game design principles are evident and have they been implemented effectively?
- Does the software appear to be technically correct and feature rich?
- Are the game design principles used appropriate to the real-world process being gamified?

Game design is a creative and unpredictable process that is carried out by trained game designers. The author spent 15 years working in the commercial videogame industry, for part of that time as a games designer.

Game Development Process Model

The following process model was commonly used by the author and others within larger games industry settings:

1. A team is created featuring senior personnel in the roles of designer, marketing, quality assurance and technical.
2. Broad goals are defined.
    a. What market is to be targeted?
    b. What genre of game is appropriate?
    c. What are the key U.S.Ps (unique selling points):
        i. What core game mechanics will make it fun?
        ii. If this is a gamification product, aimed at education or industry, what is the real-world process being gamified and what game mechanics might best wrap around that?
3. Paper prototypes are made very quickly.
    a. These are tested within the team.
4. Code prototypes are made quickly.

    a. These are tested with small focus groups selected appropriately to match the target users.
    b. These are tested with professional developers outside the team to reduce potential for bias.
5. The design is frozen, the team expanded, and a commercial version is developed.
    a. More focus testing is undertaken.
    b. Quality assurance testing is undertaken.
6. Feedback is sought after release and further updates implemented.

   NOTE: reviews are happening at every stage and it is common to alter the design and go back to a previous point (an agile development approach).

How widespread is gamification?

Gamification features are evident in thousands of applications:

- Commercial sector: loyalty programs for supermarkets, Nike's fitness ecosystem Nike+, eBay's ratings systems, etc.
- Education: guiding and increasing student engagement.
- Industry: optimising staff performance
- Government: China's 'Sesame Credit' citizen behavioural control app (Reis, 2019).

In 2018, gamification worldwide was estimated to be worth £3.4 billion (Dale, 2014).

Drawing on the above process, author experience, game reviews and game design literature, the following gamification applications were selected for analysis.

2.11.1 Successful gamification case studies

'Ribbon Hero' (Microsoft, 2011) and 'Zombies Run!' (Six to Start, 2012) have used a wide range of game design principles and a non-oppressive approach (discussed below), they've both achieved huge success (Dredge, 2015; Faulkner, 2011) as mass market consumer gamification apps, both have million plus users. Similarly, Road Warrior (Herger, 2012) has done the same within industry and Classcraft (Classcraft Studios Inc., 2017) within education. In the field of language learning, the mobile app Duolingo (Duolingo, 2011) is a hugely popular mobile application utilising a gamified approach.

Each will be evaluated and their game design mechanics discussed. Analysing some of the most successful gamification applications available should provide an insight into best practice in terms of game design. Where there are common approaches and lessons to be learned these can feed into a set of guidelines for the design of future gamification applications.

2.11.1.1 Case Study: Ribbon Hero

Ribbon Hero 2 (Microsoft, 2011) is a gamification project developed by Microsoft as a plugin for their flagship word processor, Word. Ribbon Hero makes learning the complexities of this powerful software more fun. It is not compulsory, there is no real-world reward and it uses more game design principles than the usual points and competition (see Table 4). It was developed as a collaboration between Microsoft Game Studios and Microsoft Word's development team, and it has millions of users (Faulkner, 2011).

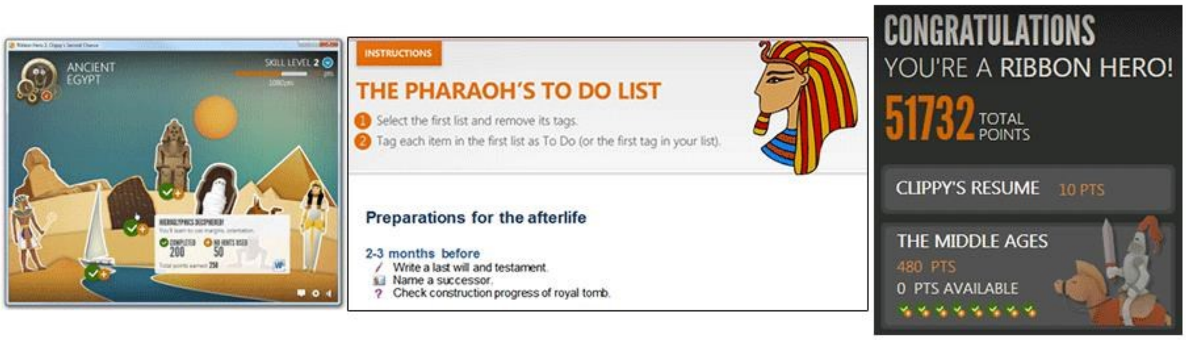


Figure 25. Ribbon Hero interface (Microsoft, 2011)

New users are presented with a familiar looking videogame themed progress screen (see Figure 25), it shows tasks completed, suggests new tasks, measures progress towards tasks and displays points scores. Each high-level task is then broken down into Word-specific task lists which can be 'ticked off' as they are completed in exchange for points. Alongside low-level points rewards, for minor tasks, more significant progress is punctuated by a comic strip. This mimics the way visual theming and episodic narrative in videogames is used as a form of reward, revealing each chapter of a story. To provide a high-level view of progress, a summary screen allows 'players' to judge the value of one task group to another. Players can choose between lessons out of sequence, supporting multiple tasks asynchronously gives the player maximum agency. Leaderboards are used to share progress and compete against other users.

Unlike many gamification projects which have been imposed in the workplace, participation is not compulsory, and the system features a number of different games design principles: narrative, regular feedback via sound and visual effects, context sensitive help and out of order progress. Although hugely popular, Ribbon Hero is still just teaching users to operate an interface in a way that encourages rote learning, a common criticism of gamification generally. Given such detailed and simplistic tasks, it's possible for the software to directly assess their completion and eliminate any scope for cheating.

2.11.1.2 Case Study: Zombies Run!

Zombies Run! (Six to Start, 2012) is a very popular mobile app, with over a million sales, designed to make jogging more fun by gamifying the activity (see Figure 26). The app uses GPS on the mobile device to track where you are and how fast you are moving. The game is broken down into episodes, an episode can have an objective, and completing each episode causes you to progress through a story about a zombie invasion. Completing objectives is rewarded with 'supplies' which are virtual items representing things like food and medicine in the game. For example, once the app is aware of your best time over a set distance it then simulates you being chased by a zombie and you would have to meet or exceed that time to escape.

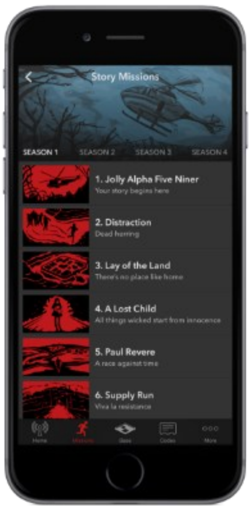


Figure 26. Zombies Run! mobile app to gamify exercise (Six to start, 2012)

The app makes use of a number of game design principles beyond points, leaderboards and rewards (See Figure 27):

- Story – each run can be part of the main story-arc, and completing objectives moves you on to the next chapter in the zombie story. There have been several 'seasons' of the episodic story to maintain user interest and it was written by a professional writer.

- Badges – certain achievements in the game reward the player with virtual badges of achievement rather than just points, e.g. capturing a target number of supplies, unlocking parts of the story or surviving a number of zombie chases. These create a history of progression instead of a singular score.
- Supplies – certain objectives provide a virtual reward with no real-world value (such as running enough to capture some medicine), but they go beyond simple progress indicators as they are used to maintain and improve your base.
- Base – in the fictional story of the game you live in a town and the supplies you earn are used to maintain and enlarge the base providing a significant long-term goal.

Figure 27. Zombies Run! has videogame-like presentation (Six to start, 2012)

Its implementation of leaderboards is innovative, with separate leaderboards linking to real-world events like Halloween, where those paying to take part receive a real-world medal in the post. As with Ribbon Hero, participation is not compulsory and accurate measurement using GPS is used to prevent cheating.

Going further than Ribbon Hero, this app uses so many game design principles and tropes that it could easily be mistaken for a videogame.

2.11.1.3 Case Study: Road Warrior

Road Warrior is a gamification web application developed by the company "Systems, Applications and Products" (SAP) to help its large sales rep workforce improve their knowledge and skills. Staff training traditionally took the form of fictitious sales scenarios used to learn how to better market SAP's products. This was gamified by automating the scenarios as videos followed by a quiz, with trainees earning points and badges displayed on a leaderboard. Players can challenge each other in a question and answer battle that is similar to the popular television quiz show "Who wants to be a millionaire" (Stellify Media, 2019). Unusually for an industrial gamification application, it has been designed to look like popular gaming websites, there is no real-world reward and participation is not compulsory (see Figure 28).

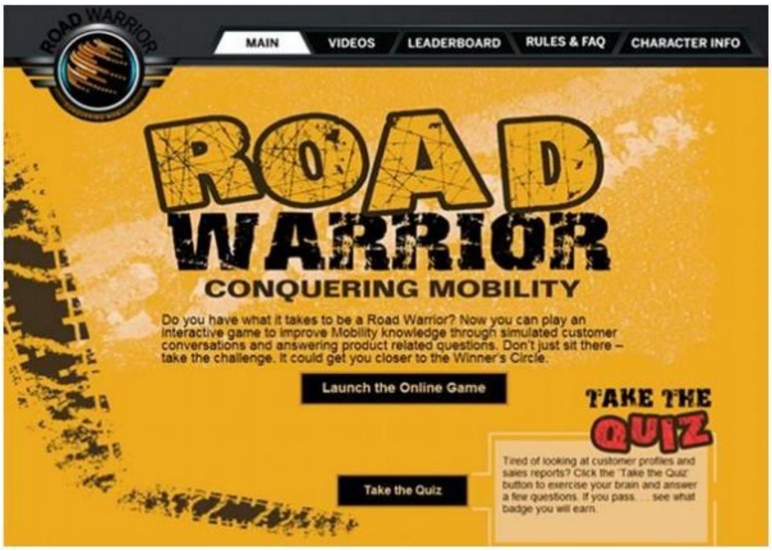


Figure 28. Road Warrior gamification application by S.A.P (Stellify Media, 2019)

2.11.1.4 Case Study: Classcraft

Classcraft is a web and mobile based gamification platform aimed at young teenage and pre-teenage school children that draws on the common visual themes and game mechanics of fantasy role playing games (Classcraft Studios Inc., 2017). It has a focus on increasing class engagement and assisting teachers with behaviour management (Valle, 2017). Students use the web or a mobile app to register and create a fantasy style game avatar using fantasy genre clichés: warrior, wizard and healer (see Figure 29). The teacher can then give players goals (such as handing in work on time) which are rewarded with 'action points'.

If there are negative student interactions (e.g. being late to class, interrupting, etc.) the teacher can 'punish' a player by reducing their health. Students group into teams and if a team member does have low health, the rest of the team can spend their 'action points' healing or protecting that team member. As well as persistent goals, a teacher can run a multi-choice quiz with students earning rewards for successful answers.

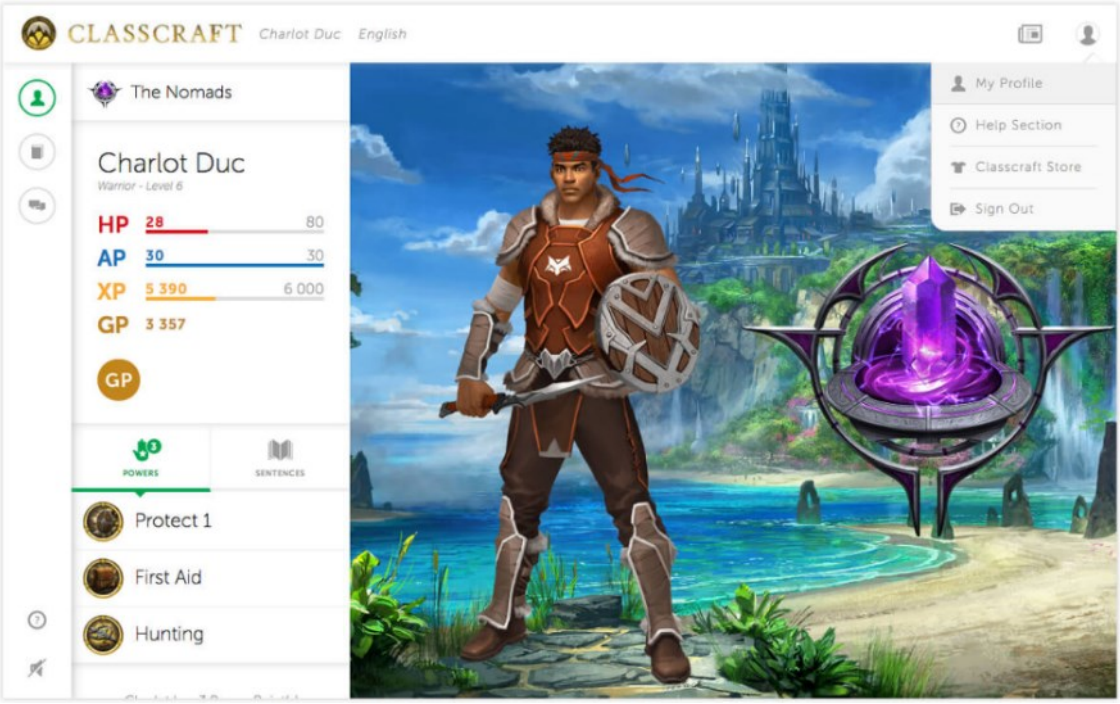


Figure 29. Classcraft main user interface (Classcraft Studios Inc., 2017)

Again, this app makes use of several game design principles beyond points, leaderboards and rewards.

- Quests - a sequence of goals laid out on a fantasy style map that shows each student's progress through a sequence of tasks.
- Customisation of appearance - students rewarded with in-game currency can spend it on items of clothing and pets (fantasy creatures).

- Videogame style artwork - the app is presented using 2D high quality fantasy artwork that is reminiscent of styles found in web and mobile role-playing games.
- Boss battles - a multi-choice quiz pits students against a monster (such as a dragon or similar fantasy creature), if the students win by answering enough correct questions then the monster is killed.
- Team play - protecting your teammates encourages players to bond.
- Although its design and presentation parallel the videogame genre of role playing games closely, it does not actually implement a videogame, instead the traditional gamification conventions of points, leaderboards and extrinsic rewards are used with the visual presentation and terminology of videogames overlaid. The similarity in name to Unicraft1 is coincidental.

The success of Classcraft in a school is dependent on the skill of the teacher in creating a playful atmosphere within the class and encouraging the students to take pleasure in their studies and student interactions, as facilitated by the game, promoting intrinsic motivation (Sanchez, Young, & Jouneau-Sion, 2017). On its own the game can create an environment dominated by extrinsic motivation, the pursuit of progress within the game for its own sake, a negative outcome that sees students lose focus on real-world learning.

2.11.1.5 Duolingo

Duolingo is a mobile app language learning platform released in 2011 that became a huge hit with mobile phone users with 300 million accounts created (see Figure 30). It is designed to accompany traditional language learning activities and prompts the user to spend a few minutes each day practicing their language comprehension and translation skills. There have been a number of studies that have confirmed a statistically significant improvement in student performance when the app is used alongside other learning materials (Grego, 2012; Munday, 2016). It shows the benefit of embedding relevant learning content alongside the usual gamification elements and blurs the line between gamification and educational game. Some users have claimed they can use Duolingo alone to learn a language, but the authors (Duolingo, 2011) describe it as a tool to enhance third party approaches to learning (e.g. books, online courses, college courses, etc.).

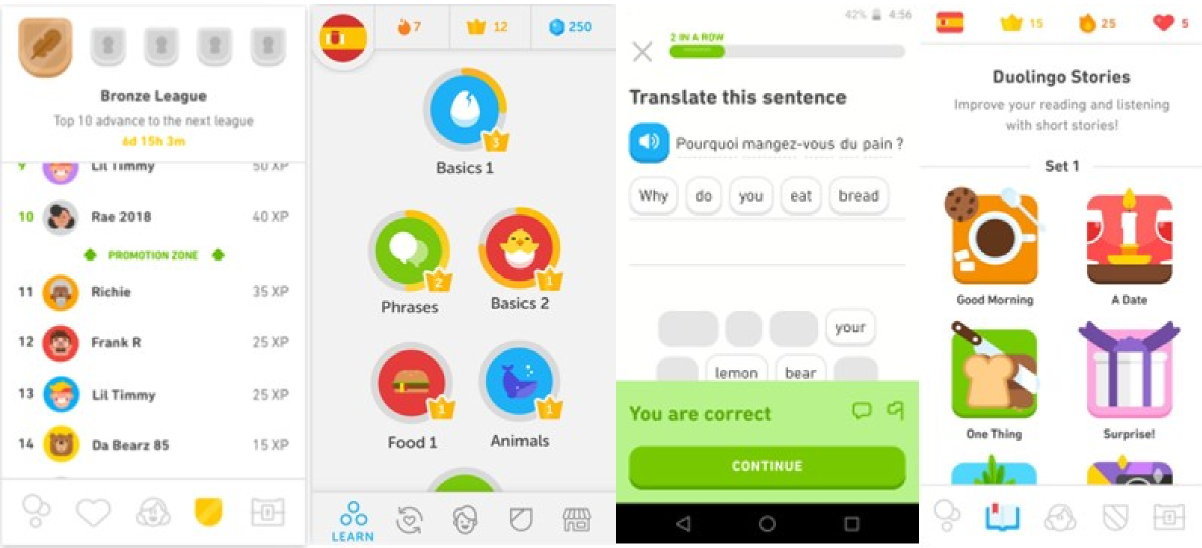


Figure 30. Duolingo interface screens (Duolingo, 2011)

The app uses the traditional gamification features of points, badges and public leaderboards, but goes further.

- Embedding language learning quizzes into the app so the user feels there is a direct link to their learning.
- Leaderboards are split into different ability groups so players are more likely to make progress up their ‘mini’ leaderboard.
- Competition via the leaderboards resets periodically so instead of one competition you could easily fail, there are regular competitions each month giving you more chances to win.
- As a mobile app it uses phone notifications to remind users to keep taking part, along with reminders about competition progress.
- Story mode simulates an annotated conversation between two people with the user scoring points if they can successfully answer questions about its contents.
- Drop in or out at any time, but badges slowly fade and if you don’t play often enough they disappear. This provides a small amount of pressure to keep playing.
- Its efficacy is limited by its free-to-play monetisation strategy which stops players periodically and asks them to undertake a paid monthly subscription. If they don’t subscribe, then they cannot use the app for 24hours.

2.11.2 Unsuccessful gamification case studies

Unfortunately, the characterisation of gamification's design features doesn't necessarily help to inform good design, as it is these very aspects (and their limited scope) that have been the subject of so much criticism (Dale, 2014). Gamification’s tendency to take existing processes, regardless of efficacy, and then encourage users to perform them better, faster and longer is often seen as problematic. It has been suggested that this approach encourages shallow, rote learning, rather than creating novel processes, structures or systems (Raftopoulos et al., 2015). Others accuse gamification of exploiting games design by reducing it to a raw behaviouristic manipulation of the user, defined by derogatory terms such as “exploitationware” (Bogost, 2011).

Games are meant to manifest play, joyful activities, yet gamification is criticised for stripping away the richness of game design to focus on crude motivational levers of competition to psychologically manipulate people into performing in some desired way. This is often achieved through rote learning, competition, peer pressure, supervision, measurement and compulsion (Fuchs et al., 2014; Raczkowski, 2013). This then leads to users experiencing a lack of agency and creative control, key features of intrinsic motivation (Deci & Ryan, 1985).

Although industry insiders report that many gamification applications fail (Dale, 2014), details are not often publicised for reasons of commercial sensitivity. However, some gamification project failures have made the press and there are lessons to be learned from those failures.

2.11.2.1 Case Study: Disneyland – the digital whip

Disneyland hotels use a system of paper tallies to monitor the performance of their back-of-house staff and trialled a simple gamification based digital version at their Paradise Pier hotel (Lopez, 2011). Tallies monitor how fast staff clean rooms, load laundry, iron, etc. and this has long been used to monitor performance. When the company digitized this process, based on staff ID cards, a simple gamified leaderboard was introduced. Staff are listed by name in order of performance on large screen monitors in workspaces, with those meeting key targets in green and those below target in red. The company felt the system would help people understand their performance and encourage friendly competition amongst staff.

Workers began referring to the system as the “digital whip”, some workers did indeed compete, but this resulted in dissention and stress (Kim & Werbach, 2016). The worker’s union representative said, “employees have been known to skip bathroom breaks out of fear that their productivity will fall and managers will demand an explanation”. Although a simplistic gamification implementation, the next section describes how the same negative results are sometimes seen in technically superior systems with a greater breadth and depth of gamification design features.

2.11.2.2 Case study: Wupperman Steel

Wupperman Steel (Wupperman, 1872) is a metal galvanizing plant in the Netherlands employing hundreds of steel workers, in skilled, but repetitive roles, for a range of industrial clients. Its staff were seen as key in the company’s performance, they wanted to reduce accidents, stoppages and defects while increasing employee performance, training and teamworking (Vegt, Niko; Visch, Valentijn; Vermeeren, Arnold; de Ridder, 2018). Wupperman partnered with a ‘serious games’ design company, &RANJ (Ranj, 1999) and set about designing a very sophisticated gamification platform.

The system was quite pervasive in the working day of a Wupperman employee and information was displayed all over the factory, with participation compulsory. At a departmental level there were visual representations of the entire department’s performance against management set targets (see Figure 31).

Figure 31. Wupperman departmental target screen (Vegt, Niko; Visch, Valentijn; Vermeeren, Arnold; de Ridder, 2018)

This could then drill down to ever lower and more specific levels of detail, here we have performance measurement against targets for a particular production line (see Figure 32), used to encourage employees to work faster. Note the inclusion of employee names and photos.

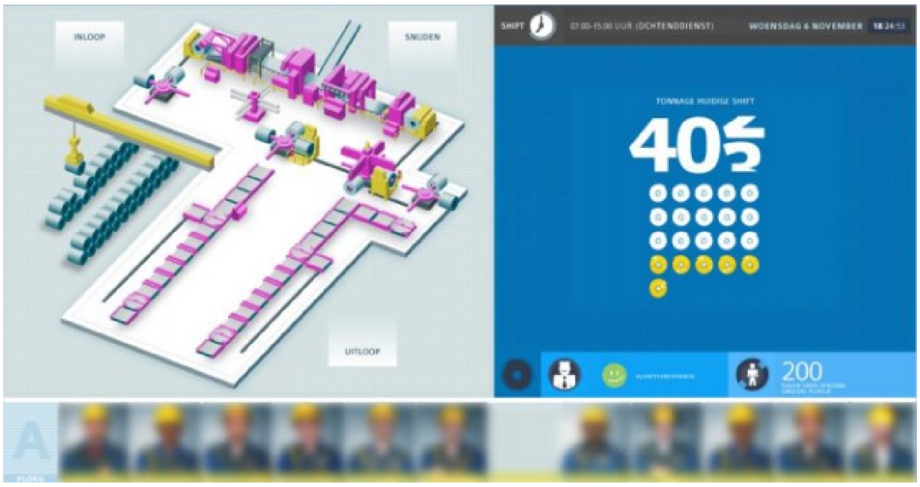


Figure 32. Wupperman production line targets (Vegt, Niko; Visch, Valentijn; Vermeeren, Arnold; de Ridder, 2018)

As well as overall performance measures, a production line's failure rate could be measured, this was a key indicator and something the company was very interested in reducing. It's even possible to identify an individual's personal profile and responsibilities within the company, the department and the specific production line, connecting their personal life with their role (see Figure 33).

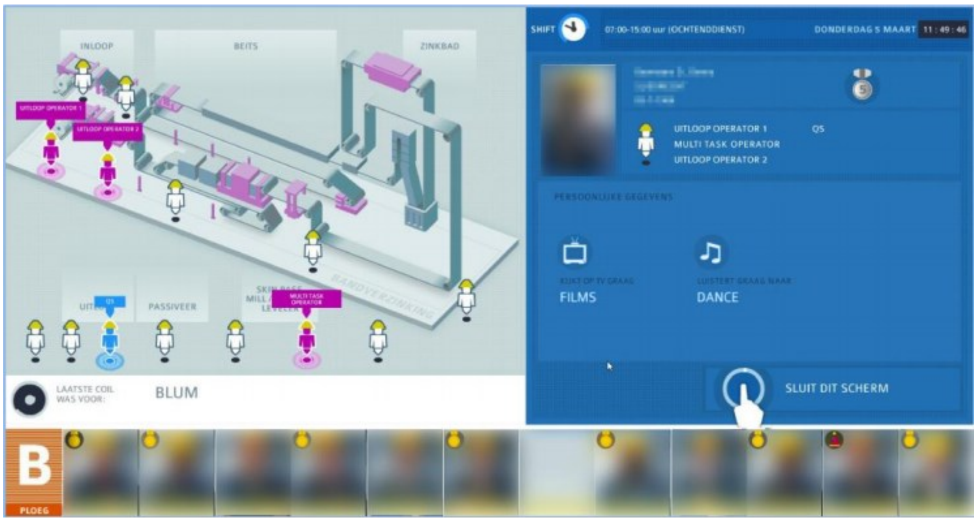


Figure 33. Wupperman personal profile (Vegt, Niko; Visch, Valentijn; Vermeeren, Arnold; de Ridder, 2018)

The system allowed customer satisfaction to be displayed in real time and to be directly associated with individual departments. There were even interactive display screens in the canteen for staff to review their performance, the performance of their team and how that related to others in the company.

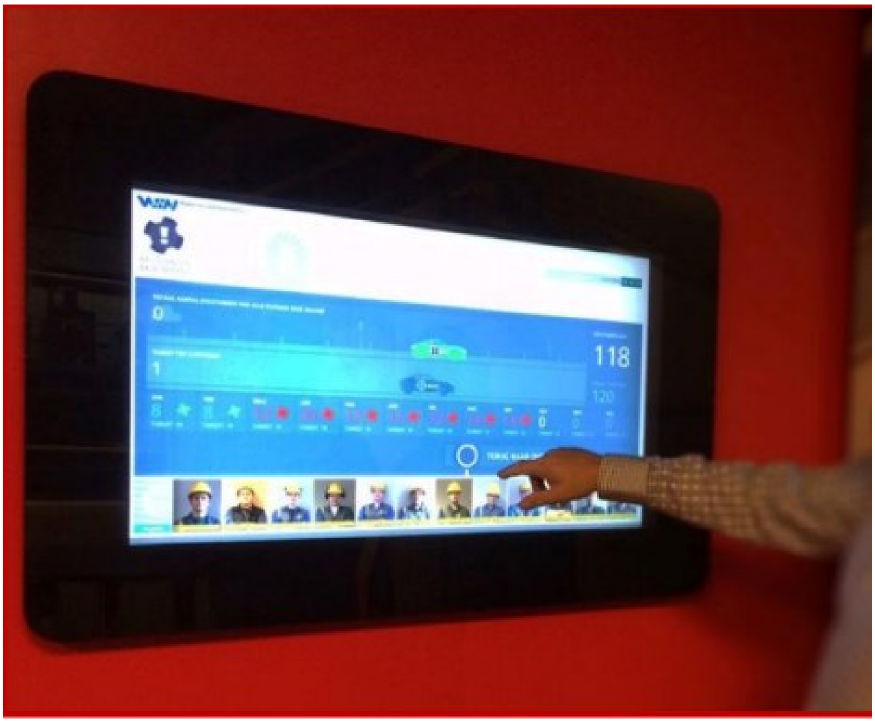


Figure 34. Wupperman canteen display point (Vegt, Niko; Visch, Valentijn; Vermeeren, Arnold; de Ridder, 2018)

Initial studies showed promising signs that the system was working and improving the performance of employees (Vegt, Niko; Visch, Valentijn; Vermeeren, Arnold; de Ridder, 2018). However, over time the side-effects on employees were severe, staff reported feeling depressed, being constantly reminded of failures (stoppages) and feeling inferior when compared to their colleagues. At the production line team level, staff began to ‘game’ the system looking for a dominant strategy (ignoring the spirit of the rules and finding efficient ways to win regardless of their ethical consequences). This would manifest as hiding or delaying problems so the system would assign responsibility to the next shift, thus protecting the current team's score, leading to animosity between staff (Bateman, 2018). Eventually the gamification system was removed.

2.12 Summary

From the case studies, there appear to be four common weaknesses to failed gamification projects:

- The application of limited game design elements (Pettey & Van def Meulen, 2012).
- Providing real-world rewards (Deci & Ryan, 2000).
- Prescriptive measurement (Cerasoli et al., 2014).
- Compulsory participation (Whitson, 2013).
- Stressful competition (Vallerand, Gauvin, & Halliwell, 1986)

UniCraft's design must avoid these pitfalls if it is to be seen as a fun positive activity by students.

2.12.1 Avoiding negative side-effects

A game should have the fundamental quality of being inherently rewarding and intrinsically motivating, but the exclusion of game elements from the core activities of gamification suggests an extrinsically motivating approach (Habgood & Ainsworth, 2011). A number of studies have suggested that extrinsic motivation damages retention, enjoyment, reflection and performance (Danner & Lonky, 1981; Deci, Ryan, & Koestner, 1999). Some recent studies point to the possibility that intrinsic and extrinsic motivation can support each other, but only when extrinsic motivation does not create an oppressive or controlling atmosphere (Cerasoli et al., 2014). Meklar et al (2017), for example, ran experiments in image tagging that found intrinsic motivation was not reduced by the implementation of a gamification enhancement based on points and leaderboards, when it was implemented in a non-oppressive manner.

An important factor in balancing extrinsic and intrinsic motivation is to ensure the gamification aspects are designed with a ‘light touch’. They should look attractive, like videogames. Players should not be forced to play and should be able to opt in and out as they wish. The rules of the game should be well defined and appear fair. Feedback on progress should be clear and regular. Gamification should appear as close to a videogame as possible, without becoming tied to the learning activity (like an educational game). It should be seen as a fun addition to the core learning activity.

2.12.2 The Potential of Competitive Challenges

Part of the methodology for creating an unoppressive gamification solution is to avoid real-world reward, compulsory participation and prescriptive monitoring. This means students must have some other motivation to take part or they may lose interest (Hanus & Fox, 2015). Competition provides an alternative motivation for participating, but it can be a double edged sword (Lepper & Malone, 1987). Players respond to increasing status, promotion and task completion when making comparisons with their peers. As such, many games use competition and its psychological and biological rewards to motivate players (Gee, 2003; Koster, 2013; Yee, 2006). Such is people's desire to express competitive behaviours in games, they will even unconsciously adapt a game to better fit competition between a group of players (DeKoven, 2002).

Competition is a key motivating element in videogames that manifests in a number of ways:

- Online competitive play, with results publicly displayed on leaderboards.
- A single player competing directly against computer-controlled opponents (AI).
- A single player competing against the rules of the game and the game world to fully explore the space and unlock all content.

However, competition is a powerful extrinsic motivator and it is criticised for creating high pressure environments that reduce intrinsic motivation and prevent optimal learning. When people lose competitions they can perceive themselves to be less competent than their winning peers (Vallerand et al., 1986). Fülöp states there are two types of competition, harmful and beneficial, depending on the nature, implementation and goals of the competition (2009). Fülöp argued that, fairness and morality were the most important aspect of competition design to ensure a beneficial outcome. With fairness and morality referring to agreement between all competitors as to what the rules are and that everyone will comply with the letter and spirit of the rules. In such a competition, the process is seen as fair, there should be many opportunities to cooperate and failure should be seen as a chance to improve.

Although there are no formulas for framing 'constructive' competition within a game, videogame designers have been wrestling with these problems for many years and have come up with a range of potential solutions (Schell, 2008):

- Multiple winners – many games allow for individual and team-based competition that offers many different 'prizes' or winning categories, increasing the chance of a player being a winner of something, in order to balance losing at something else.

- Player matching – many multiplayer games assess players and group them by rank into similar ability levels. Play within such groups promotes more evenly matched competition, so there are fewer cases of players losing by a large margin. Losing a well fought competition is more satisfying than the feelings of hopelessness or boredom associate with an uneven match (DeKoven, 2002).
- Constant re-evaluation – some games don't end; winners and losers change over time so that the player always feels they have a chance to come back and they never officially lose.
- Player vs Environment (PvE) – competing against another human can be exciting, but also carries the risk of stress and frustration (Shafer, 2012). If players are fighting the environment (e.g. computer-controlled monsters), then winning or losing carries less potential stress, stigma and embarrassment.
- Value in failure for the player – in some games the act of playing is constantly generating value for the player. As an example, in World of Warcraft (Blizzard Entertainment, 2004) a player will die frequently and in the process lose virtual items of value, however, the player will also still make progress, such as added experience points or new items that persist after death. This makes death less frustrating and a long play session that culminates in player death is not perceived as a waste of time.
- Value in failure for teammates - in some games players are working together against the game environment (PvE) or in teams against other

players (PvP). Even if a specific player ultimately dies, there are mechanisms within the game design that allow them to support their teammates, who may go on to win. The stress of individual failure is mitigated by supporting the progress of the team.

These approaches are rarely applied within existing gamification projects, yet they could be exactly the kind of 'constructive' elements missing from unsuccessful attempts at gamification that include social competition (Hanus & Fox, 2015). They are not commonly used because gamification often relies on a superficial set of design principles (e.g. points, badges, leaderboards) rather than a well-designed game with a virtual game space, avatars, sophisticated rules, etc. Unicraft1 will have points, badges and leaderboards, but also a 3D game world, player avatars, computer controlled enemies and virtual currency – this depth of game design increases the possibility of more sophisticated satisfying solutions.

2.12.3 Gamification design guidelines v1

In order to progress and structure the design of Unicraft1, a set of best practice guidelines are presented, synthesised from the research and analysis reported.

1. Simple points and leaderboards are not enough, explore a wider and deeper array of game mechanics and dynamics such that players have interesting choices and the scope to develop strategies and tactics.
    - Benefit – the activity being gamified will more closely resemble a videogame, people see videogames as fun and entertaining, they learn to play and remain engaged for extended time periods

voluntarily. Players are sophisticated and respond positively to a wide range of well-chosen and well implemented game design principles.

- Why - if gamification only uses a narrow subset of game design principle (e.g. points, leaderboards, competition), then it is more likely to be seen as superficial, uninteresting, an obstacle to be overcome, pointless.

2. Try to make the application look and feel like a modern videogame.
    - Benefit – people find videogames generally appealing, attractive and fun. Videogames have common themes and visual styles that can be used to encourage people to feel like they are playing a videogame.
    - Why – if we are not going to force people to play or give them valuable rewards, we risk people ignoring the gamification. Trying to attract a player voluntarily is difficult, making gamification look like a videogame will help.
3. Avoid direct real-world reward.
    - Benefit – players should not feel added pressure to win. There must be some kind of reward, something that has value, but that value should be limited to being within the game.
    - Why - if players are offered real world valuable prizes, enticements or even money, they can find the activity too compulsive. This then changes the nature of the activity from something that is fun to something that the player feels they must win to get the prize.
4. Avoid compulsory participation when applying gamification.

- Benefit – players will perceive the gamification as ‘light touch’ where they are not pressured to take part.
- Why – people generally regard agency, creativity, imagination and independence positively, they are part of intrinsic motivation. When someone is told they have no choice, intrinsic motivation falls.
- NOTE – this will have implications for group organisation as some may not take part in the game at all or only briefly. They should still be able to fully participate in the process being gamified and there should be the possibility of them rejoining and catching up at least to allow meaningful participation within the game. It also increases the pressure to design a compelling player experience so participation is high and drop out low.

5. Competition is key to making the experience compelling and engaging, but only if it is constructive which requires adherence to the following principles:
    5.1. Allow multiple opportunities to win e.g. individual winners, team winners, winners within ranks or player groupings, winner for specific time period, etc.
    5.2. Use player matching to encourage well played games.
    5.3. Constantly re-evaluate progress, don’t declare winners and stop.
    5.4. Make the game world the enemy (PvE), not other players.
    5.5. Allow players to work together towards a shared goal.
    5.6. Ensure there is value and progress being made for both player and teammates, even if the result in that moment is failure.

- Benefit – people find competition compelling and engaging, they enjoy comparing progress, making progress, receiving feedback on progress, beating targets and reaching goals. However, this is only the case when that competition is perceived as being a positive or constructive experience.
- Why – if people become desperate to win prizes, if they are competing against their peers, if they see no way back from loss, if they feel losing has serious consequences, then competition becomes stressful and frustrating. Intrinsic motivation is reduced.

This first set of best practice design guidelines will be used to develop Unicraft1, an attempt to create a gamification platform that promotes constructive competition.

3 Methodology

This chapter explains the way data was collected to address the research question, which began with two broad aims:

- Aim one: to explore how an increased use of videogame design principles can make gamification projects more fun and engaging.
- Aim two: to create gamification applications which look more like videogames, and explore their effect on engagement.

When planning the methodology, Saunders 'research onion' structure (Saunders, Lewis, & Thornhill, 2007) was used, see Figure 35.

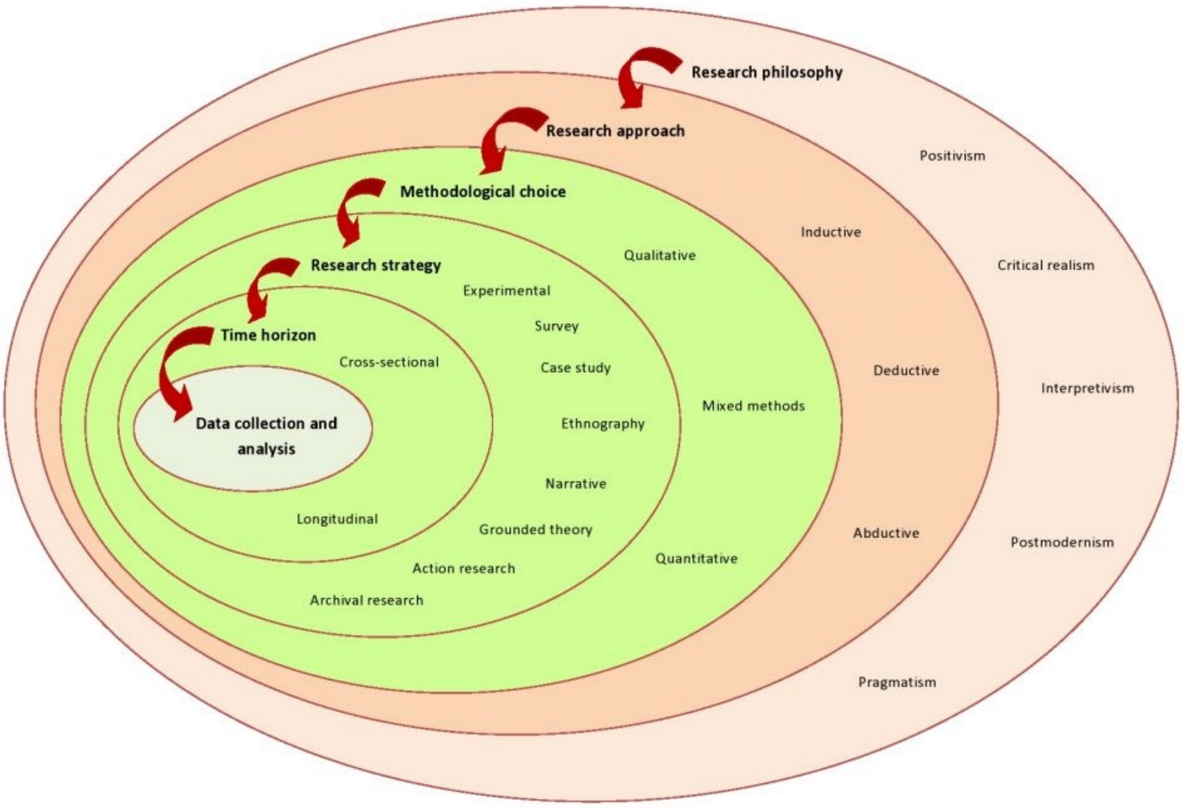


Figure 35. Research onion (Saunders, Lewis & Thornhill, 2007)

3.1 Research philosophy

This research is concerned with gamification interventions in learning environments and the optimal form of their design. This involves measurable learning related activities such as attendance, attainment, consumption of learning resources, etc. It also involves purely human factors such as how students feel, are they having more fun or do they feel they're losing agency? The measurable aspects of the research fall under the positivistic methodology, a great deal of learning activity can be measured objectively (L. Cohen, Manion, & Morrison, 2002). When it comes to the student's sense of agency, whether they are having fun, how they feel, these are thoughts, ideas, social and cultural issues requiring the author to take a more active role in interpreting what participants say and comes under the interpretivist methodology (L. Cohen et al., 2002). The requirement for both methodologies to be used together in this research means it is following a pragmatist methodology.

It is not possible to produce a set of instructions guaranteed to produce successful gamification projects. Gamification is a process of designing a set of rules and processes that allow a specific real world activity to be perceived as being more game-like. The rules and processes change with each new real world activity gamified. The aim being to harness people's compulsive desire to play games and have fun, and redirect that to performing a real world task. As such, this is a game design activity and game design is a craft, requiring both knowledge, and skill developed through experience. For someone to become a skilled game designer, which is a requirement for anyone developing gamification projects, they must first become proficient within their craft. This means not only learning well established game design principles, but also gaining experience applying them. Even when a skilled game designer develops a gamification project, there is no guarantee of success, similar to a game designer developing a new consumer videogame. The aim with this research is to create best practice design principles that increase the probability of success, while accepting success can never be guaranteed.

3.2 Research approach

The literature review included a number of gamification frameworks, but they all take a practical software engineering based Agile approach to gather requirements and implementing technology. They assume that gamification is a simplistic set of game design principles that can be used in isolation: leaderboards, points, competition, badges, etc. This research considers gamification from the point of view of the game designer and that more guidance is needed in how to craft gamification in a similar way to a videogame. That is requires a more holistic and thoughtful game design approach.

The literature review established that there is not a predefined best practice approach to designing gamification from a games designer's perspective and most gamification projects do not look or feel like videogames. This study will attempt to develop a gamification application that is closer in appearance and feel to a videogame. A wider and deeper range of game design principles will be applied in the gamification design. This is an exploratory approach, where multiple software prototypes will be developed. Live metrics will be used to collect data from the application as it is used and this will be fed back into the design process using Agile methods. Therefore, an inductive research approach is needed as a new best practice approach is to be developed (L. Cohen et al., 2002).

3.3 Research strategy

Referring back to the research aims, the goal is to see if making gamification more like a videogame results in something that participants find more fun and engaging. Whilst also examining the nature of any change in engagement. This requires a mix of qualitative and observational research techniques.

Within the field of commercial videogame development, experimentation is common, known as A-B testing. One part of the game is altered in an attempt to improve some metric and then a random selection of players will get the new version while others keep the old, data is collected and results are compared and analysed. Although fun and engagement cannot directly be measured, it is possible to measure side effects related to any changes. For example, if people play for longer, if they make more or less progress in the same time, how often they lose, etc. In this experiment, in an education environment, it would be interesting to measure changes in attendance, attainment or application usage time. To do this students would be recruited and a random selection would use the gamification, whilst another would not. One group might use some of the gamification features, whilst another would not.

This still does not conclusively tell us if the gamification process is fun and what impact it has on engagement, which is why this also used close observational ethnographic-like techniques. Participants need to be observed within their natural uncontrolled class environment and discussions and surveys used to explore how they feel about gamification. Fun and engagement are expressions of how people feel and are also related group dynamics and the culture within the group.

Within educational settings there are two forms of engagement of interest:

- Intrinsic motivation, the natural desire to learn and discover.
- Extrinsic motivation, some external coercive factor that rewards desired behaviour and punishes undesired behaviour.

Intrinsic motivation expressed as natural curiosity and creativity is vital to an educational setting and so it should be measured to ensure it is not negatively affected by the experiment.

3.4 Time horizon

Practical constraints limit how long the experiment can proceed, in an ideal scenario students would use the gamification software over the whole period of their course, but here there is only ethical consent and practical agreement for one semester.

The use of live metrics, collected and stored automatically as students us the gamification application, provides a longitudinal approach. Engagement levels always vary, any activity becomes fatiguing given enough time. Metrics allows this to be monitored, although there is no guarantee that one semester is long enough to notice any change.

Examining how participants feel through conversations and surveys requires a more cross-sectional approach. Students need time to get used to the software and the new subject they are trying to learn, so it makes sense to conduct these conversations at the end of the semester when they can reflect on the experience. However, monitoring engagement via surveys requires comparison before and after experiment.

3.5 Sampling strategy

Ideally a thoroughly random probability sample would be undertaken, however, the students are already organised into timetabled tutorial groups and this cannot be changed. Tutorial groups are created based on alphabetic surname grouping and so is not random, this should be considered when extrapolating conclusions to larger populations. Also, ethical constraints prevent any interference in selecting experimental and control groups. From an ethical perspective, it was felt this intervention would give participants an academic advantage and therefore anyone who wish to use the software should be allowed to. This resulted in different numbers of participants within the control and treatment group.

Experiment 1

A smaller number of students from one course, two tutorial groups, all students wish to use the application. A cross-over approach is taken. One group use the application for the first half of the semester, then stop. The other group operates in reverse, comparisons can then be made between the two.

Experiment 2

A larger number of students, in multiple tutorial groups, from multiple courses. The previous experimental approach is no longer appropriate. Any group not using the application at any time would be mixing with those who are. However, in this case there were students who agreed to be in the control group and not use the application at all.

3.6 Data collection method

The mix of experimental and observational techniques requires a mixed methods approach, with quantitative and qualitative data collection. Analytics software metrics allow the collection of quantitative application usage data. For example, who is using the application, when, for how long, what are they doing with the application, etc. Attendance and attainment are already recorded as part of normal class operating procedures. Quantitative measurement of engagement can be done using a pre and post experiment survey. The 'motivated strategies of learning' questionnaire has been used to measure intrinsic motivation in educational environments for many years (Pintrich, 1991).

In terms of how students feel about their engagement with study, are they having fun, how staff feel in administering the gamification system, these require qualitative measurement. Interviews can be used small groups of participants to understand how they feel about using the gamification software and with staff, to better understand their experience.

3.7 Data analysis technique

Qualitative data from interviews will be used to explore how students feel about their studies during the experiment, are they having fun and are they engaged. Students will be split into small groups and provided with themes, presented as questions to guide them through structured interviews. Recordings of these interviews will then be transcribed and each participant identified and matched to their particular metrics data. Player typologies can then be used to identify common themes in player behaviour using narrative analysis. For example, ‘killers’ might describe a desire to exert control or dominance over other players during interviews and metrics might record them buying more powerful equipment than others in order to facilitate their dominance.

Quantitative data from analytics software, attendance, attainment and surveys will undergo statistical analysis, both as a descriptive analysis of the sample and where possible to infer predictions about the wider population. ANOVA and T-tests will be used to look for statistically significant changes in engagement, attendance and attainment.

Analytics software data

- When different users log in and out.
- Which buttons they press.
- How much virtual currency they earn?
- How often they get the correct or incorrect answer in quiz?
- How often do they make wagers on quiz outcomes and how much they bet?

- A mixture of time values and unique codes representing activities connected to specific users.

Survey data

- Likert scale responses to questions on engagement

Attainment data

- Class test scores as a percentage

Attendance data

- Attendance expressed as a percentage

3.8 Methodological limitations

This experiment is concerned with designing gamification which has applications in almost any real-world activity, most commonly industry and education. However, this research takes place in a higher education institution so is specific to higher education. It also does not implement a truly random sample as students are pre-sorted into tutorial groups by surname and modification of grouping was prohibited by ethical considerations (see Appendix A – ethical approval). The students taking part are all computing students and there are further limitations specific to each experiment:

- Experiment 1
  - Facilitated by the author, potential bias.
  - Small group of 26 students.
  - All males.
  - Average age 21.
  - Intrinsic motivation not measured.

- Experiment 2
    - Not facilitated by the author
    - Larger group of 69 students
    - One female.
    - Average age 20.
    - Intrinsic motivation was measured.

3.9 Summary

Both experiments have been constrained by practical and ethical considerations. The first experiment showed the efficacy of the complex software analytics, but highlighted missing data on the important question of how students' intrinsic motivation is affected, this was rectified in the second experiment.

4 Unicraft1

This chapter describes the first phase of design and development for Unicraft1. This gamification concept was conceived to follow the theoretical guidelines set out previously (see Gamification design guidelines v1) for creating gamification applications that promote constructive competition. Unicraft1 was used in an empirical evaluation that was used to refine the gamification design guidelines (see Gamification and competition - design guidelines v2) and develop Unicraft2.

4.1 Design

The game design process, like the technical design that follows it, will be an Agile process based on repetitions of requirements gathering, game design, technical design, experimental prototyping and testing, to refine the app (Keith, 2010). Prototyping will rely heavily on paper prototypes which allow game designs and user interfaces to be constructed and tested very rapidly (Brathwaite & Schreiber, 2009; Fullerton & Swain, 2008). The formal game design process, ‘mechanics, dynamics and aesthetics’ was used to develop the battle game embedded within the app (Hunicke, Leblanc, & Zubek, 2004).

4.1.1 Objectives and overview

The initial design objectives for Unicraft1 were to use the guidelines (2.12.3) and explore which common gamification practices where appropriate to a second-year degree course with the aim of increasing satisfaction, attendance and attainment within a specific subject for the student cohort. Drawing on common gamification methodologies the following features were prioritised:

- Gaining points and/or badges (achievements) for certain activities:
  - Attending timetabled tutorials and lectures.
  - Handing in assessments.
  - Engaging with the class e.g. asking questions, answering questions, demoing work, helping other students, etc.
  - Completing tutorial exercises.
- Being able to compare progress, anonymously, with other students using a leaderboard.

These features were incorporated into a bespoke mobile application which students could download to their own phone or tablet. The application was designed to resemble a common 3D mobile game, a genre which all the students were familiar with. Enhancements were made to the gamification objectives to help make the app appear more game-like:

- Each student made a 3D virtual avatar, in a similar process to many videogames, they created their own in-game character.
- Points and badges would also be accompanied by virtual credits used to reward the student. These credits buy virtual items to customise the student's avatar.

- Avatars are given an anonymous nickname which can be seen on leaderboards.

Finally, the application would get an actual videogame embedded within it that could be turned on and off. This game would be the platform for competition between students, it would take the form of a battle, students versus some computer-controlled enemy. This would initially be unavailable to the students and then remotely activated halfway through the study.

4.1.2 Mechanics, dynamics, aesthetics

The MDA process was used to design the embedded battle game:

- **Mechanics** - the player will need a 3D avatar that can be equipped with weapons and armour of differing power (guideline 2), allowing the player to make decisions about purchases and encouraging them to earn more currency (guideline 3). Spawn points within the arena are defined to allow enemies to emerge and spread out within the 'furniture' of the scene (guideline 2) i.e. trees, fences, bushes, rocks, etc. This should also slow down enemies as they move to attack and prevent them bunching up. To give the player more direct influence over the outcome of battles, they could 'catch' health escaping from vanquished enemies which would then increase their avatar's health (guidelines 1 and 5.6). This could be automatically shared with the team of player controlled avatars, encouraging a sense of teamwork (guideline 5.5 and 5.6).
- **Dynamics** - the game must be endless, as we can't predict how long users will play or how much they will spend on weapons and armour (guideline 5.3). If play is restricted to an 'arena' where enemies appear in greater numbers over time, with more powerful enemies appearing, then the

challenge will grow. This should encourage the player to collect more powerful weapons and armour. By increasing the rate of enemies appearing in the arena and their toughness, the player is encouraged to bring teammates to help (guideline 5.5) – another goal of positive competition. If the players' avatars are shown in 3D then they can see the equipment they are using and take note of the differences between players (guideline 1 and 2). Powerful expensive equipment should be larger and more colourful, incentivising other players to earn more money for similar upgrades. Similarly, 3D enemy units should also display increasingly large and colourful equipment as they increase in toughness. This provides further encouragement for the player to upgrade their equipment to survive for longer. If the player avatar is moving from one enemy to another autonomously then obstacles in the scene would make that movement look more interesting, and slow down and space out the enemies so they don't just attack the player from all sides.

- **Aesthetic goals** - challenge, competition, sensation, and fantasy. This project is exploring the use of competition as an extrinsic motivator, so challenge and competition are obvious aesthetic choices. A fantasy theme helps shift the game's environment and avatars away from the reality of the educational setting and provides abstraction for displaying battle scenes that are not meant to be realistic or gratuitous. A battle between warriors is a common form of videogame competition and allows players to show off their avatars. To help ensure competition is a positive experience, players should not fight each other, so battles need a computer-controlled opponent. A fantasy battle with melee weapons and warriors being ‘killed’ provides for obvious feedback as to who is winning and a more sensational experience. The player will not be in direct control of their avatar so it should move from one opponent to another automatically, but there should still be a way for a player to have some direct influence and control over the outcome of the battle.

4.1.3 Production values

Production values can be a problematic issue for educational games. Videogames are a popular pastime amongst a wide sector of society, so it's likely that users will have already experienced commercial blockbuster videogames created with million-pound budgets and Hollywood production values. It's unsurprising that educational games can be judged harshly in comparison (see Figure 36). This issue links to guideline 2:Try to make the application look and feel like a modern videogame.

Figure 36. Comparison of educational games and commercial videogames - top left is Rocket Rounding (TopMarks, 2020), bottom left is Earth Squad (BBC, 2020), right is commercial hit game Battlefield 5 (Electronic Arts, 2018)

If an educational game has only narrow application to some specific set of learning outcomes, then it follows that a large development budget is often not justified. Even if such a budget is available, a sophisticated game can take years to produce while school curriculums and learning outcomes can change regularly.

When gamification is presented in a videogame format then it will similarly be compared with popular commercial videogames, however, the more generic nature of gamification justifies more development time and effort as the software that is produced can have wider application. Also, gamification wraps around an activity, it doesn’t attempt to replace or simulate it, therefore there can be less development content required than in an educational game. This means it may take less time to develop a similar quality of presentation to a commercial videogame, than it would for an educational game.

4.1.4 Matching mobile user expectations

Unicraft1 had the objective that it should look like a modern mobile application videogame (guideline 2). Videogames are easily recognisable, ubiquitous in UK society, popular and associated with fun experiences. Gamification attempts improve understanding, productivity and/or quality, in this case, by making non-gaming learning activities feel game-like. With mobile phones/tablets chosen as the delivery platform, the app should look similar to the average commercial mobile game. Mobile videogames, whether for tablet or phone, cover a diverse range of art styles, but share many common artistic aesthetic features:

- Colourful imagery.
- Icons and buttons.

- 3D avatars.
- Motion and animation.

Some common examples are shown below ‘Clash of Clans’ (Supercell, 2012), ‘Crossy Roads’ (HipsterWhale, 2014), ‘Dashy Crashy’ (DumplingDesign, 2015) and ‘Temple Run 2’ (ImangiStudios, 2013), see Figure 37. All of them have high review scores and millions of users.

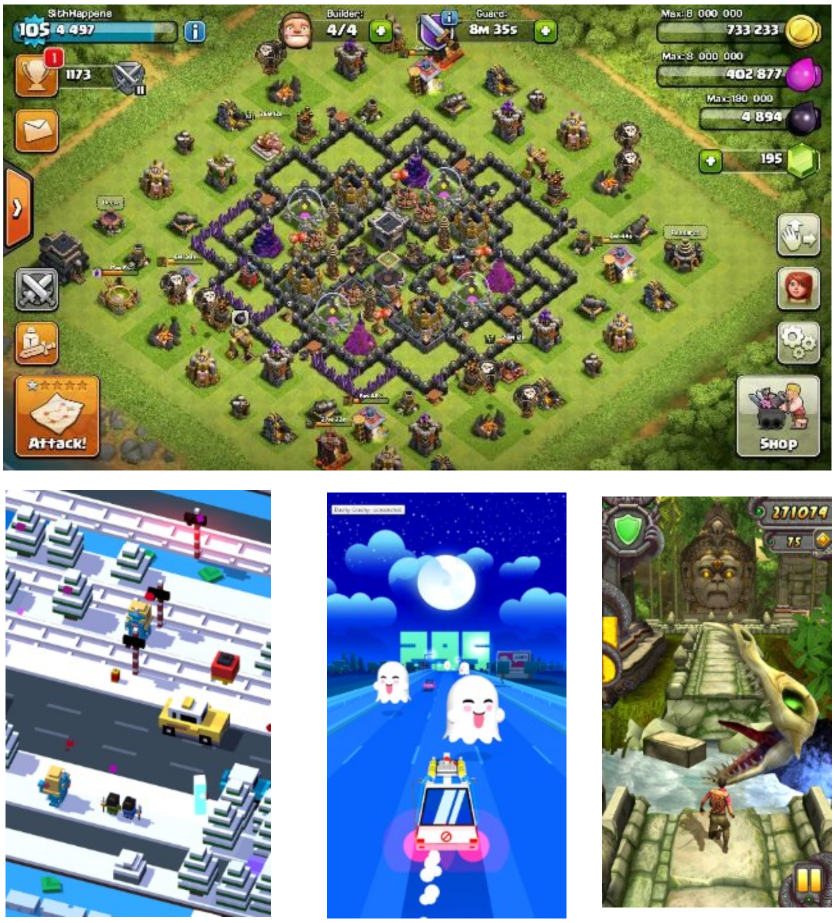


Figure 37. Common mobile game art styles. Top (Supercell, 2012), bottom left (HipsterWhale, 2015), bottom middle (DumplingDesign, 2015), bottom right (ImangiStudios, 2013)

These examples were used as a benchmark when developing the app in terms of quality of assets (i.e. user interface, 3D modules, sound effects, animations) and depth of game design (i.e. interactivity, player decisions, depth of game design).

4.1.5 Avatars

The core functionality of UniCraft has been designed around a customisable 3D-avatar system. Representing players with avatars is a common game design technique in videogames. For example, Xbox Live (Microsoft, 2016) is hugely popular and features public leaderboards built around their 3D avatar system (see Figure 38).

Figure 38. Xbox Live custom avatars (Microsoft, 2016)

The multi-million selling Animal Crossing (see Figure 39) makes use of more cartoon-like avatars which are just as effective at representing the player and providing an identifiable sense of self (Nintendo, 2020).

Figure 39. Animal Crossing avatar customisation (Nintendo, 2020)

Representing players with avatars is a common game design technique in videogames and is at the core of Unicraft1’s design, it enables guideline 3:Avoid direct real-world reward., by enabling the use of virtual currency.

In Unicraft1, the player uses credit earned through engaging with classes, to create a highly customisable avatar that gives the player a unique identity within the game (Figure 40). The provision of a public anonymous avatar fits well with the idea of constructive competition (guideline 5) as they can represent progress and status through individual visual differences while still preserving the anonymity of the player. The system creates competition to have the most impressive looking avatar (individual interpretations can vary).

Figure 40. Student customised avatars (Featherstone, 2022)

4.1.6 Smart devices in education

Unicraft1 could be hosted via classroom PCs, tablet or mobile phones, but using PCs requires navigating institutional IT barriers that don't exist on an individual's personal devices. Mobile phones and tablets are now extremely common (Mitchell & Cisic, 2006), to the point where they are banned in some schools, yet there is growing pressure to actually make use of this personal computing power in the classroom. One of the most popular uses of mobile phones, other than making calls and social media, is playing videogames.

It is therefore useful to consider the operation, look and feel of existing popular mobile device delivered educational applications, some of which may be familiar to students. One of the leading educational mobile software products is Kahoot (Dellos, 2015). Its main aim is to enable multi-choice Q&A sessions in class, with points scoring, ranking and instant feedback - a common goal in videogame development. Applications like Kahoot have taken a classic analogue educational game – the quiz and made it more like a videogame. The teacher creates quiz questions and displays them via a web interface, students then take part via a mobile phone app (see Figure 41).

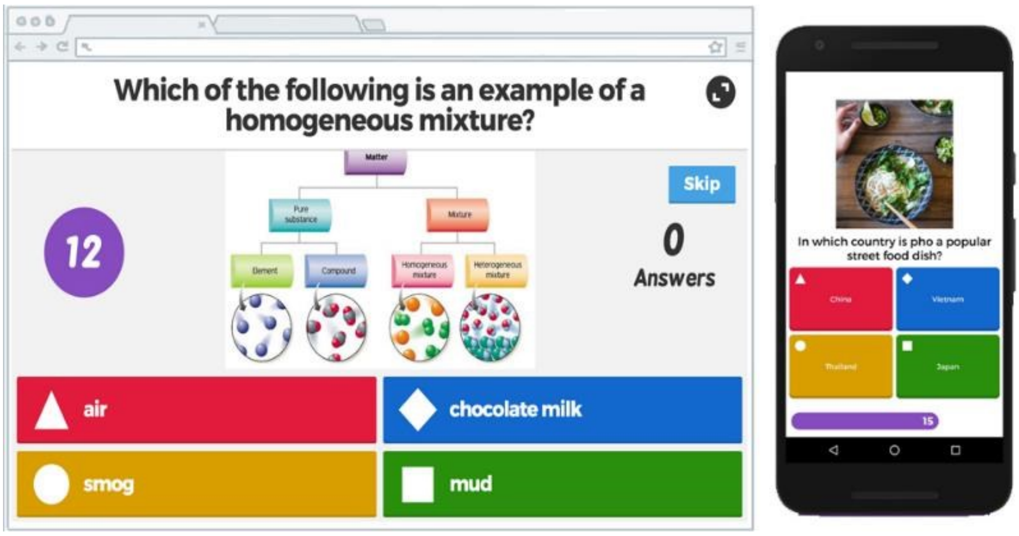


Figure 41. Kahoot!, left web interface, right mobile interface (Dellos, 2015)

Another popular example is Learning Catalytics (Pearson, 2013), which offers multi-choice Q&A with a mix of text and images on the student's mobile device (see Figure 42).

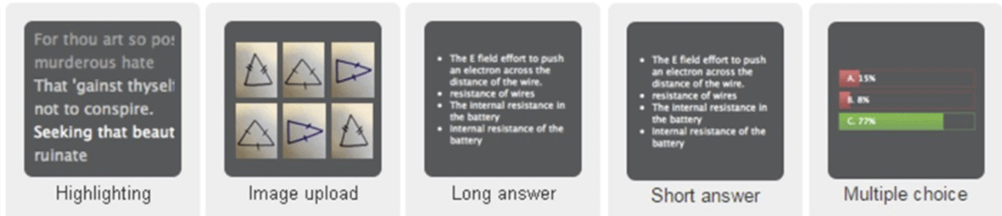


Figure 42. Smart device class Q&A examples (Pearson, 2013)

Learning Catalytics delivers similar functionality to Kahoot, but goes further in allowing teachers to embed quiz results within that ubiquitous teaching tool, Power Point. Students can see their results live, embedded within a slide. As educational games and digital devices are now normalised in the classroom, the mobile phone is becoming an ideal delivery platform.

Unicraft1 will also use mobile devices as its delivery platform, but will go much further than Kahoot and Learning Catalytics in making the application more like a fun videogame.

4.1.7 Paper design prototypes

The design process continued with several paper design prototypes as thought experiments to explore the design objectives. Initially they focused on the non-game aspects of the design, the gamification systems. User interaction (see Figure 43) and use case diagrams (see Figure 44) were used to get an overview of the desired functionality.

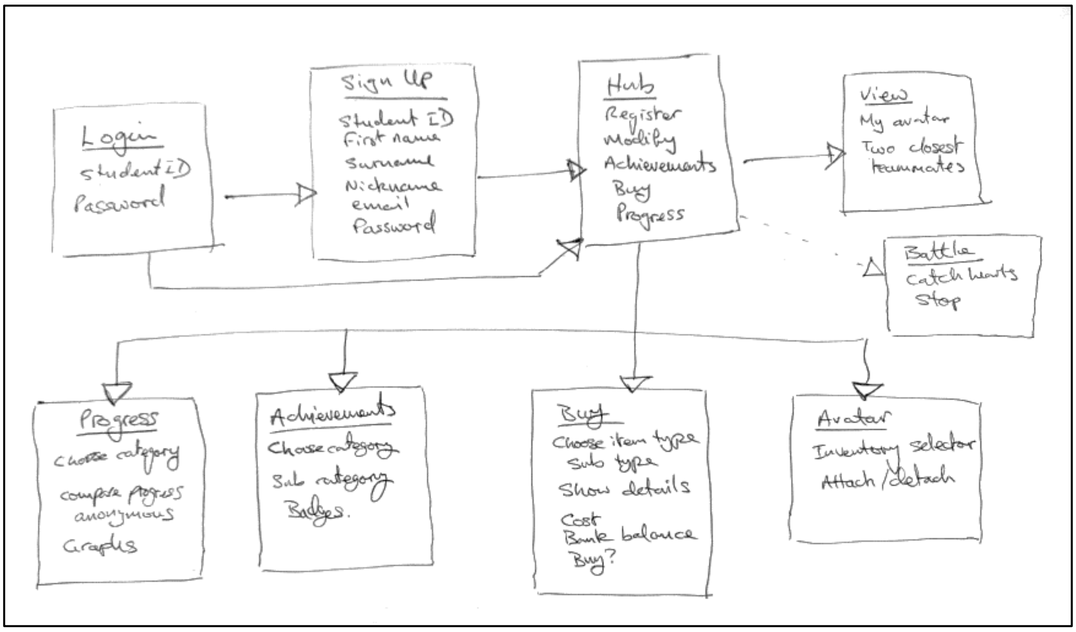


Figure 43. Unicraft1 user interaction flow example (Featherstone, 2022)

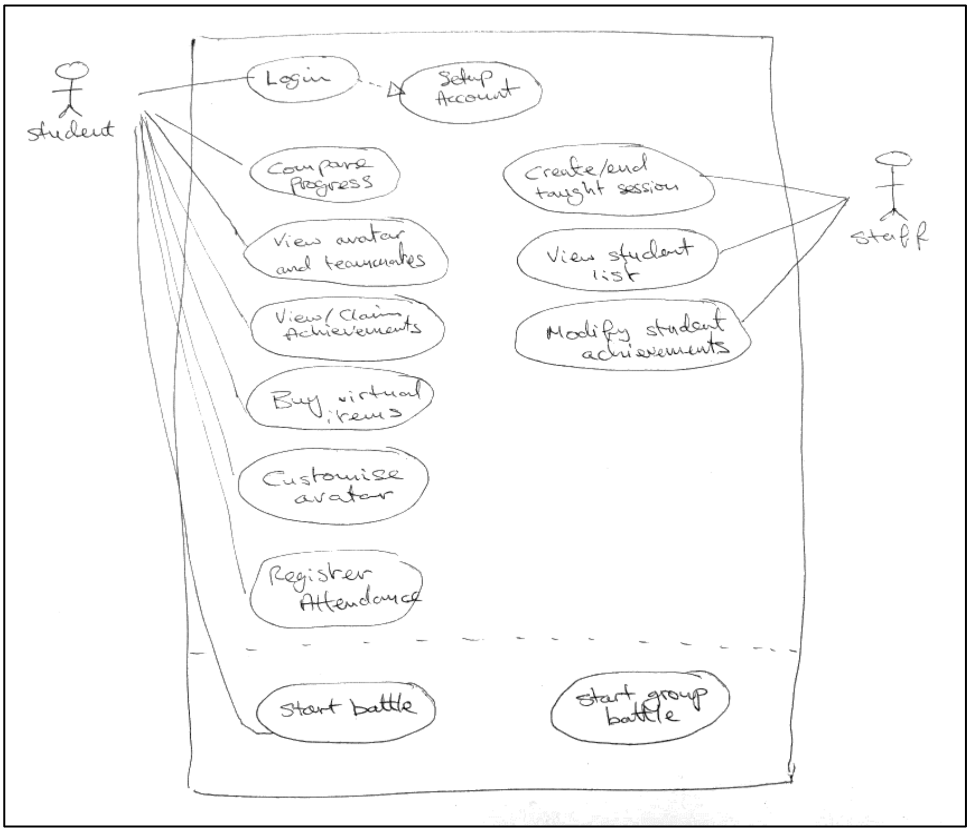


Figure 44. Unicraft use case example (Featherstone, 2022)

4.1.8 Visual style and interface prototypes

When considering the user interface of an application it's good practice to design each screen, their links and how users navigate them on paper first. Once a paper design is prepared, the developer can then desk-test the flow and how well the interface matches the specification. Any errors spotted at the paper stage can be corrected faster than if testing is left to the mobile app implementation stage. Once the functionality of the gamification aspects of the application were defined and the visual style of mobile games identified, paper prototypes were created.

The overarching goals of the design were:

1. Low cognitive load – it should be easy to learn how to use the app and intuitive, with the minimum number of interactions to solve each user action.
2. Game like – try to match the look and feel of modern 3D mobile games.
3. Modular approach to maximise reuse and keep development time to a minimum.

The mobile app's user interface had to facilitate a range of student activities:

1. Logging in – identifying the user.
2. Configuring user details – email, nickname, password.
3. Assigning and reviewing virtual equipment on the avatar.
4. Viewing the user's avatar.
5. Purchasing new equipment.
6. Answering questions in a quiz.
7. Reviewing progress and comparing with others.
8. Triggering a battle.
9. Reviewing medals and badges, both already owned and those yet to be acquired.

The user interface should resemble those commonly found in mobile 3D videogames and use components supported by the development tool. A shortlist was created:

1. Text box.
2. Slider.
3. Button.
4. Icons and image views.
5. 2D graphs.
6. 3D game and object views.
7. Drop down lists.

The interface was prototyped over successively more complex designs following an Agile design approach (see Figure 45, Figure 46, Figure 47).

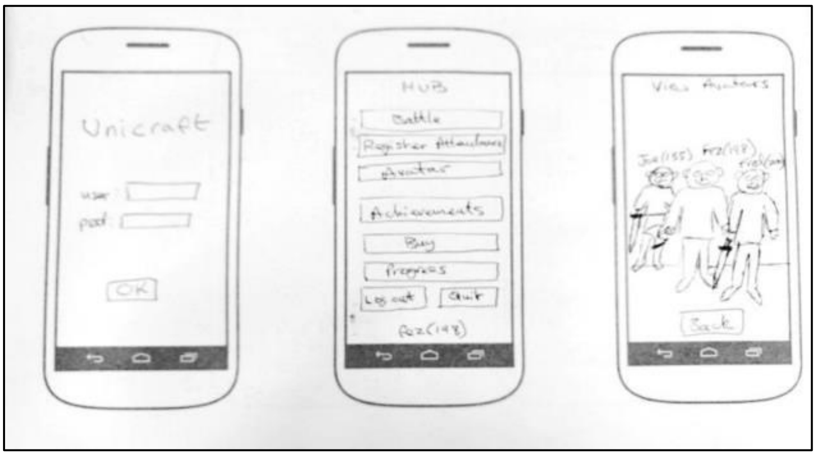


Figure 45. Unicraft interface design V1 (Featherstone, 2022)

Figure 46. Unicraft interface design V2 (Featherstone, 2022)

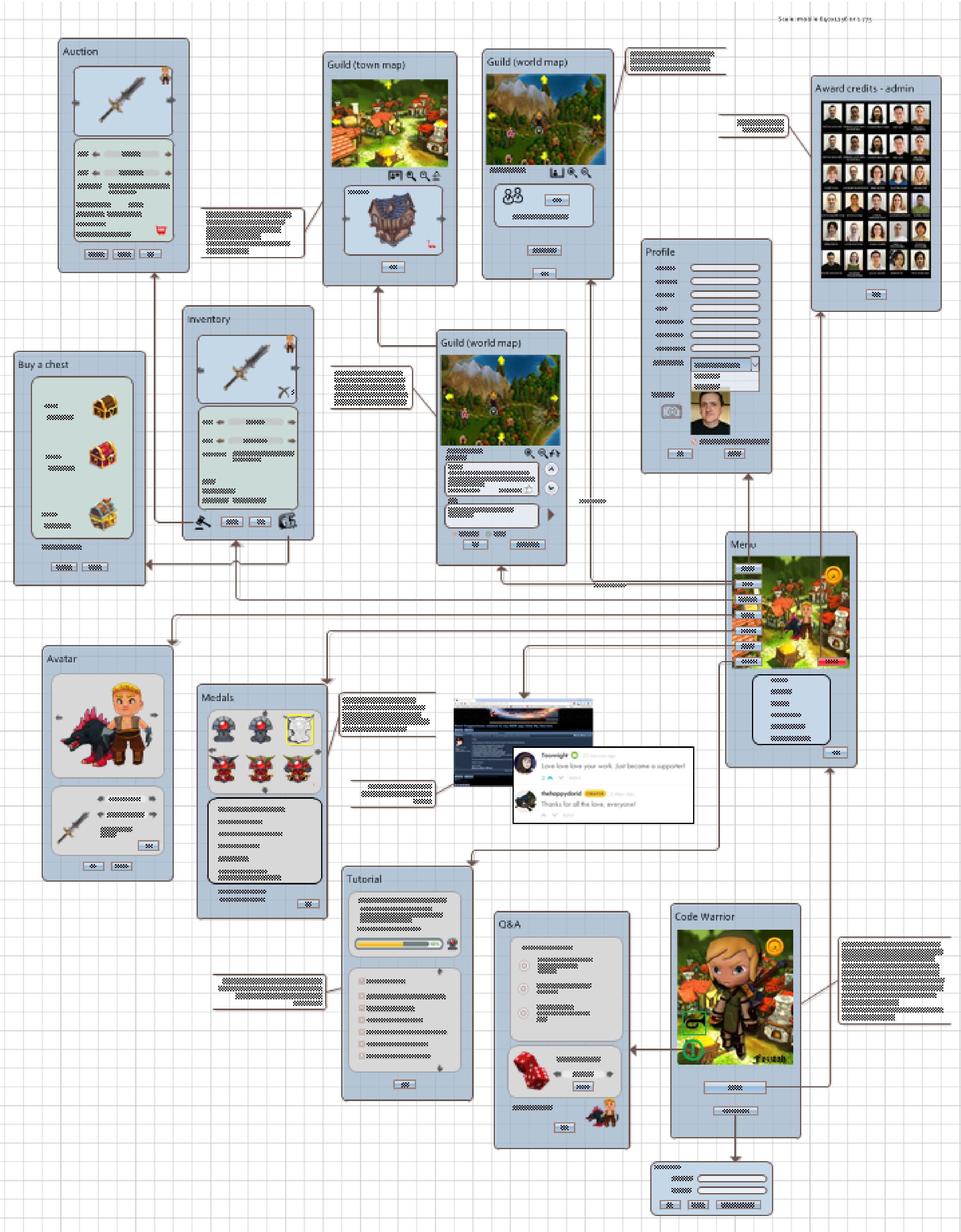


Figure 47. Unicraft interface design V3 (Featherstone, 2022)

4.1.9 The Battle Game

With the gamification aspects and interface taking shape, further design iterations on the embedded game could take place (guidelines 1, 2 and 5) to allow experimentation in the area of constructive competition. To mitigate any potential for reduced intrinsic motivation, Unicraft1 was designed on the premise that participation should be optional (guideline 4) and shouldn't contain real-world rewards (guideline 3). By using the guidelines and reviewing the MDA design process outlined earlier, there are a number of design constraints on the battle game:

- It should look attractive, fun and welcoming (guideline 2).
- Encourage community by letting people play in teams (guideline 5.5).
- Create a focus for competition between players (guideline 5).
- Have enough content so players cannot reach the end (guideline 5.3) – it's not clear how long players will remain engaged, how much virtual currency they will earn.
- Be easy to understand with minimal cognitive load.
- Simple enough that it doesn't take too long to implement – a complex AAA videogame could be in development for multiple years.
- Complex enough that users find it engaging and are willing to play multiple times (guideline 1).
- Capable of being played autonomously while the user gets on with some other work.
- Supports a shallow level of interaction so a user might choose to interact directly, but is unlikely to spend too long away from their work.

- Match the quality level expected by the average user (see Production values and guideline 2).
- Have a scoring system that rewards users who engage positively with the gamification goals i.e. attend regularly, hand in work, etc.
- Feature avatars such that players are anonymous, but still have an identity within the game and can make competitive comparison (guideline 5).

Considering these constraints, a simple ‘battle royale’ was proposed where the player(s) would face an ever-increasing number of enemies, growing in power and difficulty, until the player succumbed.

4.1.9.1 Endless grinding battle games

If the game is meant to be a competition, if the budget to develop the game is low, then the ‘endless’ and ‘grinding’ genres are appropriate. In the endless genre, players keep progressing forever, with competition based on how long a player can last. This is a repetitive genre, which could be seen negatively by players, but here it is a deliberate design choice. The benefit for this project is fewer unique assets are needed to develop the game to a more commercially equivalent standard of quality. Below are examples of popular endless games which were inspiration for Unicraft1 (see Figure 48), all of which sold in large numbers and had high review scores:

- Everyday Shooter (Mak, 2008) – the player moves around within a single screen while enemies continually swarm towards them, getting tougher and growing in number.

- Flappy Birds (McDonnell, 2014) – obstacles are randomly generated for infinite play.
- Jetpack Joyride (Halfbrick, 2011) – player controls avatar height only as the game automatically scrolls to the right and only ends when the player dies.
- Spelunky (Yu, 2008) – the player travels down with the content and platforms continually generated procedurally until the player dies.

Figure 48. Top left Everyday Shooter (Mak, 2008), top right Flappy Birds (McDonnell, 2014), bottom left Jetpack Joyride (Halfbrick, 2011), bottom right Spelunky (Yu, 2008)

It also lends itself to a type of gameplay known as 'grinding', where players engage in quite repetitive activities to earn virtual currency that they can spend on items to decorate their avatar. Endless and grinding mechanics are often seen together, hundreds or even thousands of virtual items can be produced quickly and cheaply, they then provide an incentive for players to keep repeating the same gameplay mechanics without becoming bored.

Four extremely popular examples are shown below (see Figure 49):

- Diablo 2 (Blizzard Entertainment, 2000) and World of Warcraft (Blizzard Entertainment, 2004) provided hundreds of hours of gameplay through repetitive top-down view 3D battles and exploration.
- Destiny2 (Bungie, 2017) and Warframe (DigitalExtremes, 2013) encouraged thousands of hours of repetitive play so users could earn currency to customise and improve the performance of their avatars.

Figure 49. Top left Diablo2 (Blizzard Entertainment, 2000), top right Destiny2 (Bungie, 2017), bottom left Warfame (Digital Extremes, 2013), bottom right Word of Warcraft (Blizzard Entertainment, 2004)

4.1.9.2 Initial game design conclusions

Considering the constraints outlined above, limited time and resources and the genres of game likely to meet all these constraints, the following design parameters were identified:

- The game should be a top-down 3D battle that doesn’t end until the player dies.
- It should have a consistent theme (i.e. fantasy, sci-fi, medieval), depending on asset availability.
- Progress should be based around the purchasing of virtual items so that the underlying currency can be related to gamification objectives.
- Virtual items should be visible on 3D avatars giving each player a unique look.
- It should support single players and teams of players working together against the game.
- The player’s avatar should navigate the game space under computer control so the game can be left playing while the player works.
- The game should be engaging to watch with animations, motion and visual effects.

4.1.9.3 Aesthetic of the battle arena

Assets were needed to implement the battle within the aims and constraints outlined. The chosen setting for the game was a light-hearted fantasy environment (see Figure 50) where warriors battle waves of undead monsters (see Figure 51) realised using a popular 'chibi' or 'super deformed' style

(Gamespot, 2017) appropriate for audiences of any age. This decision was also influenced by the availability of suitable 3D art assets.

Figure 50. UniCraft Battle Game scene (Featherstone, 2022)

The player's avatars are warriors that are required to battle waves of undead monsters (Figure 51) within this environment, and there is no ultimate goal or completion state to the game. Each battle's winner is the last avatar standing.

Figure 51. Example undead enemy in T-pose (Featherstone, 2022)

4.1.9.4 Paper design

Once again, ideas were brainstormed on paper prior to building software prototypes to visualise how the avatars might look, how a battle might be laid out spatially and help guide the selection of 3D assets that would be needed.

Avatar customisation

3D avatars were used for the players and the enemies, with interchangeable weapons and clothing used to indicate visually how tough the player or enemy units are (see Figure 52).

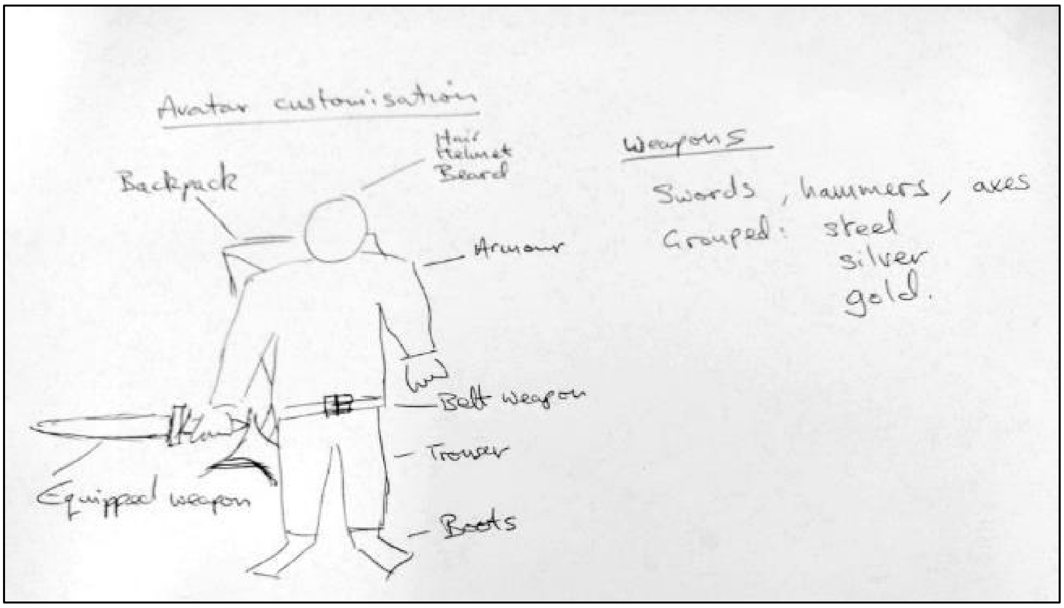


Figure 52. 3D avatar mock-up (Featherstone, 2022)

The sequence of play

One or many player avatars would be initialised into a small 'arena' littered with obstacles to make navigation more visually interesting and to stop all the units in the game simply moving to the centre and congregating in a scrum. Enemy avatars would be initialised into randomly selected pre-set locations forcing the player avatars to move around to engage them (see Figure 53).

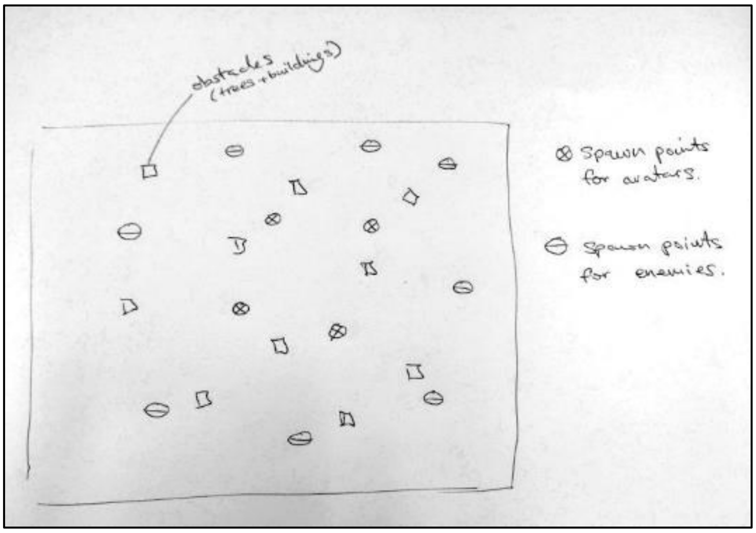


Figure 53. battle arena mock-up (Featherstone, 2022)

Interactivity

A battle can be played interactively or non-interactively:

- Non-interactive - this allows the battle to be viewed remotely on communal screens or for the player to carry on with their studies while the battle completes.
- Interactive - a player can influence the outcome of the battle by using one finger to 'grab' hearts as they float away from defeated enemies. The hearts restore a small amount of health to the player, so the avatar survives longer (see Figure 54). The impact of interacting should be small, players should feel like this is a real videogame but should not be compelled to spend time away from their studies.

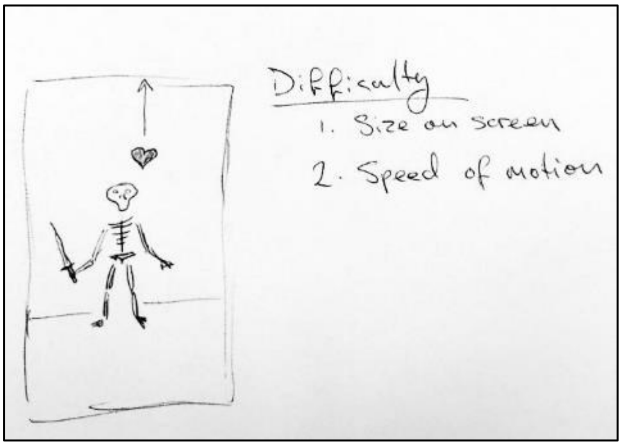


Figure 54. Minimal interactivity mock-up (Featherstone, 2022)

4.1.9.5 Design discussion

Players can lose interest with any game over time, which could lead to disengagement or cheating (Baker et al., 2009). Unicraft1's Battle Game design attempts to counter this with its compulsive public competition, simple concept, short play sessions and regular progress.

Compulsive competition

Competition is inherently compulsive; people are often drawn to competition. If one or more activities can be measured, those measurements transformed into a score and that score shared with other players, then you have the basis for a compulsive activity. Players can then reflect on their own performance if they note a friend making faster progress, they may then explore new strategies, practice to refine their skills and persist with an activity until they catch up or take the lead. Players will even assist a friend who is falling behind, offering them advice and help. People are generally happiest in competitions when they perceive a 'level playing field', where all players are making similar rates of progress (DeKoven, 2002).

Simple concept

When presented with a new game, the potential player must ascertain the rules and deduce the required skillset and time commitment for practice. The more complex the game, the wider range of skills required, the more time necessary to practice and understand. This is known as cognitive load and people will decide to participate or not based on their perception of cognitive load versus any benefit of playing, assuming they are not compelled to play (Sevcenko, Ninaus, Wortha, Moeller, & Gerjets, 2021).

The summary below shows how such decisions are made:

- Low cognitive load
    - Progress is made quickly.
    - Rules are simple or self-evident.
    - Feedback is clear and given often.
    - The game looks and plays like other popular games that most people already understand.
- High cognitive load
    - Progress is slow.
    - Rules are numerous, not self-evident.
    - Feedback is ambiguous or not often received.
    - The game does not resemble any common genres so people have no existing models of play they might apply.

Short play session

Players become fatigued by repetitive activity over time. The more sophisticated a game is, the more content it has, the longer it can keep a player engaged. All games eventually begin to reuse content, to reuse rules and become repetitive (Koster, 2013). If a game is designed to be played repeatedly for short amounts of time, then it shouldn't need to be as sophisticated, it shouldn't need large amounts of content. This is especially relevant to gamification, where we want the player to spend as much time as possible performing the real-world activity.

Regular progress

Players need to know that the decisions they are making are either correct or incorrect, so they can modify their strategies and optimise their performance. This is done through clear feedback given often. Where players are given clear regular feedback they are more likely to make progress in the game. When a player makes regular progress they are more likely to feel positive about the play experience.

One button games

Inspiration was found in the 'one-button' mobile videogame genre with popular examples being, 'Dashy Crashy' (DumplingDesign, 2015), 'Crossy Roads' (HipsterWhale, 2014) and 'Temple Run 2' (ImangiStudios, 2013). They are simple games controlled with just one finger (see Figure 55), they often rely heavily on the motivational power of avatars and have frequent, but short play sessions, making them an ideal design template.

Figure 55. Temple Run 2, one finger control (ImangiStudios, 2013)

Value in failure

When players make incorrect decisions, perform without the required skill, they fail. Failure is important feedback, but if failure is perceived as being very costly it can lead to frustration (Koster, 2013). Below are some positive and negative examples:

- Falling in a platform game
    - Positive – a life is lost and the player restarts near the platform, taking a few seconds to get back to the same point. It doesn't take long to practice the skills (repeatedly falling) to make the jump.
    - Negative – a life is lost and the player restarts at the beginning of the level, taking minutes to get back to the same point.
- Dying in a fantasy dungeon game
    - Positive – earned experience points and new magic spells are retained, the player reappears nearby, their equipment is left where they died but can still be recovered.
    - Negative – all items gained in the dungeon are lost, the player appears outside the dungeon.

Constructive competition

Although it is not possible to guarantee a ‘constructive’ competition, design decisions can be made to reduce the chance of the competition being destructive (Hanus & Fox, 2015), by focusing on cooperation, fun, progress, flexibility and fairness. The design of UniCraft’s battle system includes several specific design decisions to encourage constructive competition:

- Winning has no real-world benefit, it doesn't affect student grades (intrinsic motivation).
- Not compulsory – students can still use the app without competing (intrinsic motivation).
- Students always fight the computer, not each other (PvE).
- Students fight in teams, and even if you aren’t the team leader, a player can still earn credits by cooperating (co-operative competition).
- Members of teams are rank matched, so they are of similar ability (player matching).
- Death in battle is not wasted time, members of the team may still make progress (value in failure for teammates).
- Student avatars have public nicknames, concealing the student's actual identity (anonymity).
- Student avatars look like 'fun' videogame characters.
- Student avatars are customisable (sense of self).

The Battle Game itself consists of waves of enemies dragging themselves out of the earth and attacking the nearest warrior. Each wave has more attack damage and more health than the last, with each tougher enemy type having a unique look (Figure 56). Enough enemy waves are available such that the player could never win, regular progress is made even with an avatar outfitted with the most expensive and therefore powerful virtual items.

Figure 56. Undead enemies growing in strength from left to right (Featherstone, 2022)

Player progression comes from purchasing new customisations using the credits obtained from engaging with class activities. These items provide advantage in the game using a simple rule: the more expensive the items attached to the avatar are, the higher the health and attack damage of the warrior. For this reason, all items, weapons, shields, clothes, hair, bags, etc., come in a number of ever more expensive varieties (Figure 57).

Figure 57. Increasingly expensive virtual items (Featherstone, 2022)

The Battle Game itself was designed to minimise play time as the players are students who should be spending their day studying. As such, the game supports interactive play and completely hands-off play. This allows a range of student preferences to be satisfied:

- Watching your avatar and peers fight, together in class.
- Watching your avatar and peers fight, on a personal mobile device, while working.
- Interacting with your avatar and peers while fighting, on a personal mobile device.

4.1.9.6 Implementation

In a Battle Game the player's avatar works with others to defend against an undead army. The player's avatar and two peer matched comrades, one with the next highest rank, one the next lower rank, fight wave after wave of undead enemies, each wave stronger than the last. The app tracks how many waves the avatars survive, everyone involved gets a credit reward whenever they survive longer than previous battles. Credits allow the player to buy better, more expensive equipment and decoration (hats, clothes, weapons, beards, etc.), which in turn allows the avatar to last longer in battle.

A battle can be left to run on its own with the player carrying on with their studies or the player can interact with the Battle Game by catching hearts to replenish health dropped by slain enemies (Figure 58).

Figure 58. Battle game (Featherstone, 2022)

When capturing hearts, the weakest member of the group (the player's avatar and two peers) receives a small health increase, this nurtures the idea of working together and giving the weakest an advantage, a constructive and cooperative form of competition (Fülöp, 2009). It's important to maintain an element of skill, this is a one-finger controlled game and the obvious way to exploit this design is to just tap as fast as possible on the screen. To combat this exploit the game penalises rapid finger taps that do not make contact with a heart, if that behaviour is detected then interaction is temporarily disabled and a warning displayed. Thereby the player learns they need to time their interactions carefully which takes a modicum of skill.

By designing the game to be playable without human interaction it enables battles with the entire class cohort to be played out on the class projector or common room big screen display (Figure 64 and Figure 63). These are not credit earning matches, they allow students to share the experience, note their own standing, it reminds them to keep playing and it inspires them to earn more credits - by engaging with their studies.

The game uses an asynchronous multiplayer design (Zagal, Nussbaum, & Rosas, 2000), smart devices update player avatar configurations in real time, but the avatars are not always under player control. When a battle is started, the two warriors accompanying the player are not controlled by their own players. Their configuration and any rewards they earn are updated back to the original player's device. This provides flexibility in that a student can play the game, with the help of two peers, at any time and without the two peers being online. The next time either player goes online they will get a message informing them of any new rewards. This design also enables the game to be played communally without requiring all the participants to spend time interacting with the app – they can watch while doing something else.

4.1.10 Server technical design

The app needed a centralised server to authenticate player identity, enable data sharing for the competition elements of the app and gather metrics on player behaviour to support the experiment.

4.1.10.1 Web server backend - database design

User data from the mobile app needed to be centrally stored in a secure way that was compliant with current GDPR regulations (Gov.uk, 2018). There were two requirements driving the need for centralised storage:

1. To enable the gamification aspects of the project to work the application needed access to leaderboard metrics and other data for all users, such that a student could gauge their progress against their peers and take part in a battle.
2. To support the experiment a central record of usage metrics was needed e.g. how long people use the app, when they use it, etc.

Online data storage used a Microsoft Azure cloud hosted MySQL database backend, managed through phpMyAdmin with php scripts on the front end. This is a simple, cheap, industry standard approach that allows scalability and provides high availability and performance. It was important the app was available 24/7 and there were minimum delays while using it (ping time).

Once the technology was identified then the first step was to design the SQL database that would hold the app data. A paper prototype approach using entity relationship diagrams is a common industry design technique. The first step is to identify the entities within the data and group the information accordingly:

- User – name, password, email, staff or student?
- Achievements – id, can they self-claim or is staff authorised, credit reward.
- Earned achievements – the id of whatever they earned, when they earned it.
- Groups – students are segregated into different tutorial groups.
- Sessions – attendance is an important metric of engagement, so when did sessions take place, and which users attended.
- Events – when the student does something that needs recording e.g. attending a session, handing in some work, etc.
- Items – virtual currency rewards are spent on items for the user's avatar. This means defining what each item is, its cost, which users have them and which items are actually being warn and used currently.

Once the entities are identified the data can be normalised to organise the tables and fields to reduce redundancy and dependency. Relational integrity can then be enforced once the relationships between entities are identified. The database table design and relationships are shown in Figure 59.

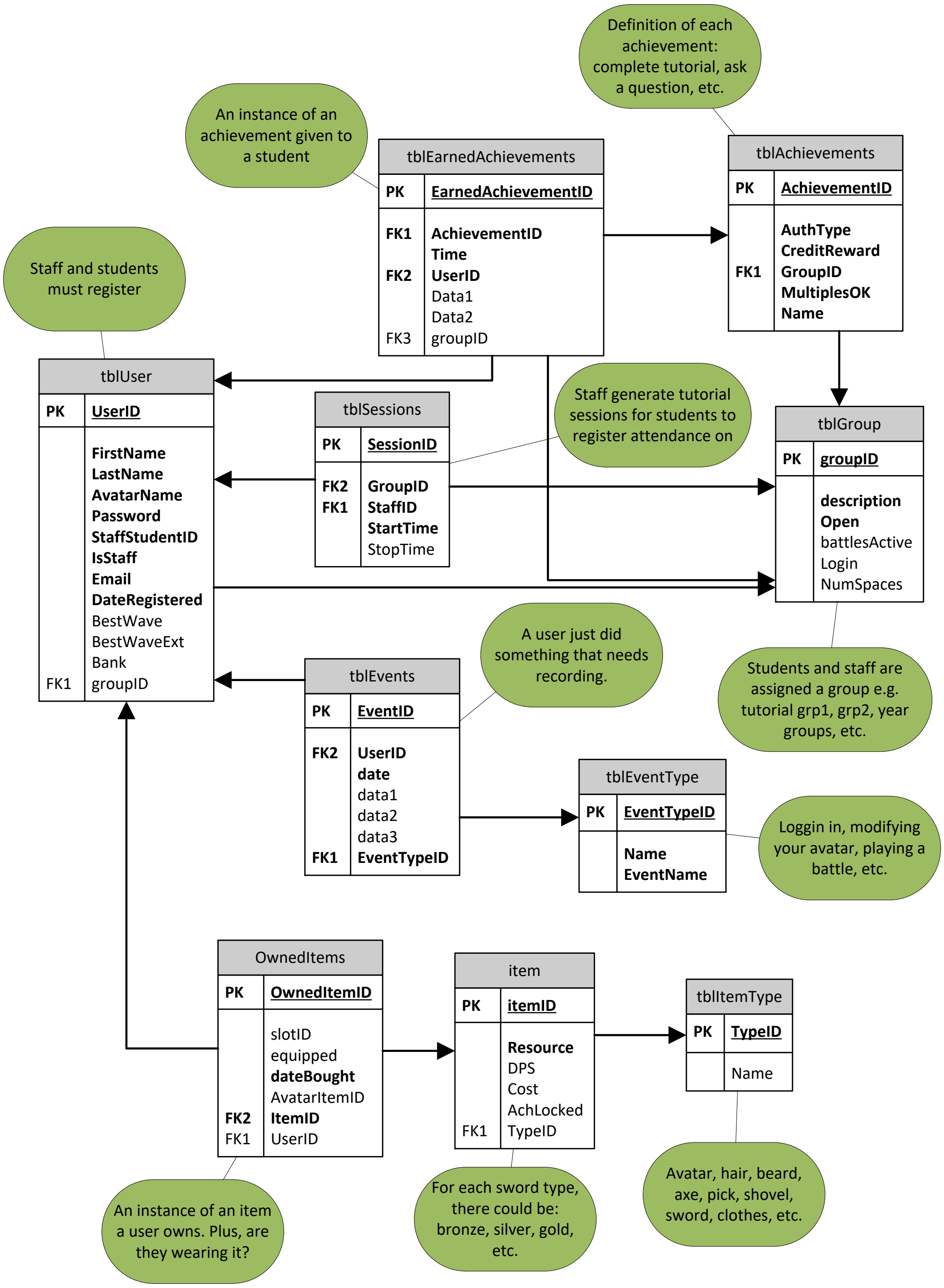


Figure 59. Unicraft1 database design (Featherstone, 2022)

4.1.10.2 Webserver frontend - php script organisation

To comply with data protection GDPR regulations and general security, the database must be protected from unauthorised access. A common approach is to hide the database from the world wide web and only allow access to it via a public facing web service running on the same server. Data requests are serviced and interpreted by this middle layer of technology so that malicious access can be rejected and the database itself is never exposed. PHP scripts are commonly used to implement this public interface to the web server and access the database (see Figure 60 and Figure 61).

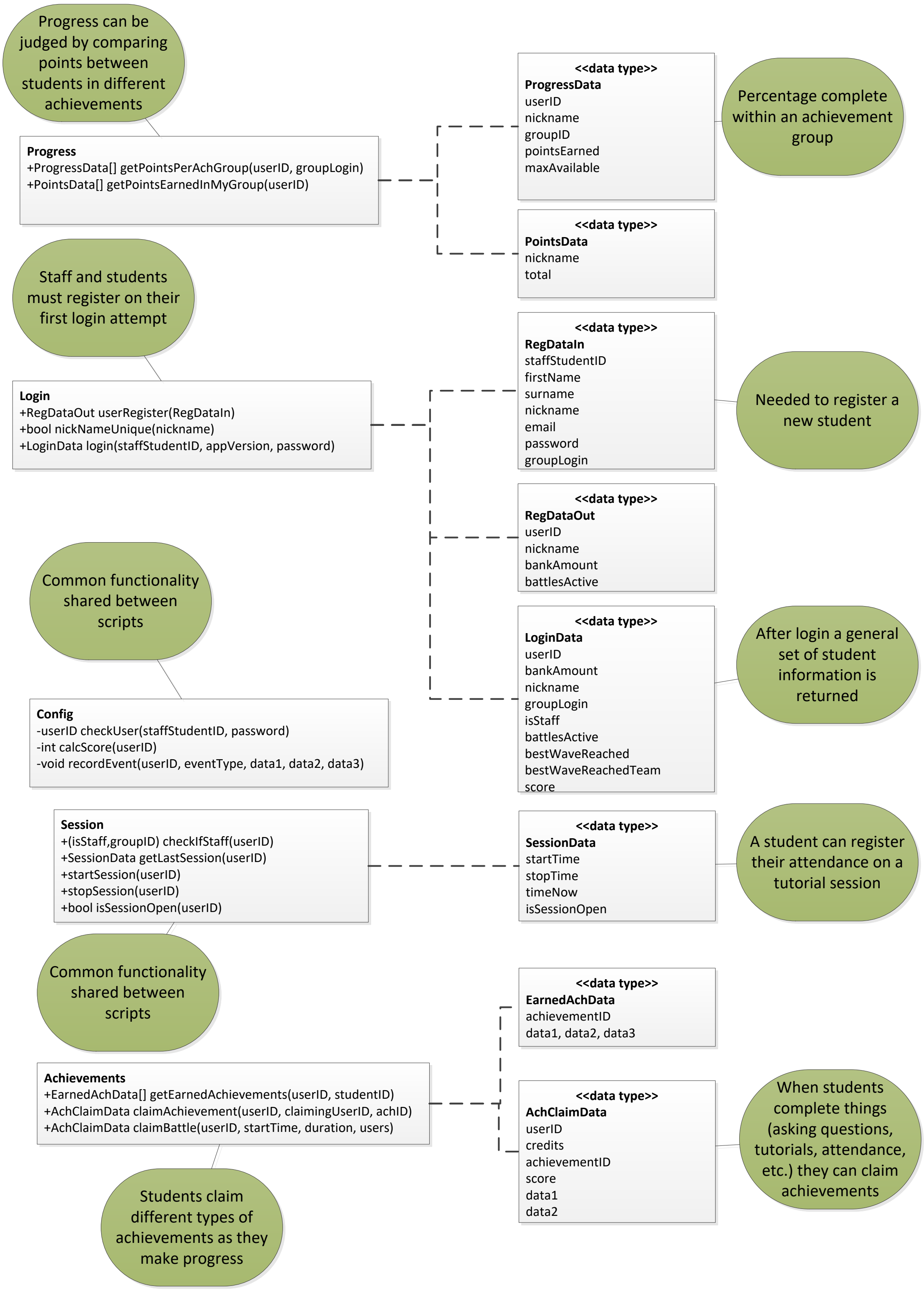


Figure 60. Unicraft1 webserver objects pt.1 (Featherstone, 2022)

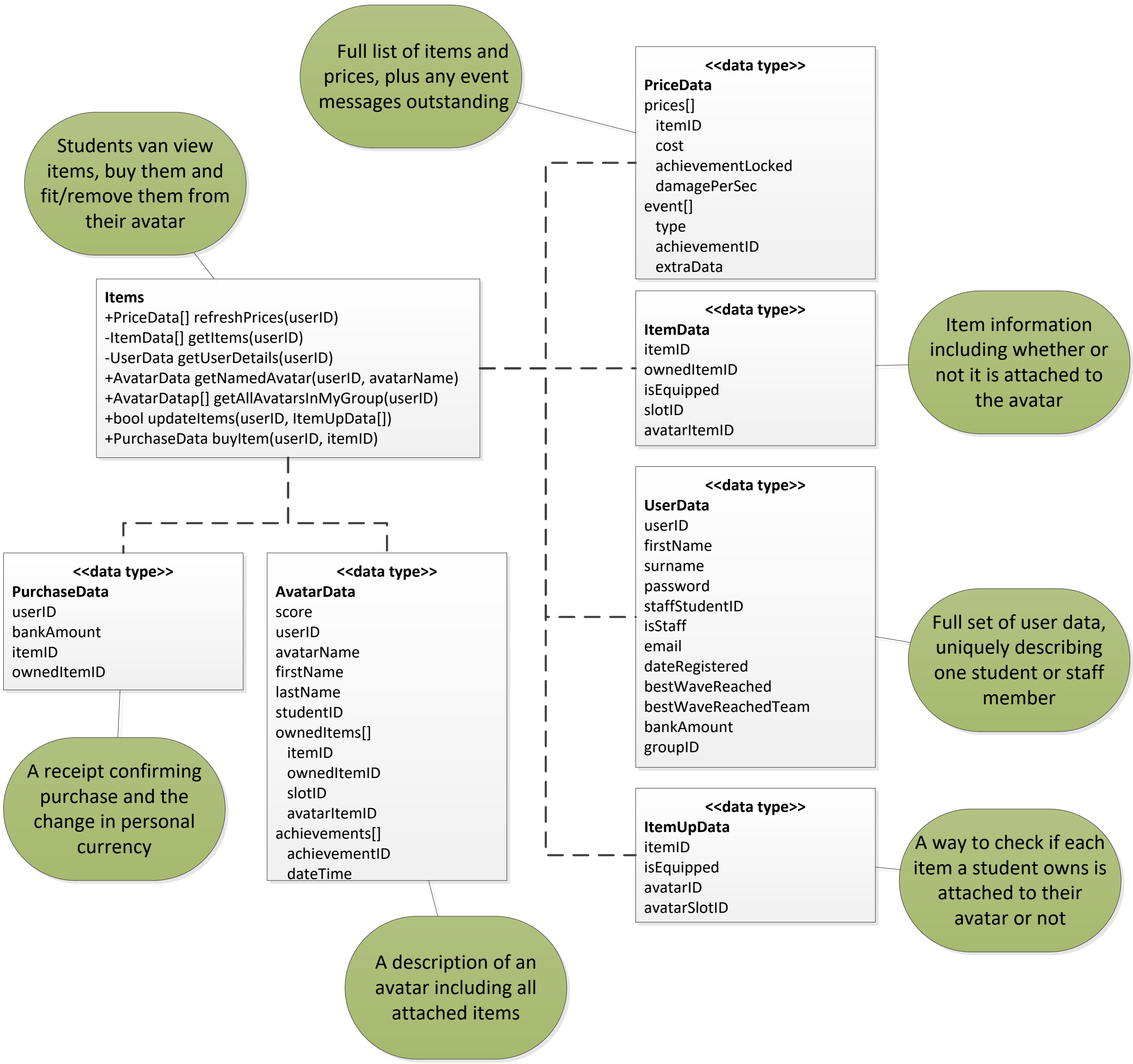


Figure 61. Unicraft1 webserver objects pt.2 (Featherstone, 2022)

4.1.11 Unicraft1 features

A summary of the final set of design features for Unicraft1

- Educational game application delivered via mobile devices.
- Looks like a 3D mobile videogame.
- Players create unique accounts with anonymous avatars.
- Classroom activities are logged and recorded as players progress, this can be reviewed within the app.
- Progress earns virtual credits which can be used to purchase virtual items to customise avatar appearance and enhance performance in battle.
- All players can compare progress anonymously and are ranked.
- Players' avatars can fight alone in battles against computer-controlled monsters.
- Players are matched with others of similar levels of progress to fight together against computer-controlled monsters.
- Players can compare the performance of all avatars.
- Grand battles featuring all avatars can be triggered by an administrator for display in communal areas.
- A central server collates metrics on all players using the app.

4.2 Avoiding cheating

With the application and embedded battle game now at the prototype stage, a key design issue is how players would earn currency. The player with the most currency could buy the most powerful equipment and reliably win all competitions (battles). This ability must accurately relate to their engagement and performance in class for the app to maintain credibility. Most gamification projects don't embed an actual videogame, even when those projects use videogame tropes (Classcraft Studios Inc., 2017). UniCraft does and it must be seen as fair to all participants and the results credible, so preventing cheating was a priority when selecting certain game mechanics:

- The type and value of achievements - progress is measured by the survival time of player avatars in the battle game, this time is extended by earning credits and using them to buy better equipment. Most credit earning activities are either automated or have to be manually authorised by staff, e.g. asking interesting questions during class is rewarded by a member of staff clicking a button on their 'administrator' app. Practical time constraints mean some activities are under player control, but these have low credit values, so the cost-benefit of cheating is low.
- The level of interaction - the battle game is designed to be played either with no interaction or a limited one-button interaction (catching hearts). This makes the app more recognisably an interactive videogame, but also limits the scope of player interaction making it less likely that players will find exploits or ways to cheat.
- The use of asynchronous multiplayer - avatars can operate within the game under player control or as autonomous agents, which allows for multi-player participation, yet it's based on player stats recorded and stored in a secure online database supporting real time data monitoring.

4.3 System Overview

UniCraft is an Android based gamification app for smart phones (Figure 62), installed via the Google App Store (Featherstone, 2017). As well as playing on a smart device, the Battle Game embedded in the app can be played autonomously, with all student avatars taking part, on a PC. This allowed the game to be projected onto a large screen during the start of class (Figure 64) or in the common room (Figure 63).

Figure 64. UniCraft battles played out on a class projector (Featherstone, 2022)

Figure 63. UniCraft battles played out on a large screen TV in a common room (Featherstone, 2022)

Figure 62. UniCraft is a mobile gamification app (Featherstone, 2022)

Staff and students access the system through their smart devices (PCs, tablets or smart phones), as shown in Figure 65. Unity3D was used to create the gamification software for PC and Android devices as it supports multi-platform development and is one of the leading videogame development tools in the games industry (Axon, 2016).

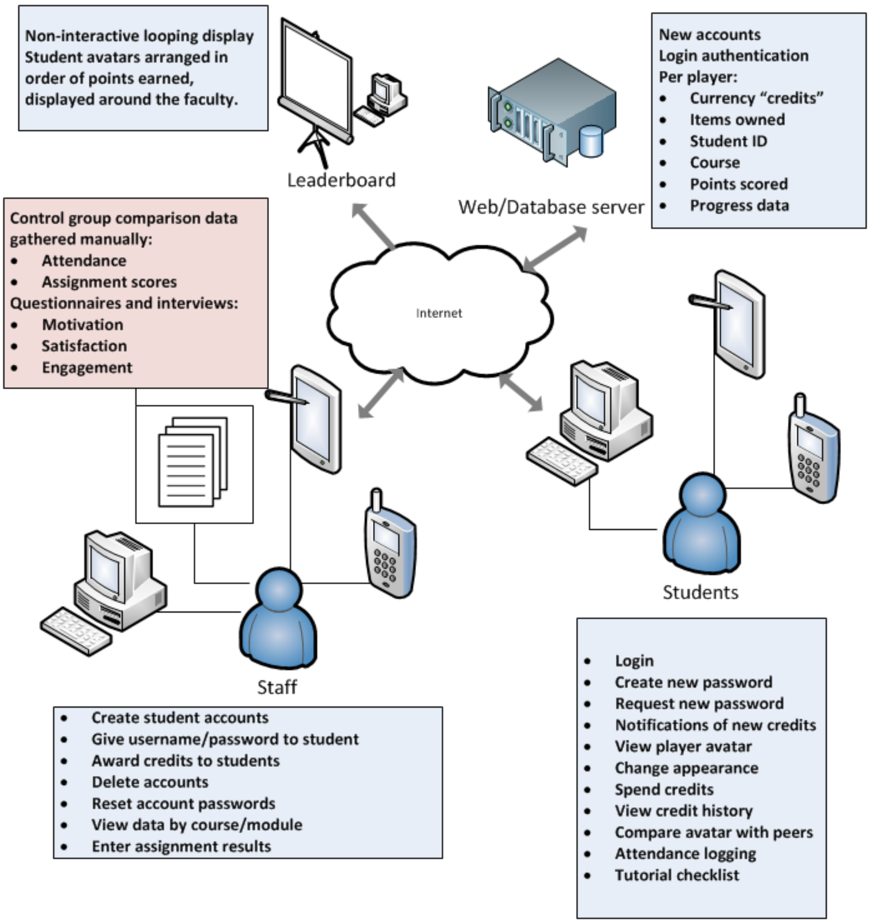


Figure 65. System architecture (Featherstone, 2022)

4.4 App Overview

The diagram in Figure 66, gives an overview of the app and how the different user interface screens link together.

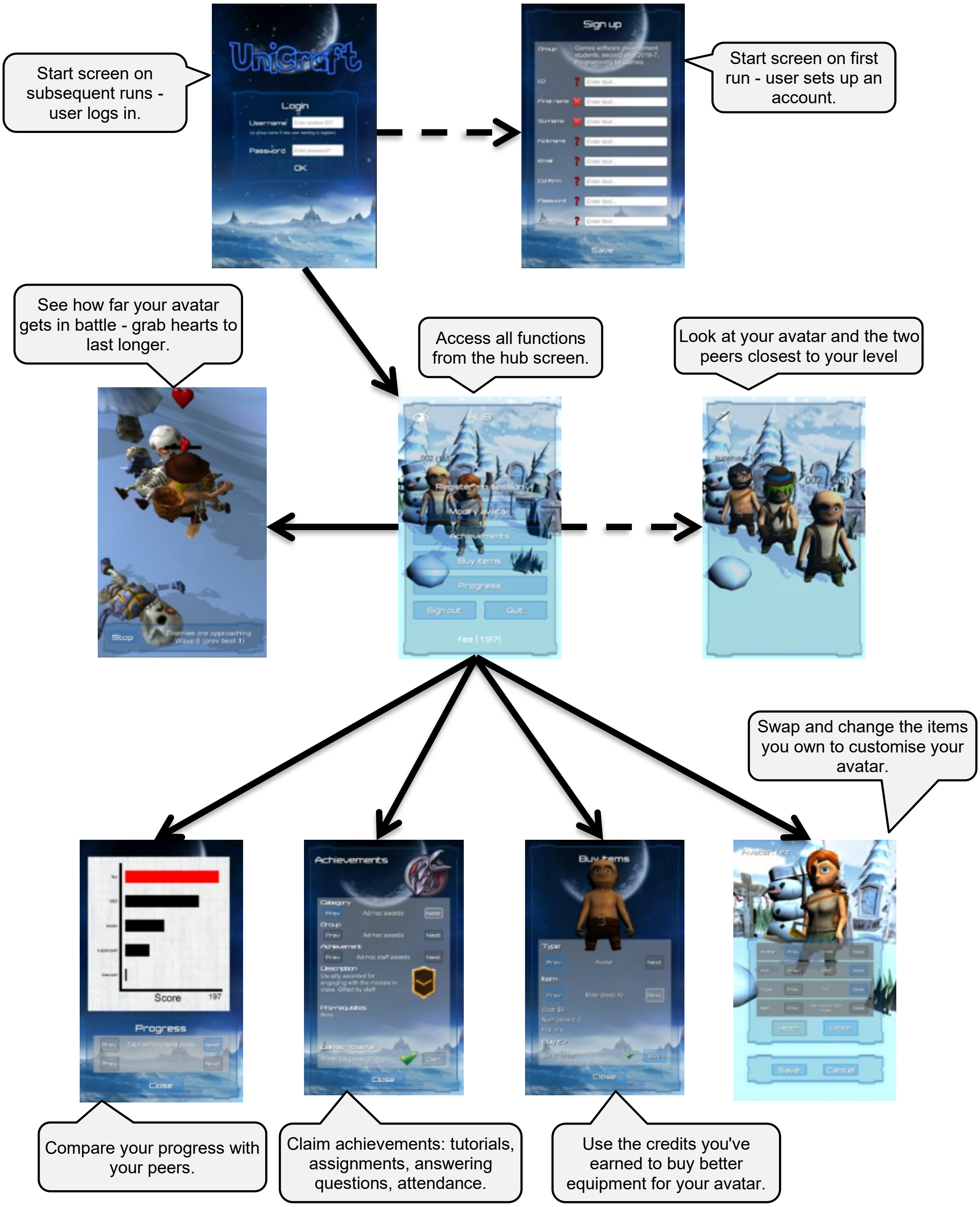


Figure 66. UniCraft user interface structure (Featherstone, 2022)

4.4.1 Hub

All functionality can be accessed from the hub screen and the student's avatar is visible in 3D in the background (Figure 67). There is an option to hide the overlaid menus and swipe to get a clearer look at your animated 3D avatar. The avatars of the player’s nearest two peers, both above and below the player's current rank, are also displayed here.

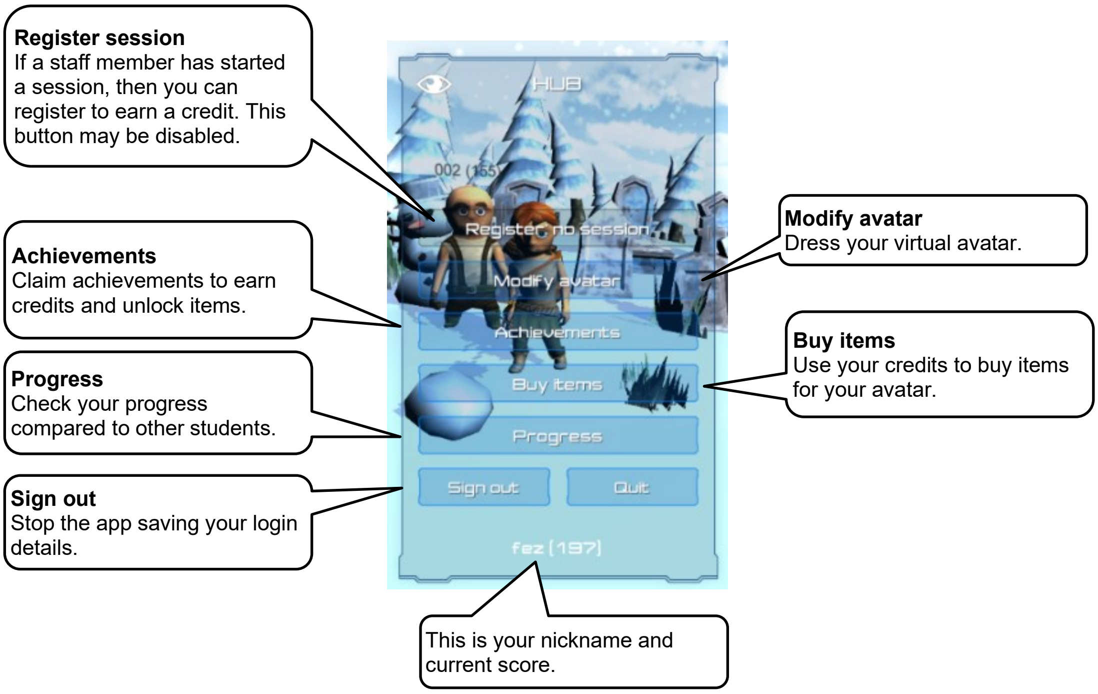


Figure 67. A breakdown of the hub screen (Featherstone, 2022)

4.4.2 Buy Items

When the player starts using the app they have a small number of credits and can buy a few basic items (Figure 68). As they claim achievements they earn more credits and also unlock more items.

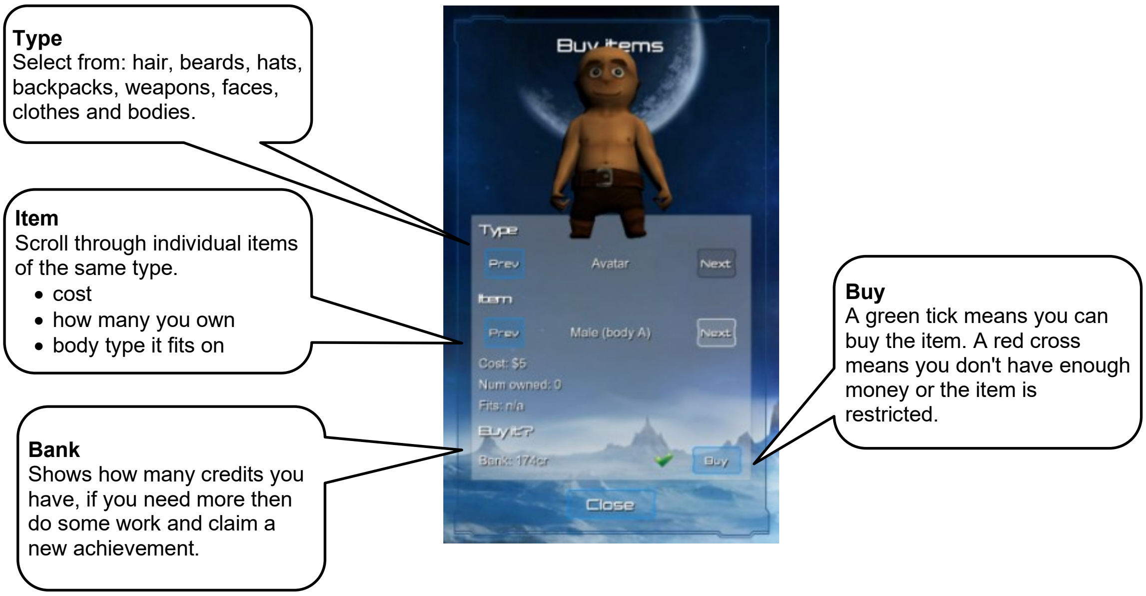


Figure 68. Buy items for your avatar (Featherstone, 2022)

4.4.3 Modify Avatar

From the avatar interface a player can select their body type and then attach their items (Figure 69). Other students will see this avatar, current rank and nickname.

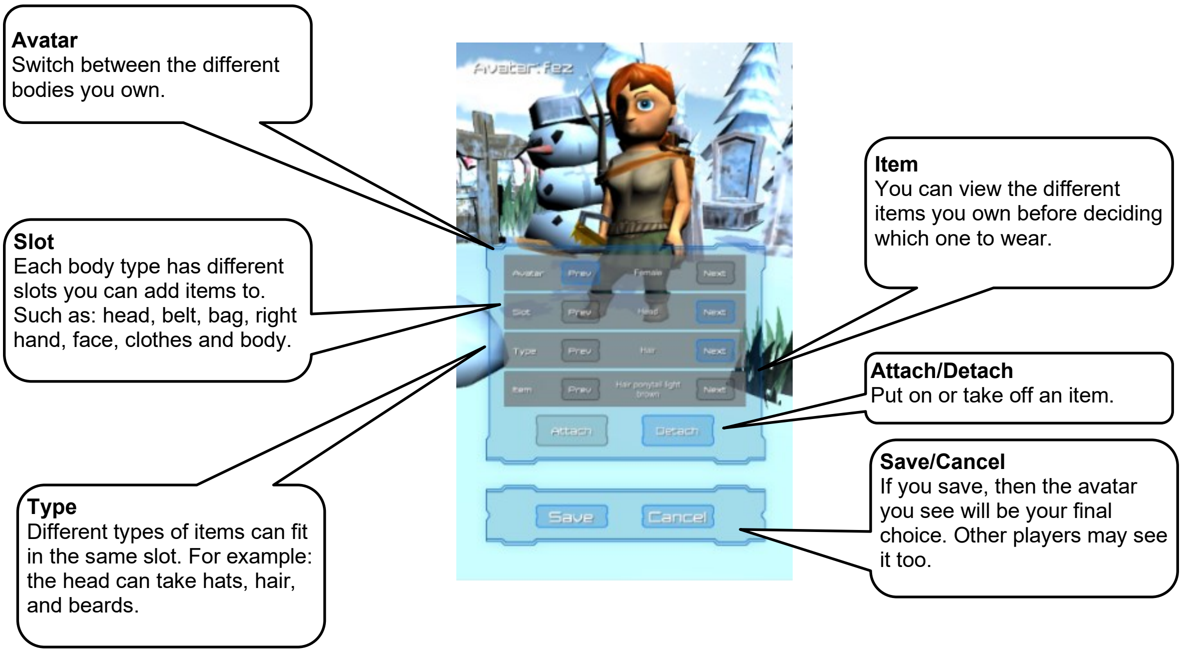


Figure 69. Modify your avatar (Featherstone, 2022)

4.4.4 Progress

Here the player can see their avatar's rank and compare it to all the other student avatars in their peer group (Figure 70). As well as an overall total score, a player can compare their progress to other students in each achievement category.

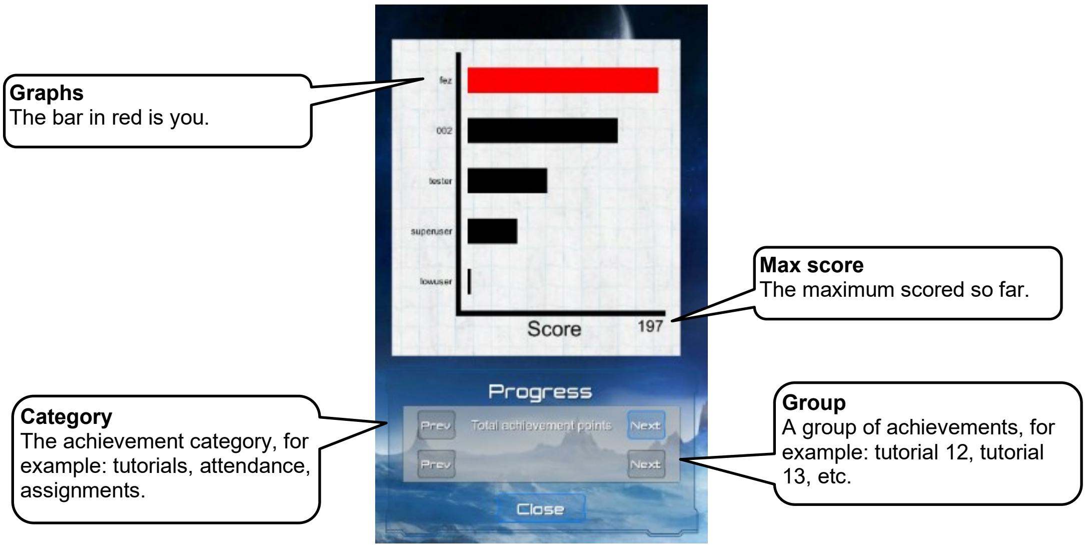


Figure 70. Progress comparison (Featherstone, 2022)

4.4.5 Achievements

Positive engagement with the subject is measured by logging achievements, for example, completing a tutorial or answering a question (Figure 71). This is how credits are earned, which can then be used to buy virtual items.

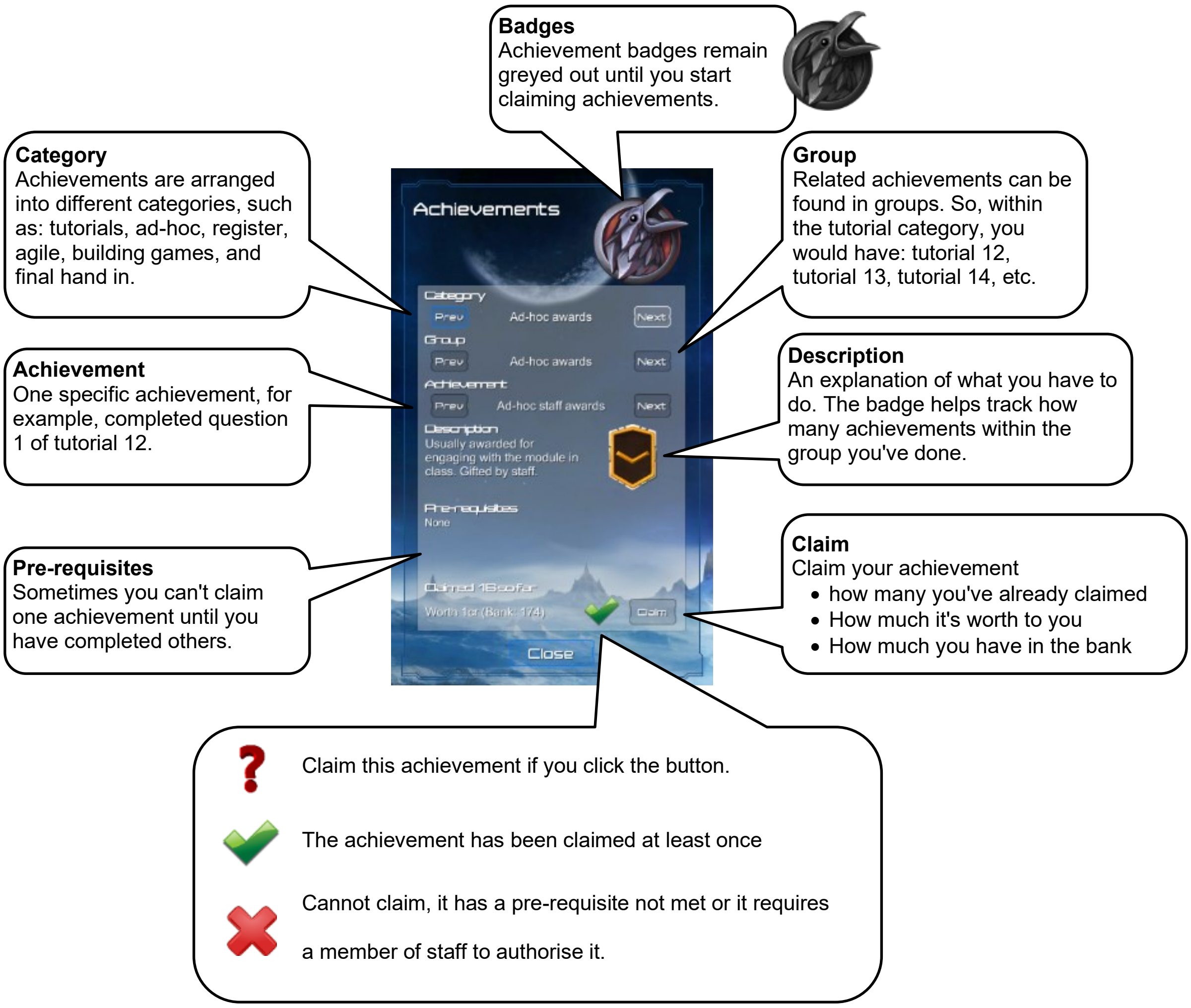


Figure 71. Claim and review achievements (Featherstone, 2022)

As the app is used in an educational context where creativity is valued, automated assessment will not always be practical due to the ad-hoc nature of student engagement. However, staff confirmation of all activities would be too time consuming, so a mix of approaches is necessary, with some student self-certification.

4.4.6 Administration

When the teacher is interacting with the class they have the ability to authorise achievements for specific students. These might be predefined, for example, handing in an assessment or they could be ad-hoc, for example, a student asking a particularly insightful question or demonstrating some extra work they've completed in their own time. These non-predefined examples are particularly important as they are indicative of expressions of creativity and independent thought manifesting from intrinsic motivation (Mekler et al., 2017). In Figure 72, a teacher can select any student and simply transfer credit to them to reward any activity. A scrolling list of students allows the teacher to map public avatar nicknames to actual student names. In Figure 73, a teacher is authorising an achievement for a specific student for a specific activity, this is time consuming if extended to the entire student cohort, but it eliminates the possibility of cheating.

Figure 73. An achievement that can only be awarded by staff (Featherstone, 2022)

Figure 72. Administration list of students (Featherstone, 2022)

4.5 Summary

This chapter presented the design of Unicraft1, the initial attempt to build a videogame-like mobile constructive gamification platform. By closely resembling a mobile videogame and using a wide range of game design principles, it is hoped that students will find the application more attractive and engaging.

There are two key aims in this design that are in conflict and must be carefully balanced (see 2.5.1 The challenge of Intrinsic Integration):

1. The desire to increase students' engagement and performance in their studies.
    - The application should give them clear feedback on their progress in class.
    - They can compare that progress with others.
    - The compelling nature of competition might motivate them to engage more with class.
    - The application might make studying more fun.
    - The application uses rewards which should encourage the student to engage positively with class e.g. higher attendance, handing in work, asking questions, etc.

2. Minimising the risk that extrinsic motivation used in (1) might reduce intrinsic motivation.
    - Make rewards virtual with no real-world value i.e. credits used to purchase upgrades for the student's 3D avatar.
    - Rely on the compelling nature of videogames, do not make using Unicraft1 compulsory.
    - Design for constructive competition e.g. PVE not PVP, participants are anonymous, teamwork encouraged.
    - Use a wider range of videogame design principles so the gamification feels more like a videogame and might therefore be more engaging with only 'light touch' extrinsic motivation.

5 Study 1: Evaluating Gamification

5.1 Research questions

Unicraft1 carefully avoids common gamification principles, powerful extrinsic motivators such as compulsory participation, public progress comparison and direct peer to peer competition. Without them, why would a student bother to use the application, why would they remain engaged with it? Competition is one of the most powerful extrinsic motivators, Unicraft1 attempts to implement a more ‘light touch’, constructive form of competition within its Battle Game.

Does UniCraft’s Battle Game improve the overall application, and are there any potential side effects resulting from its inclusion? Internal game metrics are capable of providing a detailed, accurate picture of engagement with the application over time, allowing us to compare the difference in student engagement with the Battle Game enabled and disabled. Quantitative metrics will capture the impact of the Battle Game and qualitative measures will be used to assess any potential negative side effects common to competitive gamification (Fülöp, 2009).

Therefore, our hypothesis is that:

- Constructive competition will lead to an increase in engagement with the application when the Battle Mode feature is enabled (as compared to when it is not) without damaging intrinsic motivation.
- Conversely, destructive competition would become stressful for participants, and decrease students’ intrinsic motivation, resulting in a decrease in engagement.

As well as primary quantitative measures of engagement, we are also interested in using qualitative interviews to further investigate whether:

- Failure can cause participants to feel reduced self-worth or embarrassment.
- Any perceived potential for cheating causes players to lose faith in the activity.
- Compulsive activities can take time away from other tasks (in this case studying).

5.1.1 An iterative design process

When considering introducing gamification, one or more real-world tasks are identified and then a decision is made about what is to be improved: understanding, quality, progress or efficiency. The iterative design process, seen in Figure 74, was developed and applied to help create gamification tasks which were perceived by users as "fair" in line with the theoretical discussion on cheating. Using this approach helped to reduce the potential for loss of engagement if users perceive a gamification system as unfair.

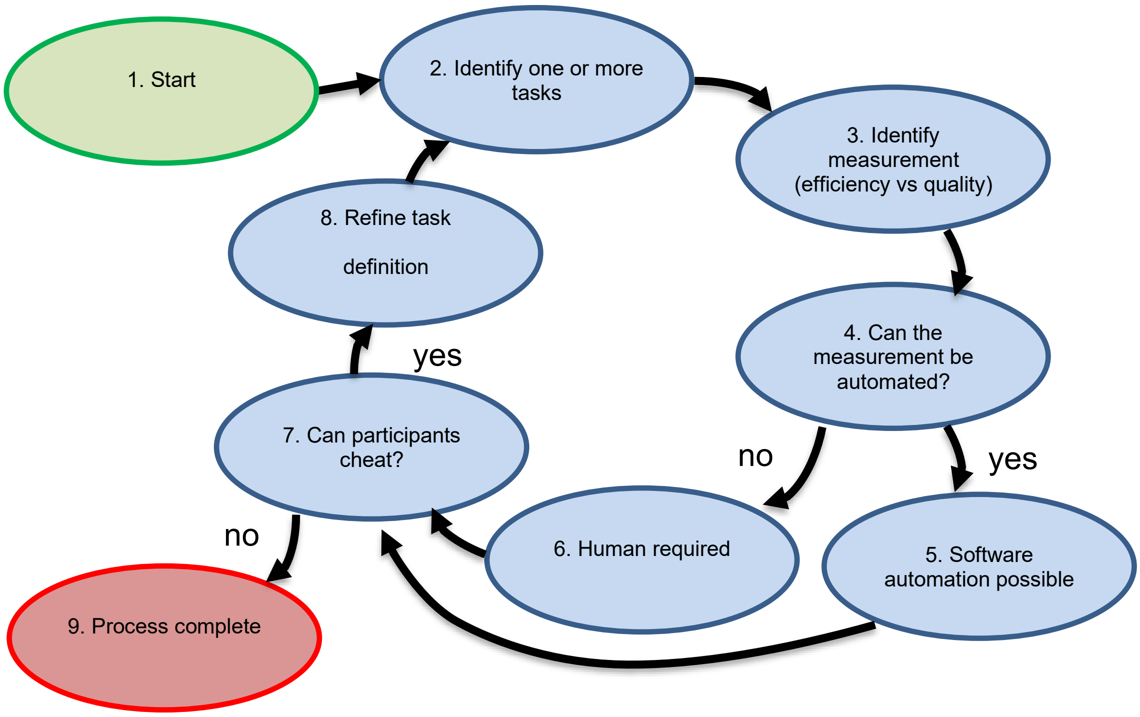


Figure 74. Gamification iterative design process (Featherstone, 2022)

Iterative design process explanation

1. **Start** - select a project to gamify, e.g. improving fitness by taking up running.
2. **Identify one or more tasks** – what real-world tasks make up the project, e.g. running further each week, running until a goal distance is achieved.

3. **Identify measurement** – what should be measured within the task: progress, performance and how might that be done, e.g. time and distance ran.
4. **Can the measurement be automated** – can it be recorded by computer, e.g. yes, if there was a mobile application to record the data on.
5. **Software automation possible** – how would a computer record the data, e.g. via gps.
6. **Human required** – how would a human administrator or participant record the data, e.g. by logging the distance and time manually.
7. **Can participants cheat** – given the implementation of measurement is it possible to cheat, e.g. manual entry could easily result in cheating, gps recording would be more robust, but the user could use a vehicle while recording to cheat.
8. **Refine task definition** – if the potential for cheating is unacceptable and avoidable alter the task and repeat the cycle, e.g.
    - If mobile devices were too expensive to provide, then manual entry might be essential, but if the scope for cheating was judged too high then the task could be altered so an official recording had to be made by a trusted administrator.
    - If mobile device availability was guaranteed to participants, but cheating using vehicles was a real concern then the value of the activity within the gamification project (points score, credit reward, etc.) could be reduced to decrease the motivation to cheat.
9. **Process complete** – move on to the next task within the project that requires gamification, if there are no more then this design phase is

complete, e.g. improving fitness by running could consist of a number of real-world tasks: diet, weight training, solo running, group running, increasing distances, different types of terrain, etc. Each task needs one or more gamification approaches with associated measurement. When all the possible tasks have been implemented (or discarded as impractical to measure without excessive cheating) then this part of the design phase is complete.

5.2 Design

This was a within-groups study over 12-weeks, with two treatment groups and a crossover design. For the first 6 weeks, group A had access to the gamification app both inside and outside of classes, and group B had classes as normal (without access to the app). For the second 6 weeks group B had access to the gamification app, and group A had classes as normal. This cross over approach ensured both groups had the same exposure to course material both with and without using the application and that the order of exposure was not influencing results. Within this structure the Battle Mode was only available for the second 3 weeks of group A's intervention, and the first 3 weeks of group B's intervention, to isolate the effect of this specific gaming element. This approach would help identify if the order or exposure to the battle game was influencing results. The organisation of the study is shown in Table 7.

	Weeks in semester											
	1	2	3	4	5	6	7	8	9	10	11	12
interview						A						B
normal lessons	B	B	B	B	B	B	A	A	A	A	A	A
using the app	A	A	A	A	A	A	B	B	B	B	B	B
battle game is available	×	×	×	✓	✓	✓	✓	✓	✓	×	×	×

Table 7. Organisation and schedule of study, A and B refer to two tutorial groups of student participants (Featherstone, 2022)

App interaction data was automatically recorded directly from the app throughout the 12 weeks (see 5.2.2 Metrics). Follow up semi-structured interviews were conducted to give context to the metrics data and in particular to ascertain how students felt about competition and their attitudes to cheating. It was decided to interview students as soon as they had finished using Unicraft1, so group A were interviewed in week 6, group B in week 12. A mix of quantitative and qualitative measures were recorded as part of the study. This included in-app metrics and semi-structured interviews.

5.2.1 Participants

A second-year undergraduate computer programming module was used for the study, which ran for one, 12-week long semester. In line with the ‘unoppressive’ design aims of Unicraft1, the 38 enrolled students were optionally offered the chance to participate and 26 volunteered to take part. There were a number of practical and ethical constraints to consider. The students were already split into two groups, and university policy was to perform this split based on surname. Although not a truly random selection, aligning the treatment groups with existing tutorial groups limited cross contamination between students in different phases of the study. For ethical reasons and in line with Unicraft1’s design aim of not using real-world reward, student's final grades could not be influenced by the study. Those students who did not have an appropriate Android device were provided with one.

5.2.2 Metrics

By using mobile devices as the delivery platform, it is possible to gather data remotely about each user and their behaviour. For Unicraft1 to be successful students must actually use it, so it is important to record when and how often the application is used. If progress is measured by claiming achievements such as attendance, completing work, answering questions, etc., then a record of what is claimed and how often is needed. The key feature of gamification in this study is constructive competition, which takes the form of 3D avatars equipped by the students with ever more powerful items, trying to survive longer in competitive battles. Therefore, it is important to measure what virtual items are being purchased, how often battles are fought and how students progress within those battles.

The following information (metrics) were recorded when students used Unicraft1 (see Table 8):

Data item	Description
Login	Together these metrics tell us when a student uses the application and for how long.
Sign out	
Exit	
Viewing points/credits earned	Gaining points should be extrinsically motivating, which means students should be interested in looking at them.
Viewing points/credits earned per achievement group	
Modifying an avatar	Customising and upgrading the avatar should be engaging and so students should spend time regularly doing that.
An achievement awarded by a staff member	Some achievements (handing in work, answering a question) can only be authorised by a staff member, but are staff members remembering to do this?
How many battles were played	The battles should deliver compelling constructive competition, but do students initiate them on their device?
When a user claimed an achievement	Some achievements can be claimed by the students (completing a tutorial).
When a virtual item is purchased	Students should find cashing in credits for virtual items compelling, but are they doing it?
Maximum battle game level reached	Battle game progress is mainly dictated by the value of upgrades attached to the avatar. If students are spending credits on equipment then avatars should reach higher levels in battle (facing more powerful enemies).
How long a battle game lasts	Similarly, if avatars are growing more powerful then battle games should last longer unless the students terminate early.

Table 8. Metrics in Unicraft1 and their purpose (Featherstone, 2022)

The mobile app logged user activity (metrics) to an online web server via standard http requests to PHP scripts. As a result, the app would only function if the student had an active Wi-Fi or data connection, but this did also allow the student to use the app outside the class and at home. The PHP scripts used SQL queries to interrogate a relational database that was used to store the large amount of event information each mobile app was generating as each student claimed achievements, bought items and modified their avatars.

5.2.3 Structured Interviews

With immediate feedback from the metrics data collection system it was possible to identify interesting anomalies within the app data:

- spikes in usage – these matched when timetabled lessons took place where battles were shown at the start.
- usage outside class time – some students liked to work at night and then would use Unicraft1 at the same time.
- levels of engagement of different users – there were widely varying views on the app, some students appreciating certain aspects, disliking others.

This informed a question script for the interviews (see Table 9). Participants were all encouraged to attend, the interviews were held in large groups, audio recordings made and then transcribed. Analysis of interview answers can be seen in the section Structured Interviews.

1	How often do you play games on a smartphone?
2	Do you complete all assessed module work set by the lecturer? For example, tests, group projects, etc.
3	Do you complete all non-assessed module work set by the lecturer? For example, tutorial tasks, optional homework, etc.
4	Do you enjoy Programming for Games?
5	Do you feel motivated by this module?
6	Does this module provide opportunities for creative expression? For example, making your own games.
7	Do you know how much progress you are making in this module compared to other students?
8	Can you predict what mark you will probably get in this module?
9	Is it important to you that you can gauge your progress?
10	Which parts of the application do you use?
11	When do you use the application?
12	Do you think it's useful to encourage friendly competition between students?
13	Are the competition elements of this app fair?

Table 9. Interview questions (Featherstone, 2022)

5.3 Results

Analysis of the in-app metrics and interviews are split into overall group results and individual case studies. Students were selected for case studies by identifying those who attended interviews and had different usage patterns and levels of engagement.

5.3.1 Group Results

When the Battle Game became active, app usage (see 5.2.2 Metrics) overall showed a statistically significant increase of 217% (one-way ANOVA $F(1,44)=12.40$, $P=0.001$, $\eta2=0.28$) for both treatment groups. This result was predicted by our hypothesis and together with the interviews, suggests that the competition created by the game was constructive.

Treatment group	Battle game introduced	App events – battle game inactive	App events – battle game active	Increase in app usage	ANOVA
A	weeks 4-6	300	1215	305%	$F(1,18)=16.79$
					$P=0.0007$
					$\eta2=0.93$
B	weeks 7-9	383	1176	207%	$F(1,20)=3.3$
					$P=0.08$
					$\eta2=0.17$

Table 10. App usage pre and post battle game(Featherstone, 2022)

The increase in app usage is lower in group B (see Table 10), one possible explanation is that this group were using the app in the latter half of the semester when students are generally more fatigued.

In Figure 75, a selection of common event types, recorded by the in-app metrics system, are compared during periods when the Battle Game was active and when it was not. When students were allowed to play the embedded Battle Game, the online metrics system recorded more events. While it was clear from the interview data that different students responded to different aspects of the app, there were some consistent comments. For example, all students felt there should be fewer self-certified activities and more teacher-certified (resulting from a general awareness that some were cheating).

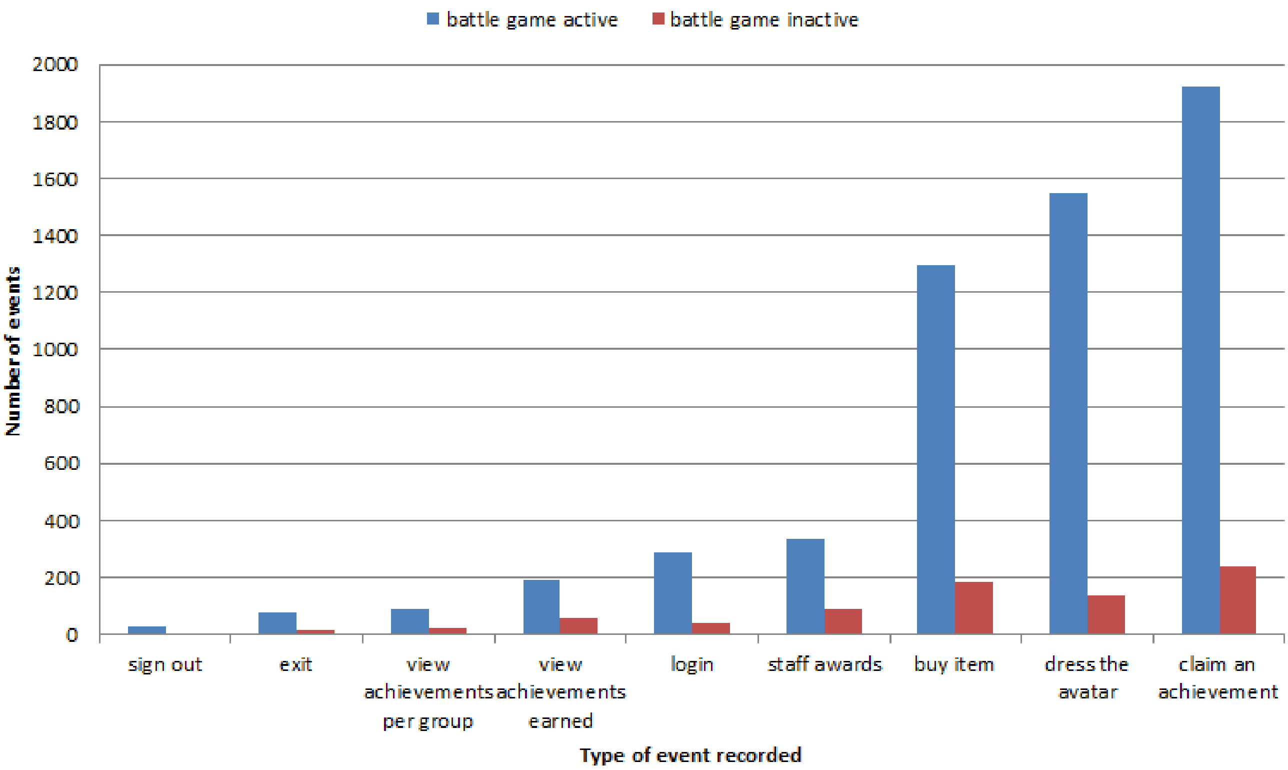


Figure 75. Rate of common events recorded before and after battle game activation (Featherstone, 2022)

Figure 76 shows the total number of achievements claimed by all players over the life of the study.

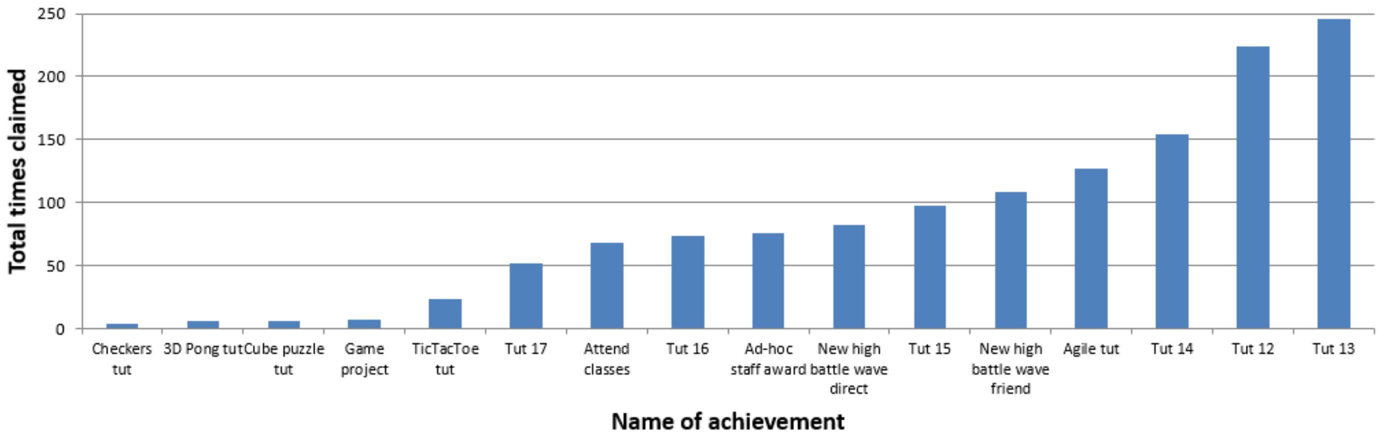


Figure 76. Popularity of achievements (Featherstone, 2022)

Students do not claim all achievements equally and sometimes that inequality is justified:

- Achievements that can be claimed more than once will be popular, e.g. attendance and battle progress.
- Achievements that involve tasks that are easy to claim and/or don't take long will be popular, e.g. early tutorials are easier than later ones.
- Achievements that involve tasks that are not optional will register frequently (e.g. a core piece of coursework).
- Achievements that have multiple pre-requisites, involve difficult tasks or that cannot be undertaken until nearer the end of the project will be less popular.

Achievement reward value must be scaled accordingly, so that more difficult, one-time only achievements have a high reward value and repeating or easy achievements have a low reward value. It was useful to be able to produce a distribution graph like Figure 76, in real-time, as a way to detect cheating or 'gaming the system':

- Cheating - a small number of self-certified activities (tutorial achievements) could be claimed by students repeatedly, some students took advantage of this resulting in a spike in the number of claims. This was spotted within hours, the exploit was fixed and the erroneous credits removed from player accounts (see Metrics, monitoring and cheating below).

- Gaming the system - identifying the most efficient way to earn credits, while ignoring the 'spirit of the game' which in this case is to encourage learning and engagement. For example, focusing on any easy to earn achievements with high credit rewards. The distribution graph (see Figure 76) shows this is not happening (the achievements with high claim rates were expected).

5.3.2 Metrics, monitoring and cheating

Every student using Unicraft1 is producing usage data as described above, logged in real time on a central server. Automated cheat detection was deemed too time consuming to develop (see 2.7 Cheating) and so this live data was checked at the end of each day based on an informal set of expectations of 'normal' usage:

Test plan

- Only those students within an active group should be logging in.
- Students should be claiming attendance in line with when timetabled sessions run.
- Students should be claiming for completed work in line with when that work is timetabled to be due in.
- Claims for completed tutorials should be spread throughout the semester, not all at once.
- Where something can be claimed once, the system should only record a single claim per student.
- Usage should roughly align with timetabled teaching and assignment deadlines.
- Battle game competitions should only be played during specific points in the study when they are meant to be active.
- Where a staff member can give an ad-hoc award to a student, that should happen within timetabled sessions and only happen 2~3 times per session.
- Each student should accrue virtual currency steadily over the course of the study.

- Virtual items for avatars should be purchased steadily over the course of the study, starting with cheaper items and then moving to more expensive ones.
- A student should have the credit in their account to buy the equipment they have.
- Students making the most progress in class should be the ones with the most virtual currency.

This system test plan was developed based on the author's understanding of the software, rules of the game and expectations of usage. There was no guarantee these assumptions were correct, but by monitoring the data it should have been possible to see variations from these estimates and then investigate to see if this was cheating or just unexpected user behaviour.

For example:

- Review the data at the end of each day.
- Identify any patterns in the data that don't fit the test plan.
    - Look at all the data recorded for the student in question and compare with teaching notes and in class feedback records.
    - Optional response – adjust the test plan as this student hasn't done anything wrong.
    - Optional response – intervening could be done in a number of different ways:
        - Change the code to correct an exploit or bug.
        - Correct that student's data if there's an error.
        - Discuss the unusual behaviour with the student to clarify.

- Note the issue but make no changes and don’t mention it to the student.

During this study, a bug was found in the achievement claiming system, a small number of valuable achievements which should only have been claimable once per student were claimable multiple times. A student spotted this and made multiple claims which generated a lot of credits, the author detected this the same day, fixed the bug in the system and then removed the excess credit from the student’s account. This was explained to the student immediately and the student confirmed what had happened.

5.3.3 Case Studies

Three contrasting student cases were selected for detailed analysis in order to provide a richer understanding of how students were using the game. A subjective post-hoc analysis of the metrics data and interviews revealed there were different patterns of behaviour. It can be useful to categorise player types to understand player expectations and behaviour (Bartle, 1996), in this study there were at least three types of common behaviour, with players exhibiting in one or more categories to a lesser or greater degree:

- **Socialiser** - motivated by the communal on-screen battles, even though the outcome of such battles does not result in a credit-based reward. May not be motivated to play the battle game on their device. This matches Bartle's taxonomy.
- **Achiever** - motivated by points scores. This player type will use the battle game communally and on their device. They are strongly motivated to maximise their score. This matches Bartle's taxonomy.

- **Exploiter** - motivated by exploiting the system. This type of player will cheat to enhance their standing and accelerate progress. The behaviour is not a good match for Bartle's explorer or killer player types but has similarities.

Bartle's taxonomy of player types (see 2.8 Player typologies) are not an exact match for the behaviour observed in this study and it may be the case that a different taxonomy is more appropriate for gamification. For example, the exploiter:

- Unicraft1 keeps players anonymous and avoids player on player competition, but exploiters will ask other people directly to reveal their avatar identity, especially if their avatar is making faster progress than their peers. They will work with other exploiters to identify exploits and cheats to accelerate progress. This behaviour has qualities of the killer, but is being pursued outside the game.
- Exploiters are not always motivated by a desire to see everything the game has to offer, as an explorer might, but they will discuss all aspects of the game with other exploiters to identify any potential dominant strategies.

Considering the categories of player we've defined above, using metrics data and interviews, three users were selected with behaviour that seemed to fit these categories. The following data analysis and interview comments show in detail how these students fit into each category. User 39 is categorised more towards the Achiever category, user 28 comes under Socialiser and user 57 matches the Exploiter category.

Figure 77 shows each user's level of total app activity, indicative of a low, medium and high-level user.

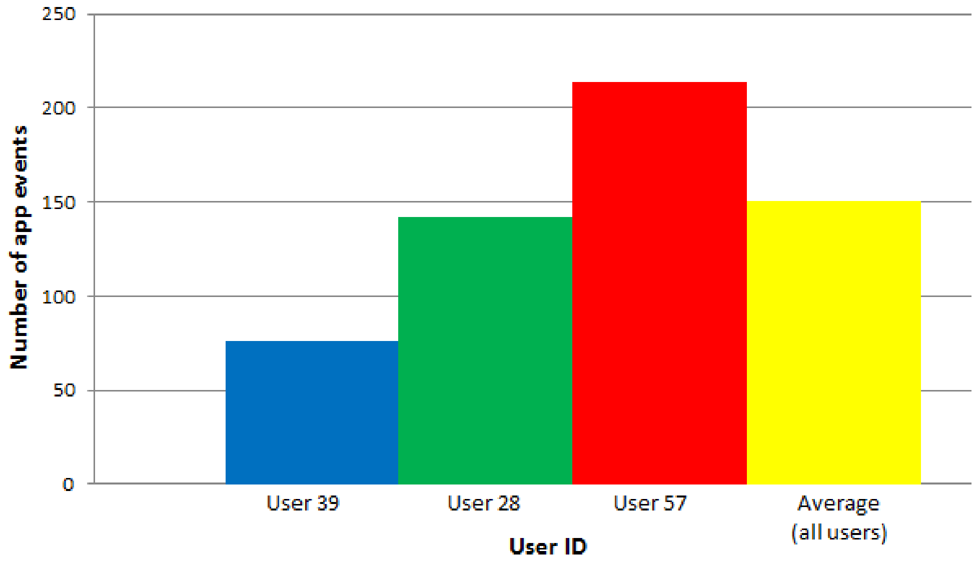


Figure 77. Total app events per user (Featherstone, 2022)

There was a wide variation in usage during the day, as can be seen in Figure 78. The app was created for a lesson that ran 9am until 1pm, but some students used it well outside those times.

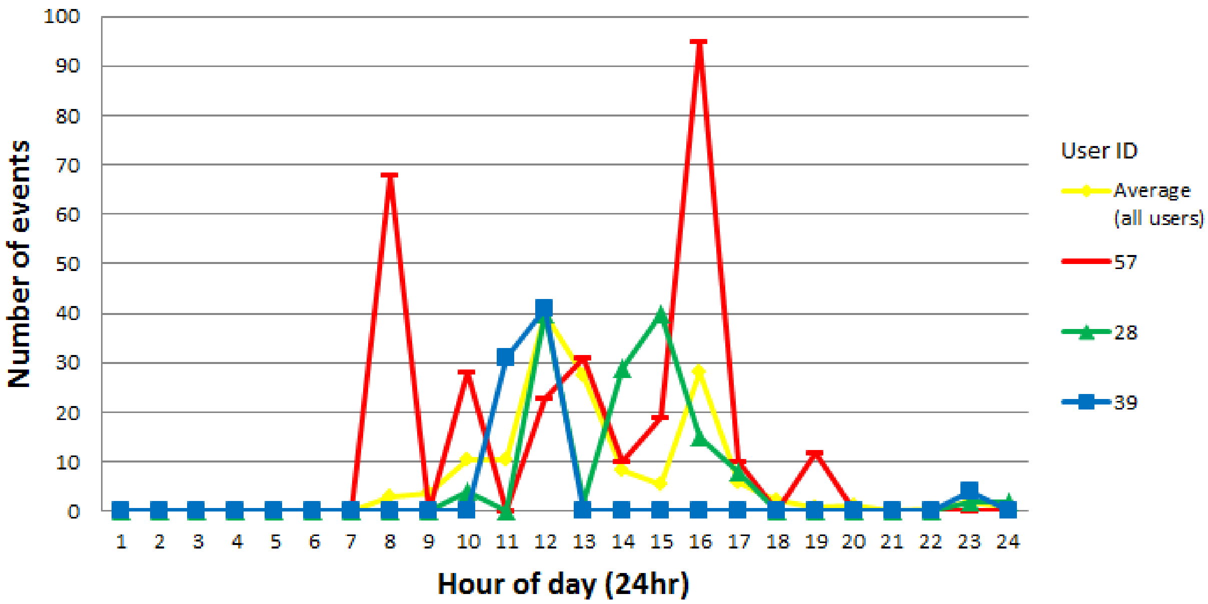


Figure 78. App usage patterns by hour of day per user (Featherstone, 2022)

The lesson ran on Thursdays with most usage recorded on that day, but some students used the app on other days, see Figure 79.

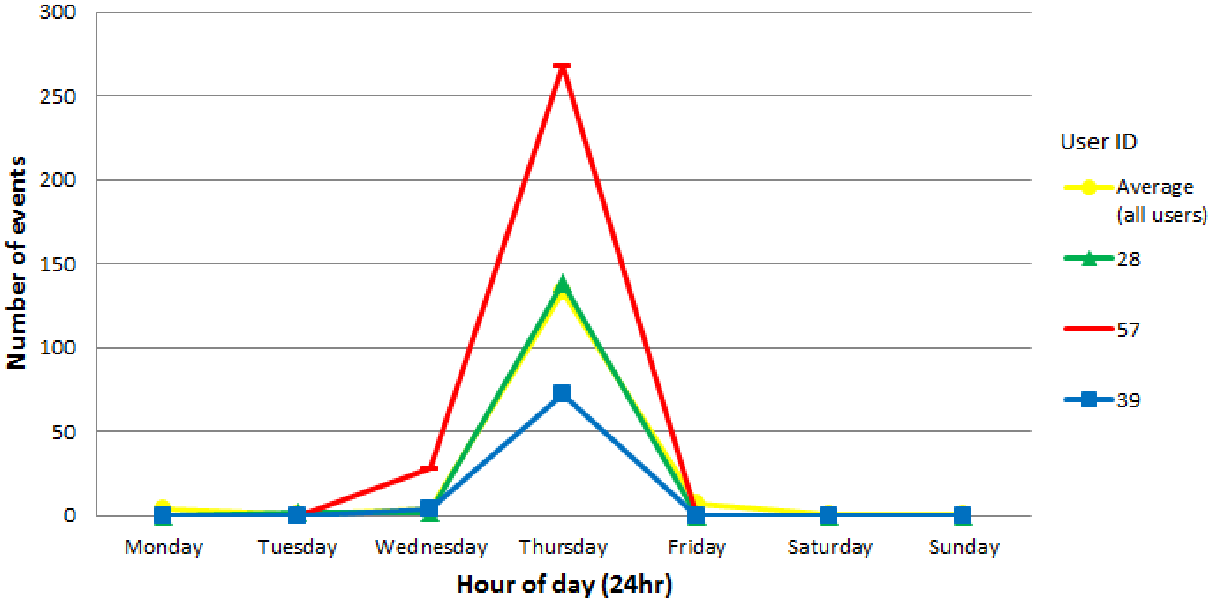


Figure 79. Usage patterns by day of week per user (Featherstone, 2022)

Playing the app's embedded Battle Game motivated some students more than others, see Figure 80.

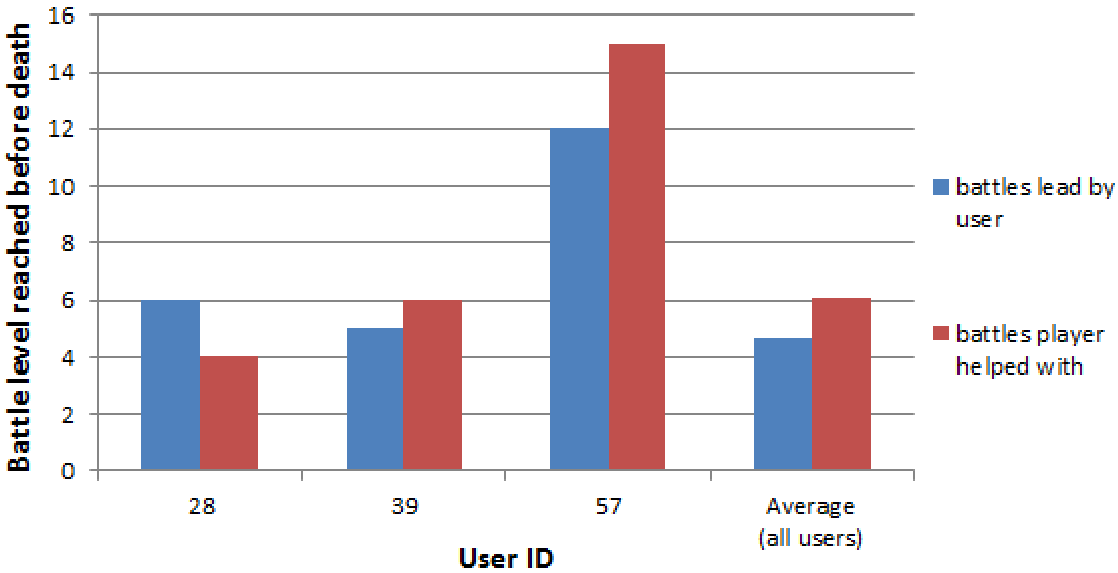


Figure 80. Highest level achieved in battle per user (Featherstone, 2022)

Looking at the time these students spent playing Battle Games shows a similar relationship, with the Battle Game taking up far more time for our Exploiter (user 57) even though he was cheating (by falsely claiming tutorial task achievements), see Figure 81.

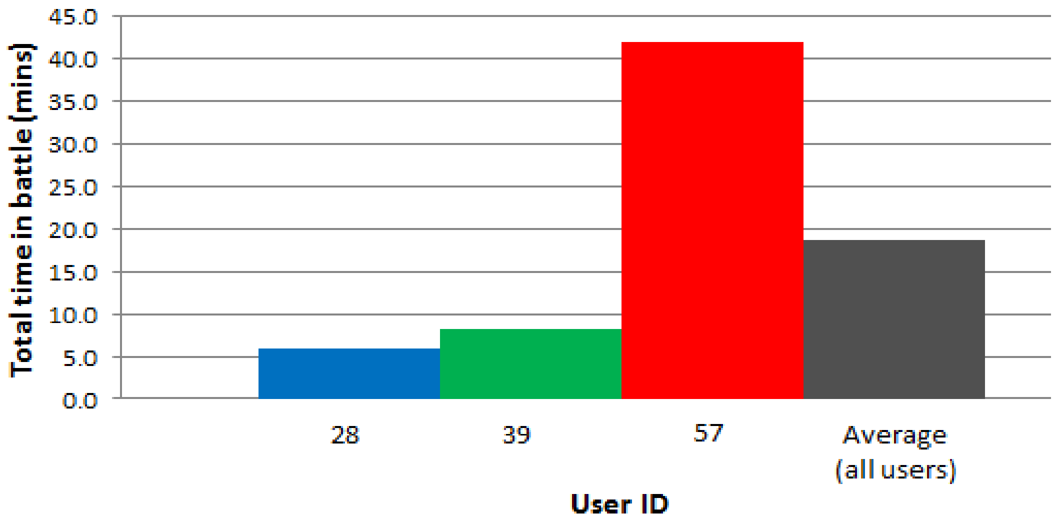


Figure 81. Total time spent in battle per user (Featherstone, 2022)

These times are for battles played out on student's smart devices, as recorded by the built-in metrics system. This doesn't necessarily mean our Socialiser (user 28) and Achiever (user 39) were not as interested in the Battle Game as our Exploiter (user 57), they just had a preference for watching battles play out on the class projector (see Figure 64) or communal area large screen TV (see Figure 63).

5.3.4 Interview analysis

Interviews allowed an exploration of these results:

Achiever (user 39): was motivated by high scores, "chasing scores, the score board is motivating me. Scoreboards are a good motivator". He was interested in how the game's systems worked, "it needs to be clearer…which weapon does what to the stats". The embedded Battle Game was attractive, "it [the Battle Game] definitely works". He would occasionally use the app at midnight, "that was when I was bored after doing some work, when I'm most productive". He was a very competitive player, "it wasn't competitive enough!" Commenting on the Battle Game part of the app, "the battle [game] doesn't require interaction, it can run on its own". Cheating was a concern, "it [multi choice Q&A] would reduce cheating". When asked if physical rewards would be motivating, "physical rewards turn people off, it should be mental, a sense of accomplishment".

Socialiser (user 28): was motivated by peer competition. When asked when he used the app, "I saw a lot of people using it in a maths lesson that followed this, playing battles … it's designed not to take up too much time, but I can imagine the lecturer being annoyed." Regarding motivation, "I didn't play battles myself, but I wanted to battle on the big screen." When asked about competition, "if you're dying all the time then obviously someone out there is putting in more time than me … that's all the motivation you need ... It's not about competing it was about what we can do as a group".

Exploiter (user 57): when asked if he cheated, "yes, I claimed everything straight away, tried to get as far as I could". When asked about the Battle Game part, "I wanted to battle on the big screen". When asked if the progress features were used, "it split the work up in a really good way, even though I was cheating, I did read them [achievement lists, see Figure 71] and looked at what I should be doing."

5.4 Summary

In line with Agile development principles the first version of Unicraft1 was a prototype, a proof of concept, design, and technology. There were a number of positive and negative outcomes, both equally important as they informed the refinement of this gamification project in Unicraft2.

5.4.1 Technology

The software platform worked well. Metrics data was gathered in real time, more sophisticated data analysis software would have been useful, but beyond the scope of this study. Raw data could be downloaded from the server at any time into a spreadsheet for quick analysis. This process was used to rapidly identify one important bug in the system. The mobile application worked well on most student Android devices, a minority of students owned Apple devices and either refused to use the provided Android alternatives or found using them frustrating compared to their favourite Apple phones. Developing for both platforms was outside the scope of this study, but it would be an important consideration if Unicraft1 was deployed more widely.

5.4.2 Unicraft1 is like a videogame

Students responded well to Unicraft1, they saw it as a videogame and most were intrigued enough to install it and try it out, even though it wasn't compulsory. Many students engaged with the software like they would any videogame and fell into well-established patterns of behaviour. Some wanted to use the game to socialise, some wanted to maximise their score, others wanted to exploit the system to beat their peers. Supporting all these different psychological desires and managing them so each type of player can find something of interest without unbalancing the game to the detriment of others did work, it was only bugs in the system that risked upsetting this balance.

5.4.3 Cheating

The exploiter category of player did find exploits to gain advantage and even though this was corrected within hours it did negatively impact faith in the game and its rules, reinforcing claims seen in the literature. Although stringent testing and high-quality software engineering processes were used, it's impossible to guarantee complex software will ever be bug free. This reinforces the need for ongoing testing and validation once software is deployed.

Exploiters also took advantage of self-claimed achievements i.e. anything that didn't require system or teacher authorisation. For example, claiming an achievement for completing a tutorial exercise. There's a balance to be struck between having the teacher authorise everything, which would be time consuming and allowing students to self-authorise low value achievements to save time. Exploiter category players will be more likely to take advantage of even low value activities and abuse them to accelerate their progress.

5.4.4 Competition is compelling and can be constructive

The Battle Game confirmed how compelling and extrinsically motivating competition can be, causing a 217% increase in app usage once it was activated. Interviews confirmed that this had been received constructively (positively) by the majority of users and had not caused undue stress. This is a positive sign for maintaining intrinsic motivation, but this was not specifically measured (yet).

5.4.5 Engagement

Students commented that while they appreciated Unicraft1 they felt it could be tied more closely to their learning. As has been discussed previously, a custom designed educational game embedding learning outcomes directly within its design is often seen as an ideal solution to using games in education (see 2.4 Educational games). However, this often brings increased development time, inflexibility and is not always successful (achieving knowledge transfer to the real world is far from guaranteed).

With hindsight, one obvious enhancement would be to incorporate teaching related quizzes directly into Unicraft1, with correct answers generating more virtual credits. This would tie Unicraft1 more closely to a specific topic, but only as far as writing the quiz questions and answers, which would not be too time consuming. The extra development time required is within the scope of the study for the next phase, Unicraft2.

5.4.6 Attainment

Changes in student attainment were not measured, this will be done with Unicraft2 and a larger group of participants from multiple courses. There were some positive comments from students indicating the app had made them more aware of their progress and had helped them organise the remaining work they had to do.

6 Unicraft2

This chapter describes the second iteration of design and development for Unicraft. This iteration attempts to build on:

- the first attempt at a set of gamification design guidelines (see '2.12.3 Gamification design guidelines v1').
- the results of the first study above.

This continues the theory that optimal gamification designs should closely resemble videogames and not rely on oppressive forms of extrinsic motivation. Unicraft2 was used in an empirical evaluation of both the design guidelines and technology.

6.1 Design

The results of the Unicraft1 trials were generally positive, but there were three main areas identified for improvement:

- The application should be integrated into the student experience of lectures and tutorials more closely.
- Competition elements should be more compulsive to maintain engagement longer.
- The possibility of cheating must be reduced.

The participants are already familiar with multi-choice quiz activities, so this was an area chosen for inclusion in Unicraft2 as a way to address the first issue of increasing integration into student experience (it also influenced the inclusion of new guideline 5.4). They are not used in all subjects within the students' university but are sometimes used as a fun activity or as part of assessment. Quizzes are implemented as either paper and pen exercises or make use of electronic 'clickers'. It was decided that Unicraft2 would incorporate multi-choice quizzes directly in the mobile app. Students would then be allowed to wager their virtual credits on the outcome of these quizzes.

Self-certification within the app was a source of cheating, the credit reward for self-certified activities was reduced and more rigorous testing undertaken.

Increasing the compulsiveness of the application was important given that students were not compelled to use the application and could start or stop using it at any time. Although the battle game did facilitate compulsive competition, it was felt more could be made of virtual currency and the compulsive power of wagering that currency.

With these three areas of focus: quizzes, virtual currency and wagering – the following sections discuss how they might be used within Unicraft2.

6.1.1 Multiple choice quiz - case studies

The multi-choice quiz is a common component of educational assessment, it's commonly used in schools all over the world as a technique to create a more playful classroom. The quiz is commonly used in gamification projects as a way to measure learning and assign points and rewards based on participant performance (Cheong, Cheong, & Filippou, 2013). It lends itself to automation and is therefore particularly popular in distance learning, educational games and web-based assessment. Quizzes have been shown to increase engagement in educational contexts and increase exam results (Mckeown & Maclean, 2012).

Unicraft1 encouraged students to record scholarly activity (completing tutorials, asking questions, handing in work, etc.), but this was done reactively, after the activity was complete. Participant feedback suggested that engagement would be higher and last longer if there was an element of pro-active use of the app directly within a scholarly activity, “it should be more educational” (see Appendix D – interview transcripts study 1). As quizzes lend themselves to automation via software and are widely used in educational contexts it was decided that Unicraft2 would be extended to include such functionality. To assess best practice in existing quiz technology, some of the most popular apps were analysed.

6.1.1.1 Case Study: Socrative

Socrative is a mobile phone based assessment package built around the concept of multi-choice quizzes (Maimon, 2010). It consists of an editor for the educator to prepare and administer each quiz and a participant application to allow users to take part (either on mobile or PC). It is used by 350,000 teachers in 1700 schools across America. Socrative has been shown to have a positive impact on student performance when used regularly in lessons to assess student progress (M Dakka, 2015).

To simplify creating a live quiz the educator uses their version of the Socrative app to generate a virtual "room" with a unique ID, display each question and show the responses (see Figure 82).

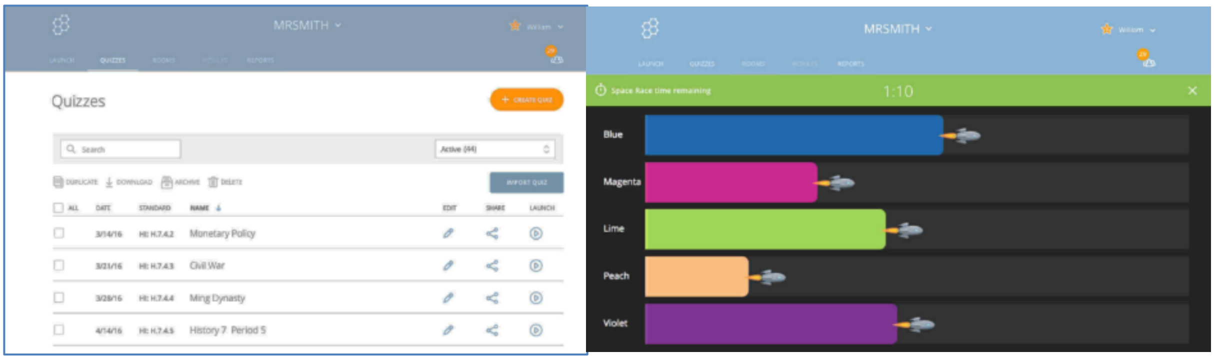


Figure 82. Socrative quiz editor and admin screens (Maimon, 2010)

Participants on site or at home then use the room ID to connect to the quiz and take part while their identity can be kept anonymous (see Figure 83).

Figure 83. Socrative user mobile app (Maimon, 2010)

This is a popular system, easy to use and free for limited group sizes, it is already used in some parts of the institution where this study was undertaken. However, it is quite plain in appearance and although it implements some gamification features, it doesn't track users from one quiz to the next so there is no persistence. Unicraft2 was designed to emulate the simple and easy to learn functionality that Socrative demonstrates.

6.1.1.2 Case Study: Kahoot!

Kahoot! is a very popular quiz application that has 50 million active users (Brand, J; Brooker, J; Versik, 2013). It is generally used with younger students and tends to make use of images more than Socrative (see Figure 84).

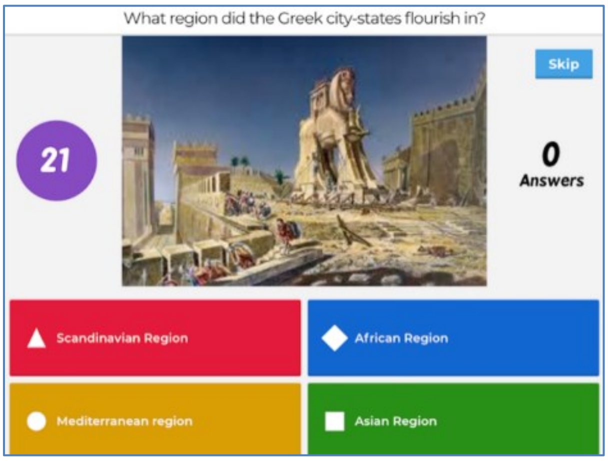


Figure 84. Kahoot! question interface (Brand, J; Brooker, J; Versik, 2013)

Unlike Socrative, it is designed to integrate more closely with ongoing assessment and so users are not anonymous to the teacher, but can use nicknames displayed publicly to partially hide their identity.

As a result of users generating a persistent account, it can make greater use of gamification features like the leaderboard (see Figure 85).

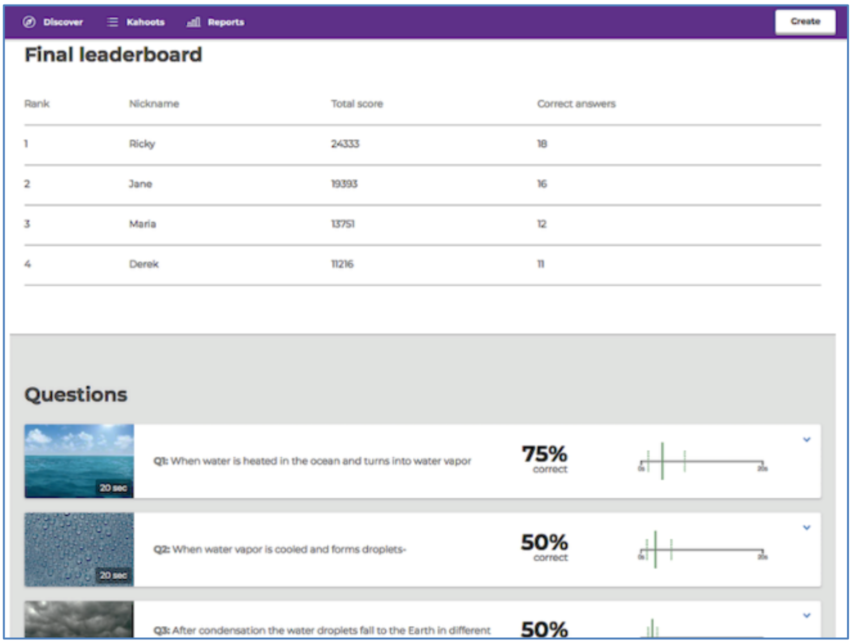


Figure 85. Kahoot! Leaderboard (Brand, J; Brooker, J; Versik, 2013)

Unicraft2 will take a similar approach of partially hiding student identity. Again, this software has quite a plain appearance even though it favours more graphical quiz presentation.

6.1.1.3 Case Study: Poll Everywhere

Poll Everywhere is a technically sophisticated voting application that runs on PC, Mac, web and mobile (Vyduna, J; Gessler B; Eby, 2007). It is already in use within parts of the institution where this study was undertaken. It is used in over 100 countries and is popular with large corporations due to its reputation for scalability, multi-platform compatibility and reliability. As a result, it is one of the more expensive applications to use. Its quiz editor and quiz administration interfaces are very easy to use and have a polished 'Microsoft windows' like appearance (see Figure 86).

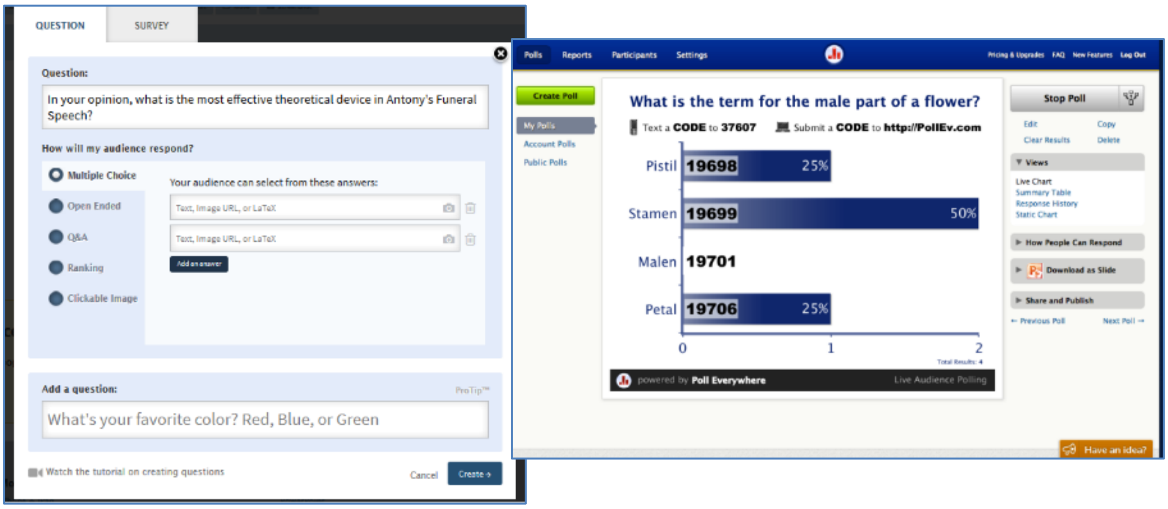


Figure 86. Poll Everywhere quiz editor (Vyduna, J; Gessler, B; Eby, 2007)

Unicraft2 will follow a similar user interface design flow in an attempt to minimise the cognitive load in learning to use the interface and the time taken to author content, while maintaining a more game-like design.

6.1.1.4 Case Study: Turning Point

Turning point, like Poll Everywhere, is a long established quiz app developer that started in 2002 and the software is used worldwide and also within the institution where the study was undertaken (Turning technologies, 2015). Like Poll Everywhere, it has a reputation for reliability and scalability, with a commensurately large price tag. It uses a similar polished interface for quiz authorship (see Figure 87) with a business-like formal presentation.

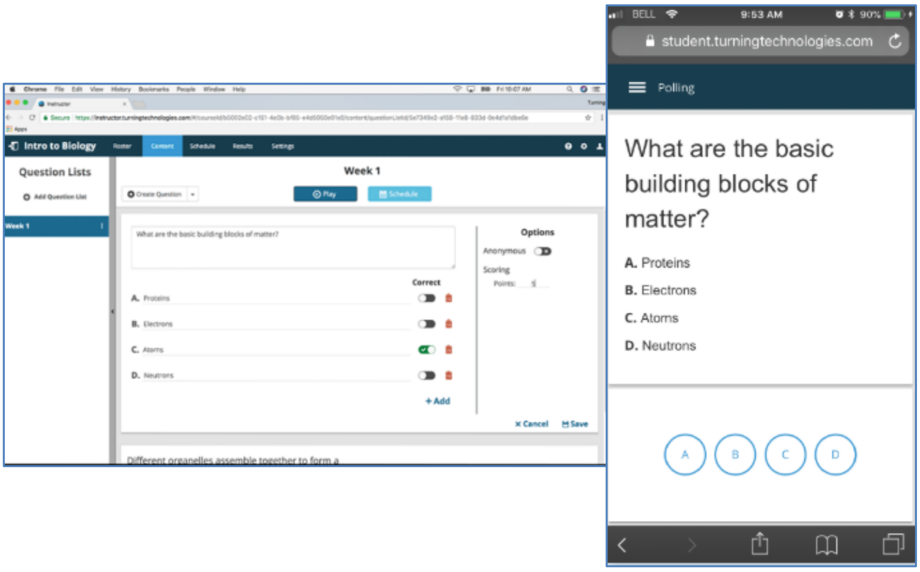


Figure 87. Turning Point quiz application (Turning technologies, 2015)

One feature that stands out with Turning Point is the ability to embed live quiz results within a power point presentation (see Figure 88). The majority of lectures in higher education use some form of presentation and embedding the quiz results view within it makes administering a quiz a little simpler and more integrated into the normal staff lecture process.

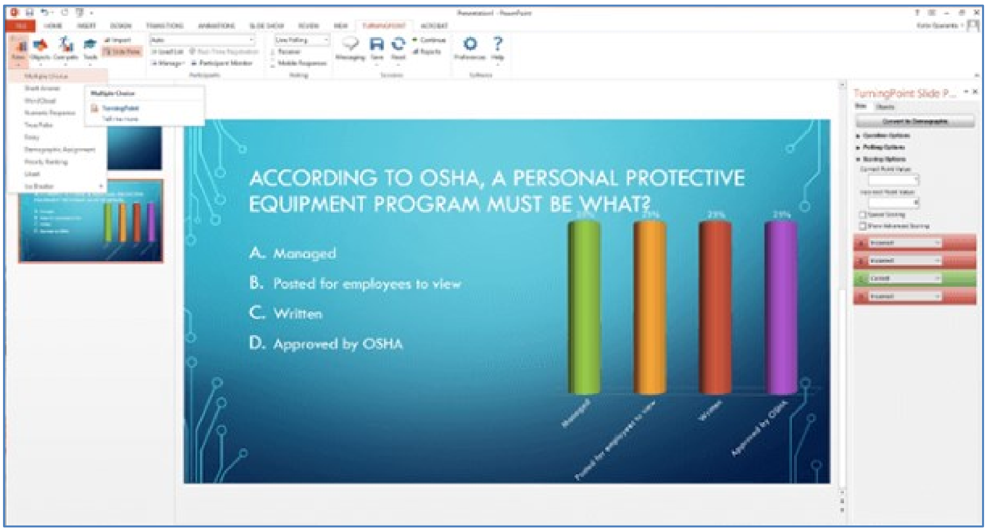


Figure 88. Power point integration of quiz results (Turning technologies, 2015)

Although it is beyond the technical scope of this research to embed parts of Unicraft2 within power point, it does show the importance of integrating Unicraft2 within the normal teaching process and minimising any interface complexity. To this end, Unicraft2's admin and results screen will run in a window, which will support resizing without compromising readability and still operate even when the app does not have focus within the operating system. This will allow Power Point or Word documents, used in lectures, to be displayed on screen at the same time as the quiz results.

6.1.1.5 Summary

Multi choice quizzes will provide a regular reminder to students that they can start or continue using Unicraft2 for fun at any time, that they can take part flexibly, introducing new content regularly to maintain interest and create compulsive activity embedded within learning (guidelines 1.4, 5.3, 6 and 7.4).

6.1.2 Wagering

Once a simple measurable activity is implemented (e.g. multi choice Q&A), that has a clear right/wrong outcome, then it's possible to reward participation with virtual credits and enhance the value of the reward, and its compulsive power, by allowing users to wager extra credits on the outcome. Wagering could increase Unicraft2's 'stickiness' and reduce the long tail effect.

6.1.2.1 Traditional spectator betting

With the rise of eSports, competitive videogames have become a spectator sport, both by attending pre-arranged matches in person, but also as virtual spectator via televised internet broadcasts of matches (Reitman, Anderson-Coto, Wu, Lee, & Steinkuehler, 2019). The game 'Overwatch' has a professional league with paid pro-players and it joins other high profile eSports games such as Warcraft, StarCraft, Diablo and League of Legends (Hill, 2017). Spectators bet on the outcome of matches in the same way they would with a football match or horse race.

6.1.2.2 P.V.P betting

Internet enabled, Player versus Player (P.V.P) multiplayer videogames allow users to compete against each other, either in one-on-one matches or team matches. Recent developments in technology allow players to bet, not on a player or team they are spectating, but on their own performance directly. 'Counter Strike Global Offensive' (CS:GO) is a popular online competitive game that saw a 1500% rise in players when gambling was introduced, leading to sales worth $576 million. It has also led to charges of corruption and cheating that echo more traditional sports gambling problems.

In CS:GO, players pay real money for 'skins' these are virtual decorations and weapons, they then use these skins in wagers on the outcome of matches. Once the winner has collected their ‘skins’, these can then be converted into real money again by selling them on. The game's developer claims this was not intended as it enables a thriving gambling operation to persist outside governmental regulation (Brustein, J; Novy-Williams, 2016). Clearly, betting is a powerfully compulsive extrinsic motivator that, like competition in general, has very great negative potential if not carefully designed.

6.1.2.3 Summary

The quizzes that students are already familiar with, once integrated into the Unicraft2 application, would provide an obvious activity for students to make wagers on. This should increase the compulsive power of the application, especially where a user might not be particularly motivated by the battle game (guidelines 5, 6.4, 6.5 and 6.7).

6.1.3 Virtual currency

A virtual currency is an alternate token of value that a game can use to create its own economy that players can take part in. Most virtual economies simulate the real world, a player performs some task or work for a token of payment, this token can then be exchanged for a virtual item of value. For example, taking on a mission in World of Warcraft to rid an area of rats, on completion a currency reward is given, this can then be used to buy a more powerful shield. This system can be abused to extend the playtime a game affords, eking out the game's content. For example, sometimes a task, like the rat example above, can be repeated over and over for more currency. In this way the similarity to a real-world job increases and the game becomes a work-like chore rather than a fun activity.

Players may voluntarily participate in such activities based on some future advantage, such as access to a new part of the game world. This is known as 'grinding' – repeating an in-game task repeatedly to earn 'money', it is a common criticism of some massively multiplayer online roleplaying games (MMORPG) yet provides powerful compulsion to players (Yee, 2006).

Virtual economies become even closer to the real world when implemented within MMORPGs as they can include player-to-player transactions with fluctuating prices, inflation and deflation.

EVE Online implements one of the most complex and sophisticated virtual economies, with the equivalent of stock market like trading (Lehtiniemi, 2008). Prices fluctuate with demand and supply and can be monitored in a similar way to the real work stock market (see Figure 89).

Figure 89. EVE online market trading screen (Lehtiniemi, 2008)

In Figure 90, a player in Ultima Online, an early MMORPG, spends hours ‘chopping’ wood to gather ingredients and increase their lumberjack skill (Garriott, 1997). With virtual currencies in more recent MMORPGs this kind of grinding can be skipped by players exchanging real money for virtual currency, items or skills.

Figure 90. Ultima Online, grinding ingredients (Garriott, 1997)

Virtual currencies allowed new monetisation strategies to emerge in videogames. Freemium or micro-transaction driven games, common on mobile phone platforms, allow games to be installed and played for no upfront cost. However, aspects of the game require the player to pay a small price for access. This can be a purely decorative item of virtual clothing, access to part of the game world itself or important game-changing weapons and items that directly impact player performance. The most famous game to use virtual currencies and the freemium model is Fortnite (see Figure 91), it currently has over 250 million players and uses virtual currency to buy 'battle passes' to access specific parts of the game world and to directly buy decorative items (Schöber & Stadtmann, 2020).

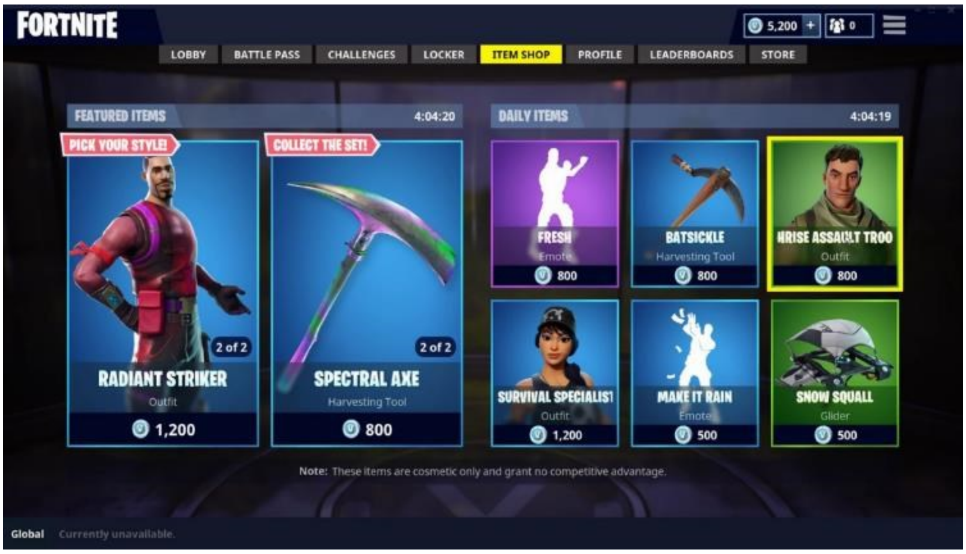


Figure 91. Fortnite V-Bucks purchasing (Schober & Stadtmann, 2020)

Usually there are two types of virtual currency, one that is purchased with real money and can be used to buy anything and another that is more limited. The limited form of currency is earned through play (grinding) and can be used to buy a subset of virtual items. Virtual currency has been very profitable, but there have been problems:

- Virtual currency that is too expensive to buy and the player must buy it with real money.
- Virtual currency can be earned through play, but it takes too long.
- Virtual currency can be used to just buy your way to success (special items granting in-game advantage)

6.1.3.1 Loot boxes

Many videogames reward player activities with 'loot boxes', which contain virtual items, sometimes purely decorative, but sometimes awarding in game advantage to the player (see Figure 92).

Figure 92. Loot box from Blizzard's Overwatch (Blizzard Entertainment, 2016)

These loot boxes might be given freely based on player performance, sometimes the player can use virtual currency earned through play to buy one, sometimes the player can pay to open a loot box, often a game will feature all of these options (Freedman, 2018). The loot box contains random items in line with ideas of positive reinforcement reward cycles discussed below. Most of the time the contents of the box will contain items the player already has, or items that are of little value, but occasionally it will contain something that is rare and worth a great deal, more than was spent on opening the box. It is this that makes loot boxes similar to a lottery and therefore as compulsive as gambling.

Some games have attempted to negate claims that they are promoting underage gambling by making the loot box content more transparent, although there are still random elements, the player knows roughly what they are buying. However, this can still be mishandled as there is a tendency to make the loot boxes contain virtual items that are otherwise very expensive, either in real currency terms or the hours expected of players to earn enough in game currency (Andronico, 2017).

6.1.3.2 Are rewards addictive?

Gambling is a powerful extrinsic motivator, as far back as the 60's Skinner identified the psychologically addictive potential of positive reinforcement and reward cycles (Skinner, 1963) also known as operant conditioning (Taneja, 2020). Initially he conducted experiments using rodents and birds (see Figure 93) before extrapolating the results to humans. If someone is given a task that results in a reward, if that reward is randomised, the individual will be compelled to continue. If the time between rewards is fine-tuned to contain an element of randomness, if the size of reward is similarly fine-tuned (sometimes nothing, often of meagre value, occasionally of very large value) then the individual will feel powerful compulsion, often labelled addiction.

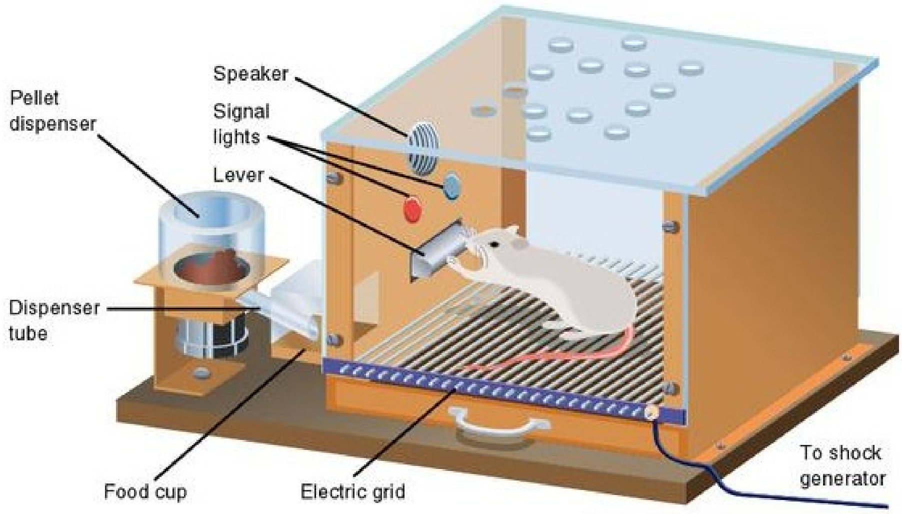


Figure 93. Skinner's operant conditioning chamber (Taneja, 2020)

Randomised rewards and making bets with virtual currency are gambling and have the potential for equal compulsion and risk, being highly addictive. Care must be taken in using the word addictive, as it is normally associated with drugs and alcohol causing a biological effect on the body. Gambling and rewards are psychologically compulsive, but are still powerful enough to destroy lives.

6.1.3.3 Gambling encourages cheating

When an individual is intrinsically motivated to engage in some task, they are doing so for the enjoyment of the task itself, an internal desire to take part for its own sake. Working on the task is its own enjoyment. In this state there is no motivation to cheat, where cheating is defined as taking shortcuts or breaking the rules or ignoring the spirit of the activity just to complete the task or complete it faster or enhance the result. Cheating reduces the time spent on task or reduces the need to develop skill in the task, for someone who is intrinsically motivated this would reduce their enjoyment and satisfaction.

When an individual is extrinsically motivated they are focused on the reward of completion, whether by financial means or increased perceived status amongst peers. Some external force is compelling them to complete the task and their satisfaction or enjoyment is not required. Therefore, there is less or no interest in the task itself and so any route to completion is considered. It is interesting to note the new field of eSports videogame betting has had a similar share of corruption (Macey & Hamari, 2018) and cheating scandals to traditional gambling sports (Holden, Rodenberg, & Kaburakis, 2017).

6.1.3.4 Safer gambling and education

The idea of virtual currencies is quite recent, appearing in games around 2005 to enable easier and cheaper handling of real-world money (A. Cohen, 2011). Players would exchange money for large quantities of virtual currency which could be spent or earned using 'micro transactions', for example, buying a new sword might cost 1000pts in game, but those points could cost as little as 10p. If those transactions were done using the actual real-world currency then it would be prohibitively expensive for such small amounts to be processed by banks. Gambling with virtual currency that had a real-world equivalent, even a small one, is exciting, but game developers have long known that it is a similar experience even when the currency has no real-world equivalent.

There are interesting possibilities in using apparently worthless virtual currency safely within educational gambling or betting. A pure virtual currency has no real-world value, so there is no physical reward compulsion. However, a virtual currency still has psychological value to the participant and it can still have importance, both in terms of social status and also personal importance when that currency is used to enhance an avatar that the player values (Behm-Morawitz, 2013).

Virtual points gambling is starting to be used in schools with participants taking part in quiz activities and wagering points on the outcome (Kurian, 2019). Often this takes the form of a quiz where a student or team of students begin with a number of points and then wager their points on the outcome of quiz questions (Thanh, 2019). Care must be taken over any implied real-world value placed on these points, obviously in a school environment they wouldn't be exchanged for money, but real-world value can come from non-monetary rewards e.g. extra break time, going home early, etc. Any real-world attachment can increase the compulsive attraction of gambling and be problematic. A fine line must be navigated between the currency becoming too valuable and the currency having no value at all.

6.1.3.5 Summary

With Unicraft2 there was a need to increase the app's compulsive attraction to maintain student engagement for longer (guideline 7), as participation is not compulsory (guideline 5.2). This led to considering allowing students to make wagers on the outcome of quiz questions (guideline 5.4). Virtual currency provides the means to make those wagers. If the game design is balanced well then users will perceive value in that virtual currency (guideline 1), as it can be used to enhance their avatars, but it has no real-world value and this reduces the chance of negative outcomes (guideline 5) e.g. reduction in intrinsic motivation, increased stress, etc.

6.1.4 Design documentation

6.1.4.1 Paper design prototypes

A number of paper design prototypes were made of Unicraft2 to fulfil the design objectives. Initially, use case diagrams (see Figure 94) and user interaction diagrams (see Figure 95) were used to get an overview of the desired functionality.

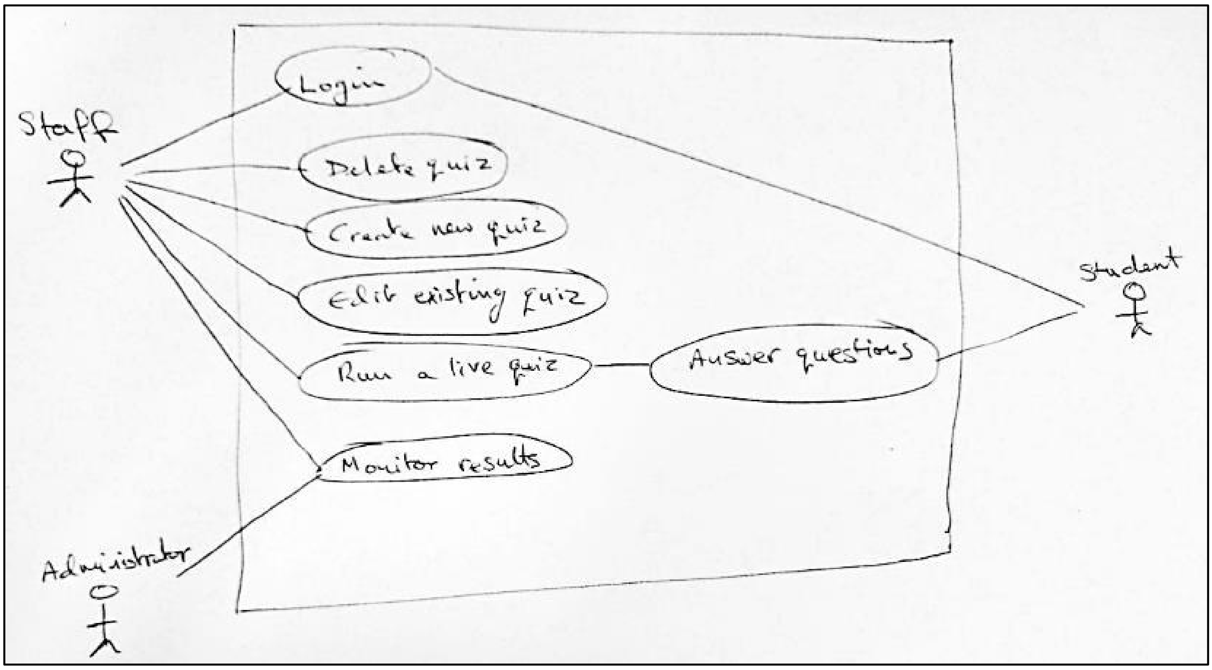


Figure 94. Unicraft2 quiz use case (Featherstone, 2022)

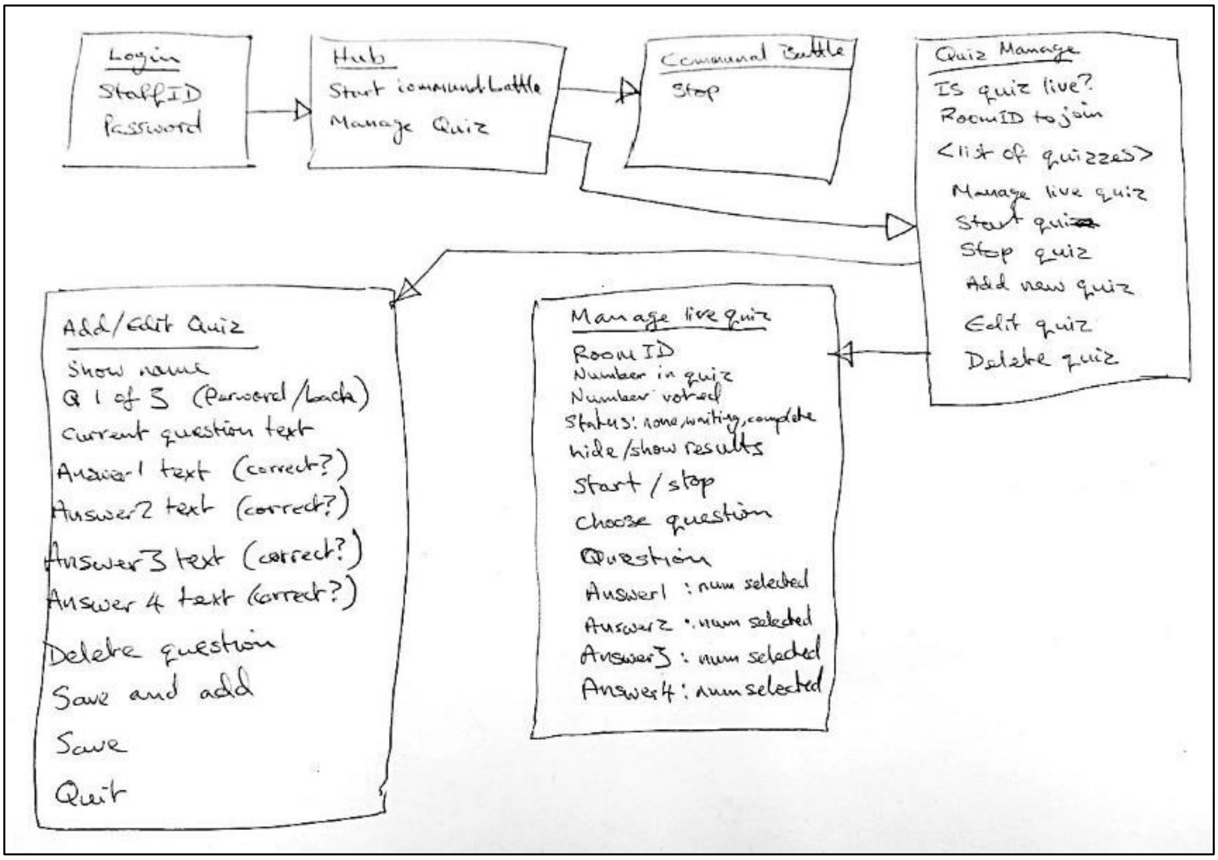


Figure 95. Unicraft2 quiz interaction (Featherstone, 2022)

6.1.4.2 Visual style and user interface prototypes

Once the functionality of the quiz and wagering aspects of the application were defined, more paper prototypes were created. The mobile app required a voting screen, with the ability to wager on the outcome of each quiz question, see Figure 96.

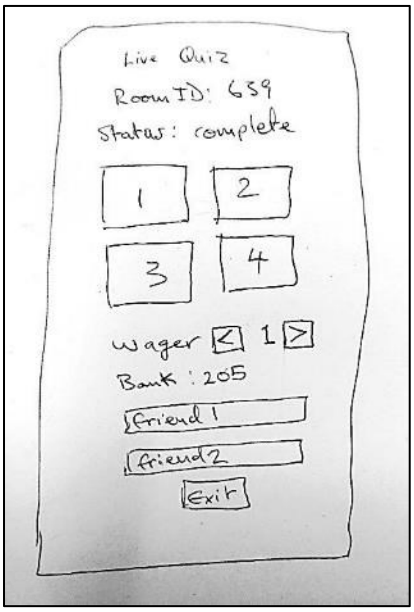


Figure 96. Unicraft2 mobile app voting interface (Featherstone, 2022)

Staff required a desktop application to create, edit and manage multi-choice quiz events, this would not need to adhere to the style of the mobile application as it's a desktop application, see Figure 97.

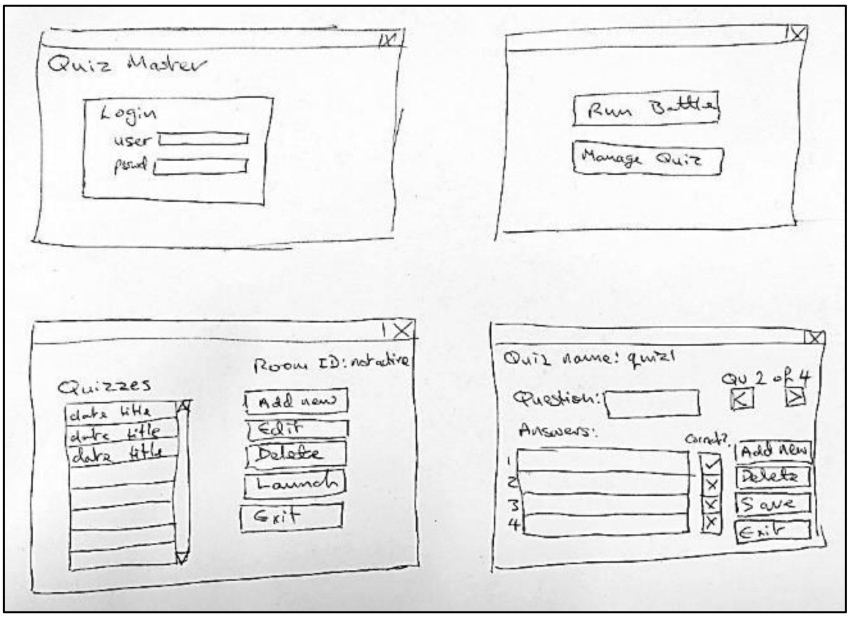


Figure 97. Unicraft2 quiz editor interfaces (Featherstone, 2022)

6.1.4.3 Web server backend extensions

The existing database backend was extended to support multi-choice quiz activities and wagering. The database table design can be seen in Figure 98.

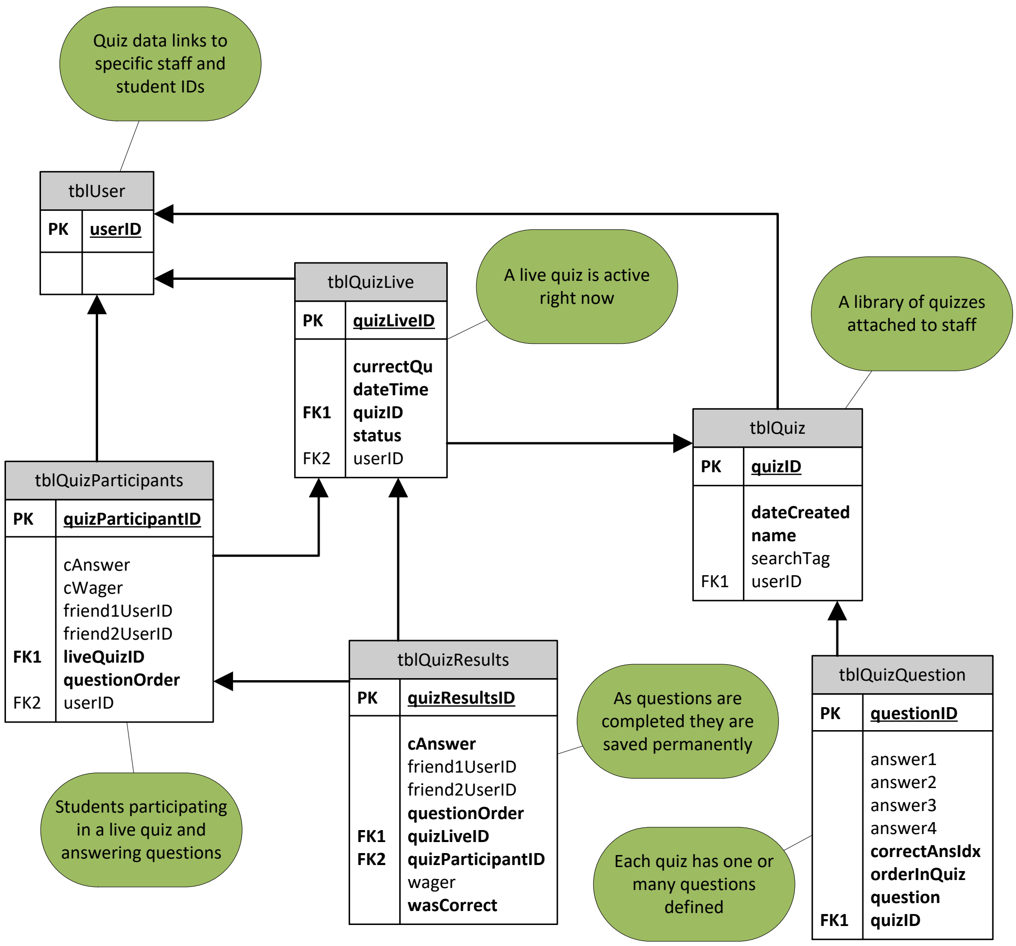


Figure 98. Unicraft2 database extensions (Featherstone, 2022)

6.1.4.4 Webserver frontend extensions

The existing webserver required a number of PHP extensions to allow a public interface to the extended database quiz tables (see Figure 99).

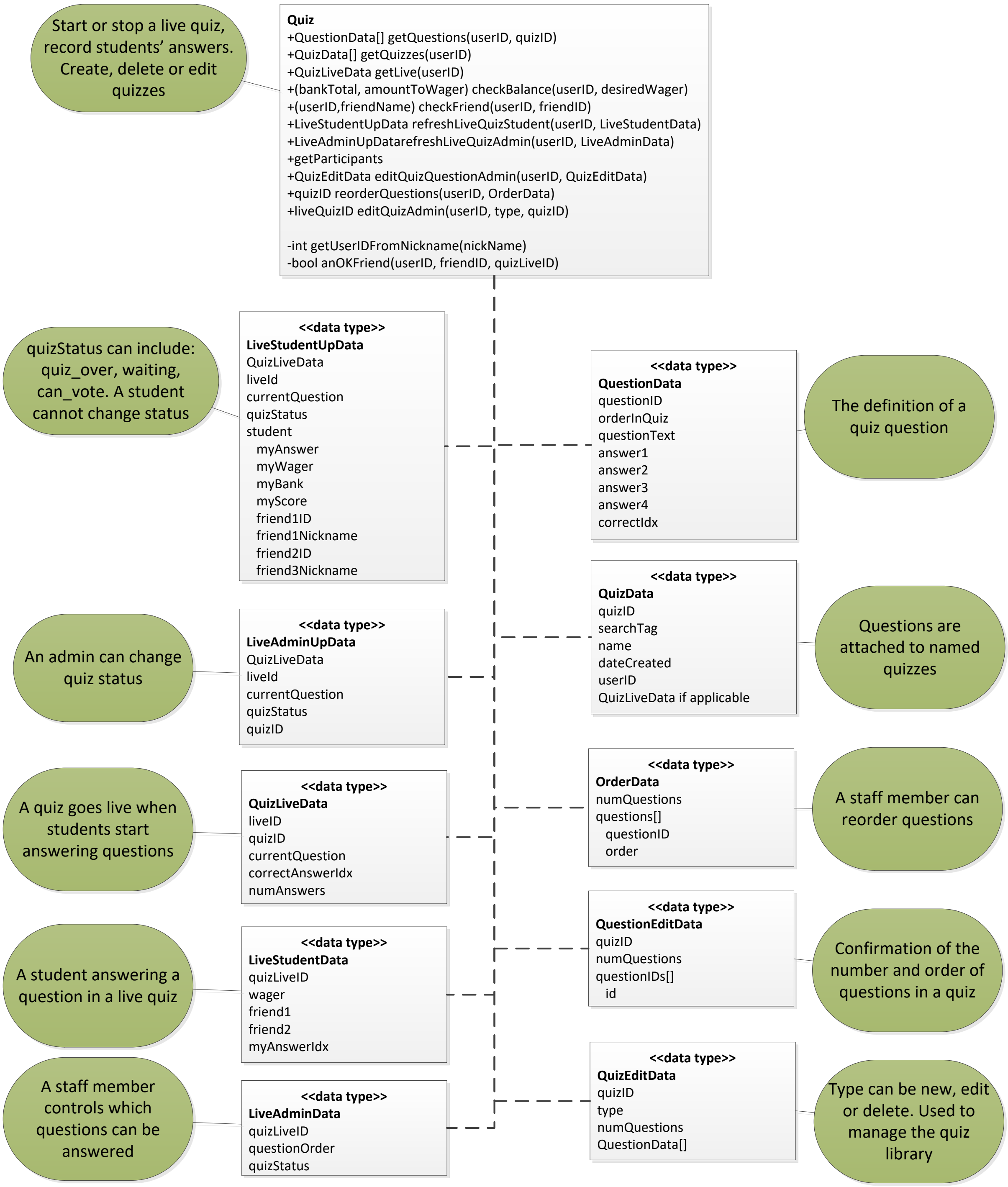


Figure 99. Unicraft2 webserver objects (Featherstone, 2022)

6.2 Quiz overview

The diagrams below give an overview of the new quiz aspects of the app and how the different user interface screens link together.

6.2.1 Mobile application

Unicraft2 has a new quiz-voting interface for live participation in multi-choice quizzes (see Figure 100). When the competitive battle game is activated, at the halfway point in the study, wagering is also enabled.

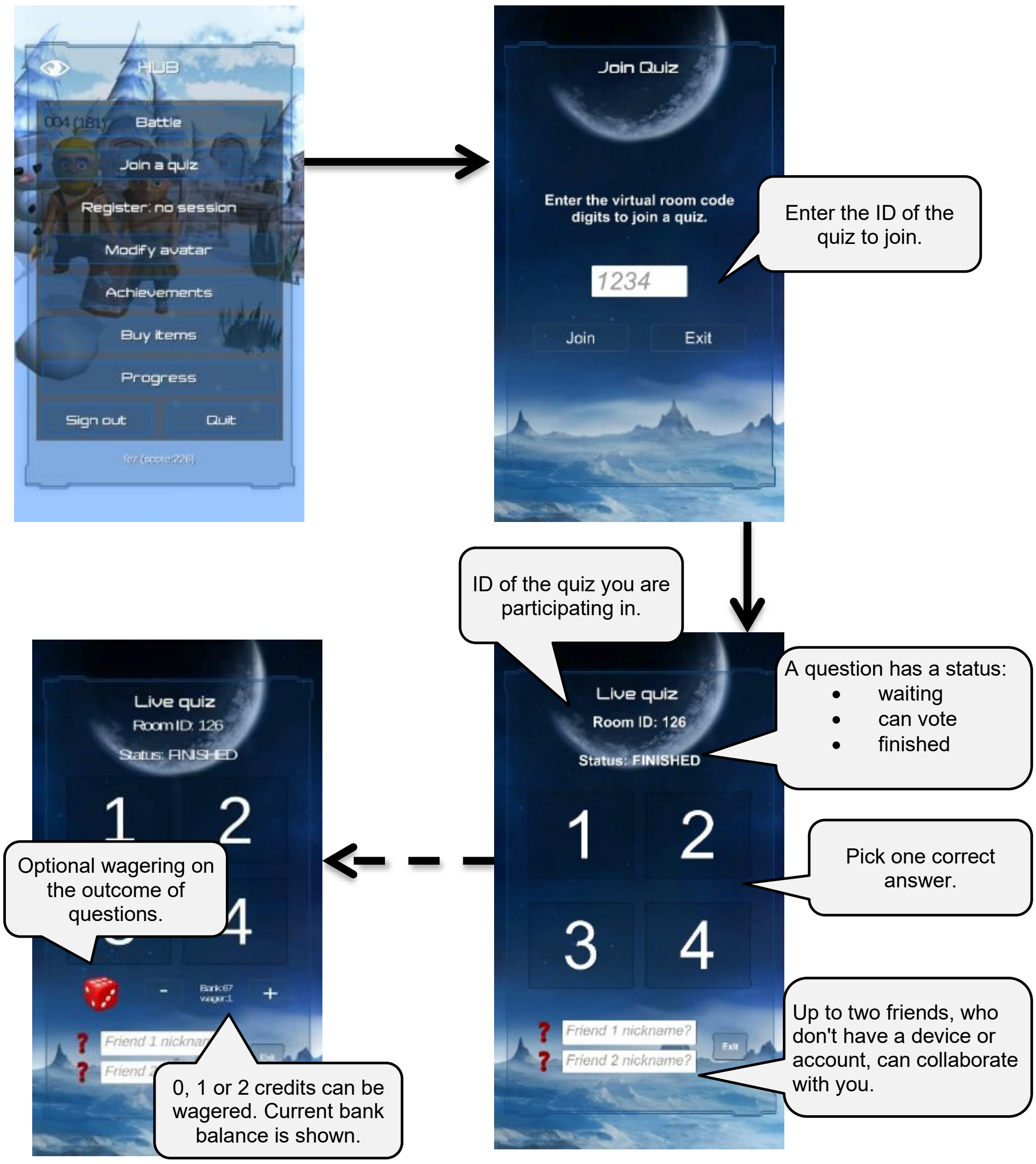


Figure 100. Unicraft2 mobile voting interface (Featherstone, 2022)

6.2.2 Unicraft2 desktop app

Once a staff member is logged in they have two options: run an asynchronous battle or administrate a quiz. When a staff member runs a battle, the system detects the staff login and then alters the format of the battle. Instead of a specific student and their two closest peer matched teammates fighting, the system finds the highest ranked 25 students and adds them slowly into the battle, from weakest to strongest, until only one avatar remains. The ordering helps ensure the highest ranked players tend to survive longest and win (see Figure 101).

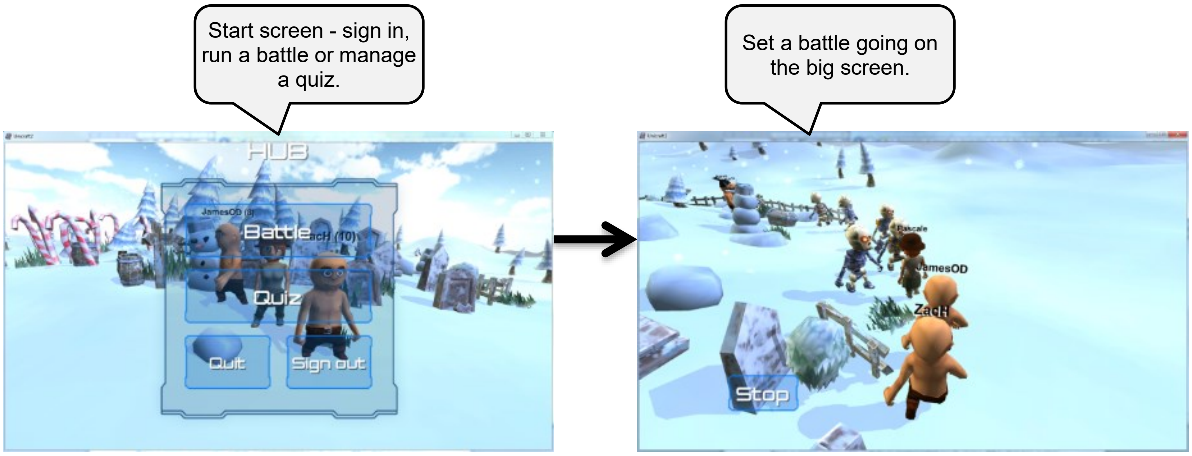


Figure 101. Desktop battle interface (Featherstone, 2022)

When administrating a quiz, the staff member is presented with a list or library of their own quizzes (see Figure 102). There are two main modes to the quiz editor:

- Managing a quiz that is live
  - Check the login-id ('Room ID') that students will use to join in
  - Check the name of the quiz that is currently live
  - Actively manage or run the quiz
  - Stop a live quiz
  - Start one of the quizzes from the library
- Editing quizzes that are not currently live.
  - Add a new quiz
  - Edit an existing non-live quiz
  - Delete an existing non-live quiz

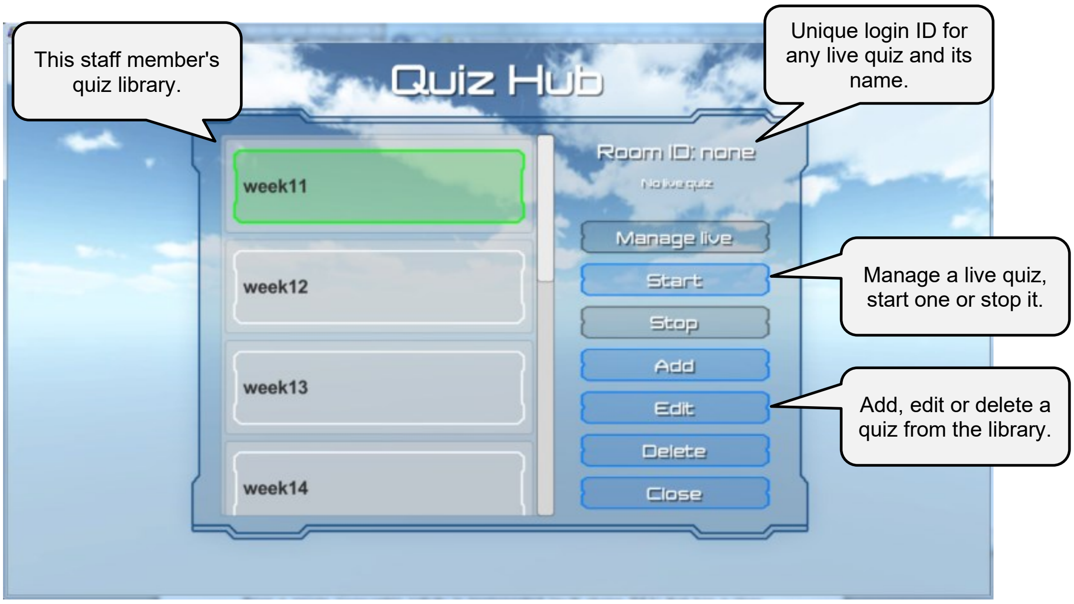


Figure 102. Quiz hub interface (Featherstone, 2022)

Creating a new quiz or editing an existing one requires the staff member to attach one or more questions to a uniquely named quiz (see Figure 103). The edit screen supports a set of related question editing functions:

- Add between two and four answers, only one can be correct
- Change the order of questions in the quiz
- Delete, add or edit the questions

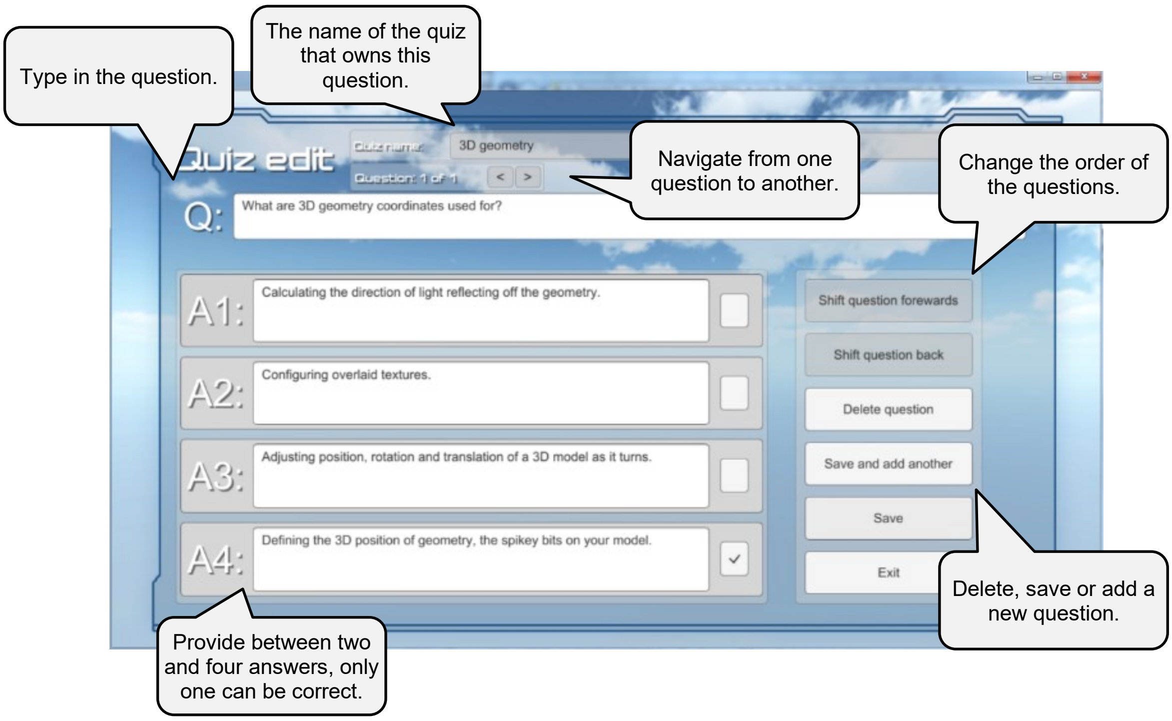


Figure 103. Quiz question editor (Featherstone, 2022)

Once a quiz is live, students can use a unique "room" code to join the quiz (see Figure 104). Staff then control which questions are available for voting. Any registered Unicraft2 user can join a quiz if they know the unique room ID, it is different every time.

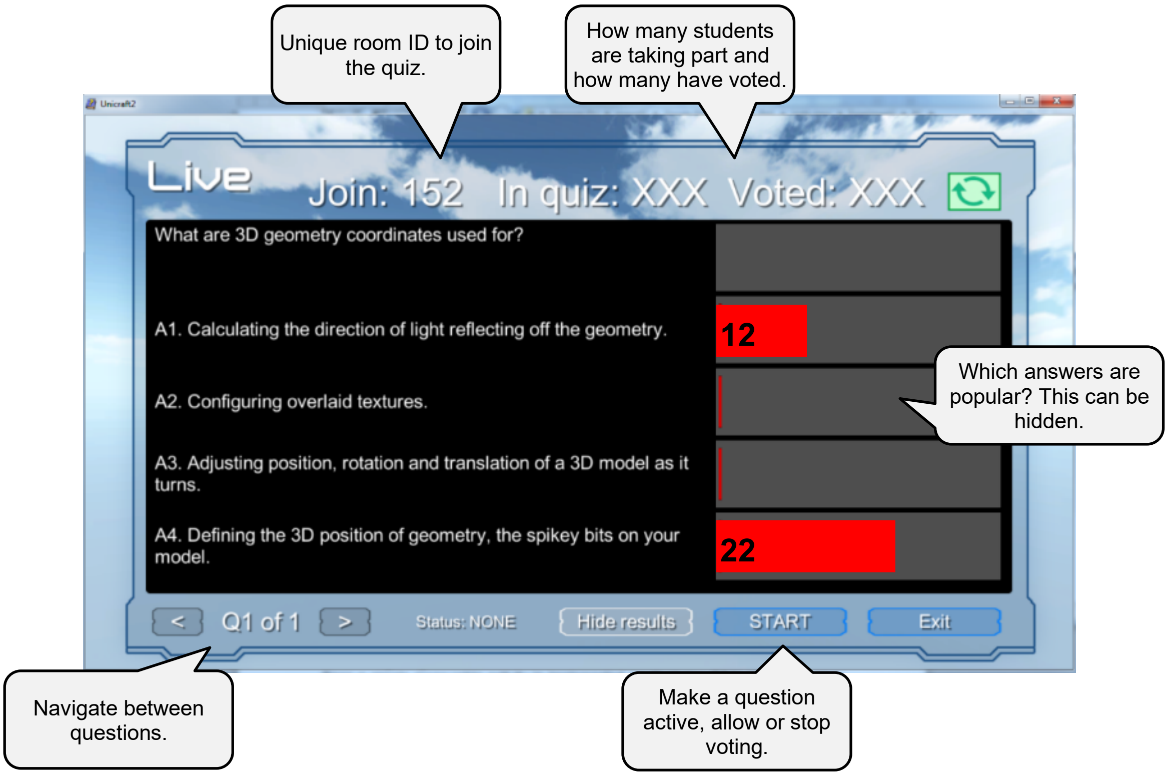


Figure 104. Live quiz interface (Featherstone, 2022)

6.3 Summary

The purpose of this thesis is to develop a set of guidelines that, if followed, increase the probability that gamification will have a constructive positive influence on participants and not reduce their intrinsic motivation. Mobile applications were developed as a way to test and refine these guidelines. The initial set of guidelines (2.12.3 Gamification design guidelines v1) were used and iteratively refined in the development of Unicraft1, based on that experiment, an improved second version of the guidelines were developed and iteratively refined in the design of Unicraft2 (8 Gamification and competition - design guidelines v2).

Based on the Unicraft1 study, three issues needed to be addressed:

1. The application was not embedded well enough in the classroom, within learning; students would question its relevance to their studies.
2. It was also clear the application was not 'sticky' enough and students would grow fatigued with it too quickly.
3. Students were cheating and exploiting the app to accelerate their progress and this was undermining student trust and faith in the application.

To address these issues Unicraft2 was designed with three main goals:

1. Embed a lightweight, easily modifiable learning activity within the app that would tie it more directly to the lesson – quizzes. This would reduce the flexibility of the application if moved to another subject, as new questions would need to be written, but this overhead is small.
2. Introduce wagers (or betting) to the system. Like competition, wagering is a very powerful extrinsic motivator, with potentially negative side effects. However, Unicraft2 already hides the identity of users and has no real-world value rewards, plus the size of wagers could be limited. Therefore, it was hoped this would limit any negative side effects while increasing engagement with the application.
3. Reduce the number of self-certified achievements students can claim and also their virtual value and increase the quality of software testing to reduce the probability of exploitable bugs in the system. It was hoped a balance could be found between cheat proof teacher authorisation of student activity (which is time consuming) and student's self-certifying they have completed tasks (which is prone to cheating).

7 Study 2: Evaluating Motivation

7.1 The question

Can videogame mechanics and aesthetics increase engagement with gamification when participants are not compelled to take part or physically rewarded for taking part? Can the lack of compulsory participation and physical reward, be replaced by constructive competition without negative impact on intrinsic motivation? Will participants still engage over the long term when they know they do not have to?

7.2 The experiment

The gamification app Unicraft2 was offered to 130 first year computing students with an average age of 20, consisting of: 64 computer science, 52 computer science for games and 66 software engineering students. The experiment ran for one semester of 10 weeks in one of their normal course subjects, 'Fundamentals Of Programming' (FoP). The students spent one hour per week together in a one-hour lecture and two hours per week in tutorials where the students were separated by course. The students were offered the Unicraft2 app in the week before the study started, they were told it was not compulsory, there would be no reward and it would have no explicit impact on their marks. The author did not teach the students, a lecturer and two tutors ran the experiment and were not otherwise involved in the development of the application and had not previously used gamification. 109 students agreed to look at the application and 54 of them used it every week until the study completed, 15 students agreed to act as a control and not use the app at all, but still take part. Note - this apparently high level of drop out was in line with falling attendance trends in this and other first year subjects these students attended. Only one student taking part was female.

Students were surveyed at the beginning and end of the project to assess their level of motivation using the “motivated strategies of learning” questionnaire (Pintrich, 1991). Gamification and more specifically competition can have a negative effect on intrinsic motivation, so it was important to monitor this metric.

The app was only offered on the Android platform, due to costs of development, but Android tablets were offered to students who did not have a compatible device. For the first 5 weeks the app provided the following gamification functionality:

- Earn credit for attending tutorials.
- Earn credit for taking part and correctly answering quiz questions in the lecture.
- Earn credit for successfully engaging in tutorials at the discretion of the tutor i.e. answering questions, demoing work, helping other students, completing work outside class, etc.
- Earn credit for completing tutorial work – this was self-certified by the students due to the time overhead of a member of staff administering it.
- Create and customise a videogame-like avatar using clothing and equipment bought with the credits earned.
- View ‘point scores’, rank and tutorial progress in comparison with other students using the app.

For the last 5 weeks the app provided the same functionality, plus more explicit videogame mechanics and competition.

- A battle game was activated where the students' avatars could fight in teams against computer-controlled enemies.
- During multi-choice quizzes it was possible to wager earned credits on the outcome of the questions, potentially doubling the wager (maximum wager was limited to just two credits).
- Battle games could be initiated:
    - On the student's device with two peer-matched teammates
    - Autonomously on the class projector with all students in the tutorial participating
    - On a large screen in the cafeteria with all students in the subject group participating.

The participants were a random selection of first year university students, chosen because this class was taught by an experienced member of staff, not the author, who was willing to trial the project. It was not practical to separate the students intro experimental and control treatments equally or by location. Ethical consent was predicated on all students being offered use of the app, hence the smaller control group resulting from the majority of the students finding the app attractive. All students were taught together in the same lecture theatre, so it was not feasible to separate them.

7.3 Attendance

All university subjects suffer from falling attendance over time, the first year of any course will tend to have the worst levels of attendance and drop out compared to later years, where students are more fully committed to completing their course. Falling attendance impacts on the Unicraft2 results as students who are not attending are also not using the app, even though their reasons for not attending may be nothing to do with the app. For this reason, only those students continually using the application throughout the study have their results included.

However, Unicraft2 did have a positive impact on student attendance in the Fundamentals of Programming (FoP) module where it was trialled. Attendance figures for all subjects the students in the study were taking are shown in Figure 105.

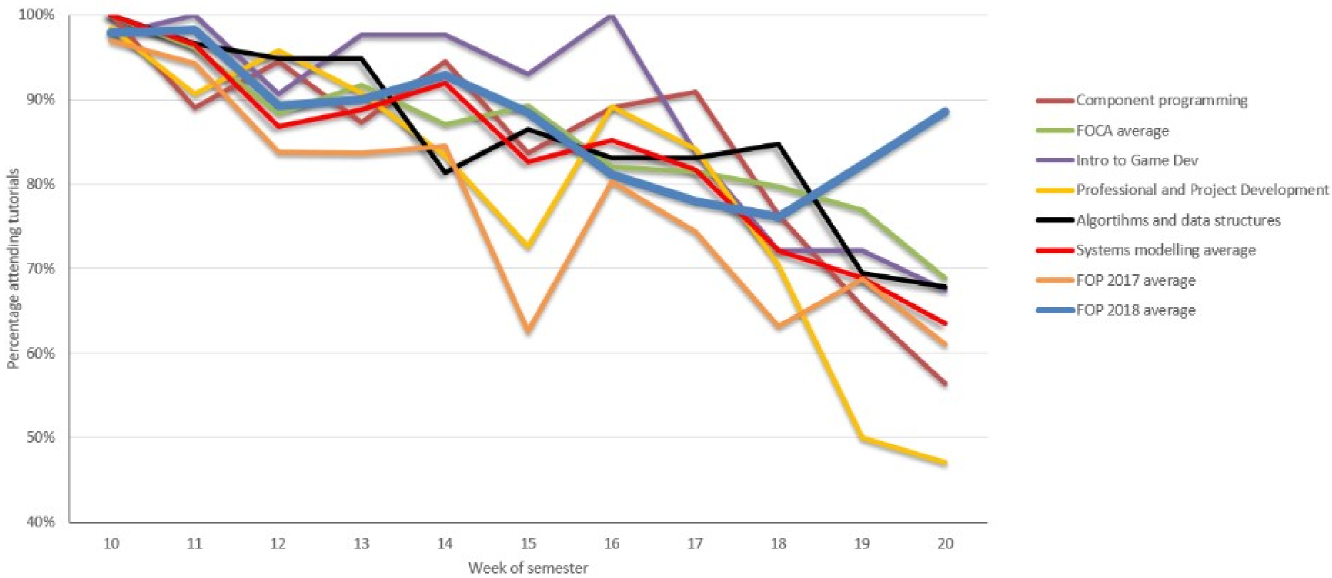


Figure 105. Attendance comparison between subjects (Featherstone, 2022)

The raw data is difficult to assess, although a marked and general decline is evident, but the difference is clear when a trend graph is generated from the data (see Figure 106).

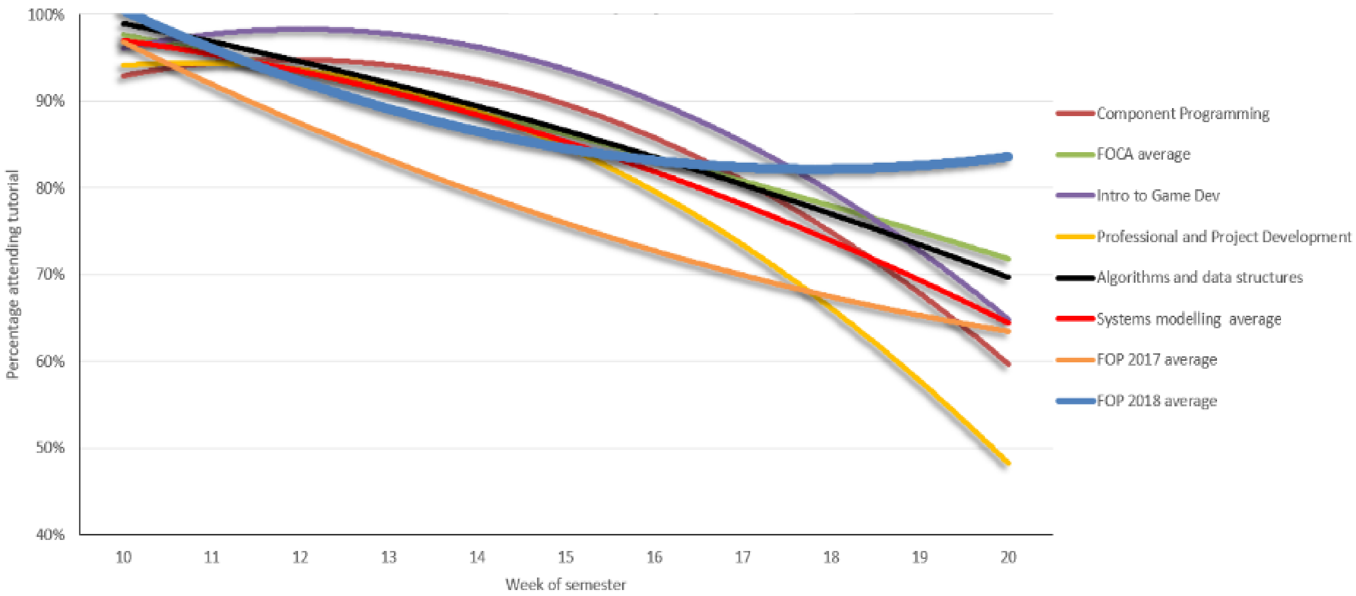


Figure 106. Attendance comparison trends between all subjects (polynomial order 2) (Featherstone, 2022)

Attendance trends in FoP outperformed all other subjects, with the introduction of battle games at the mid-way point causing a noticeable upswing. Of particular interest is the comparison between FoP 2018, FoP2017 and all other subjects:

- FoP 2018 - Unicraft2 and interactive quiz activities in lectures
- FoP 2017 - TurningPoint interactive quiz activities in lectures – this software facilitates multi-choice in-class quiz activities in a very basic way, there is little gamification content, no persistent scoring.
- All other subjects – no interactive quiz activities took place; all subjects used a traditional lecture and tutorial format.

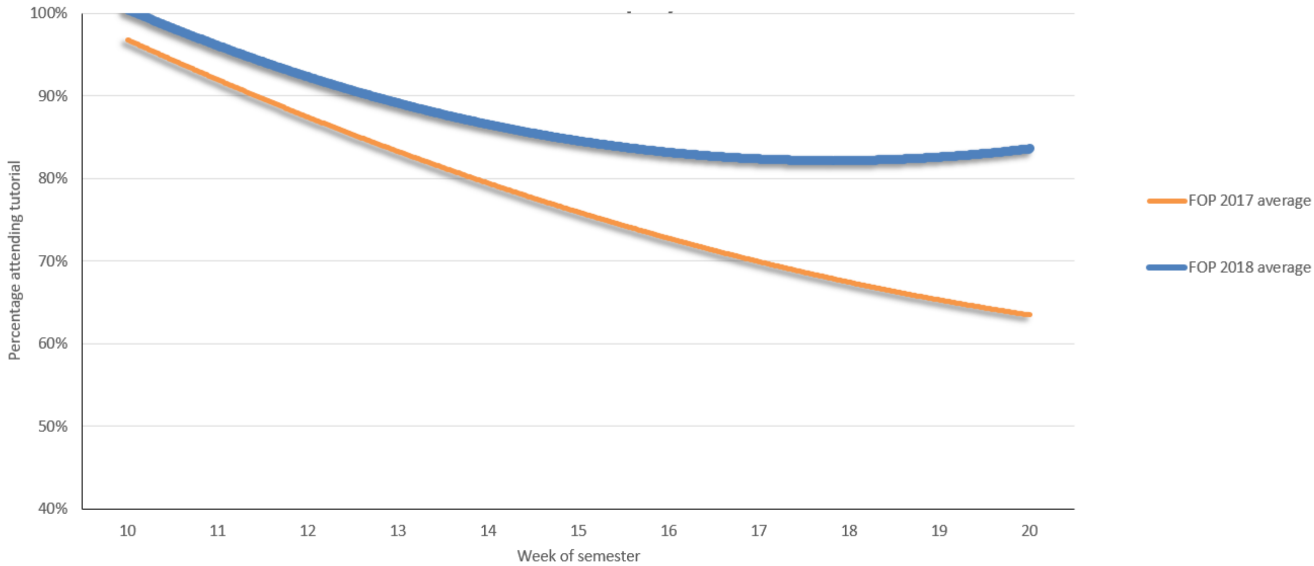


Figure 107. Attendance comparison trend between FOP 2018 and 2017 (polynomial order 2) (Featherstone, 2022)

In Figure 107, when Unicraft2 was used, attendance was 11% higher than when FoP used TurningPoint in the previous year (one way ANOVA $F(1,20)=5.1$, $P=0.035$, $\eta 2 = 0.25$). What is clear is that interactive quiz activities make students more likely to attend than when those activities are not utilised. In addition, the extra gamification elements and videogame mechanics used in Unicraft2 made students even more likely to attend. Why? A majority of students reported the FoP sessions with Unicraft2 were more fun than other subjects.

Looking at attendance in all subjects over the semester (see Figure 105), there is some negative event halfway through the semester that pulls attendance down across all subjects. During interviews students said this was when assignment feedback was returned in some subjects and it became clear, for some students, that they weren't being as successful as they might have hoped. A similar pattern can be seen in the dropout rate for Unicraft2 (see Figure 108), note the spike just after the halfway point when battle and competition were activated.

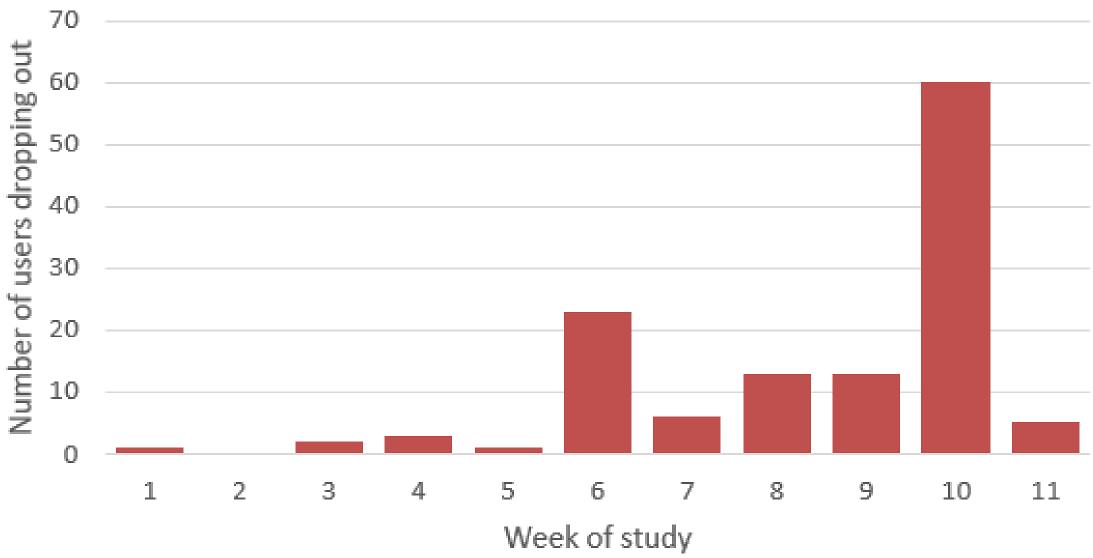


Figure 108. Users last interaction with Unicraft2 (Featherstone, 2022)

7.4 When were students using Unicraft2?

Students used the app mainly during lectures at 1pm and tutorials throughout the day, but were still using it early in the morning and late at night (see Figure 109).

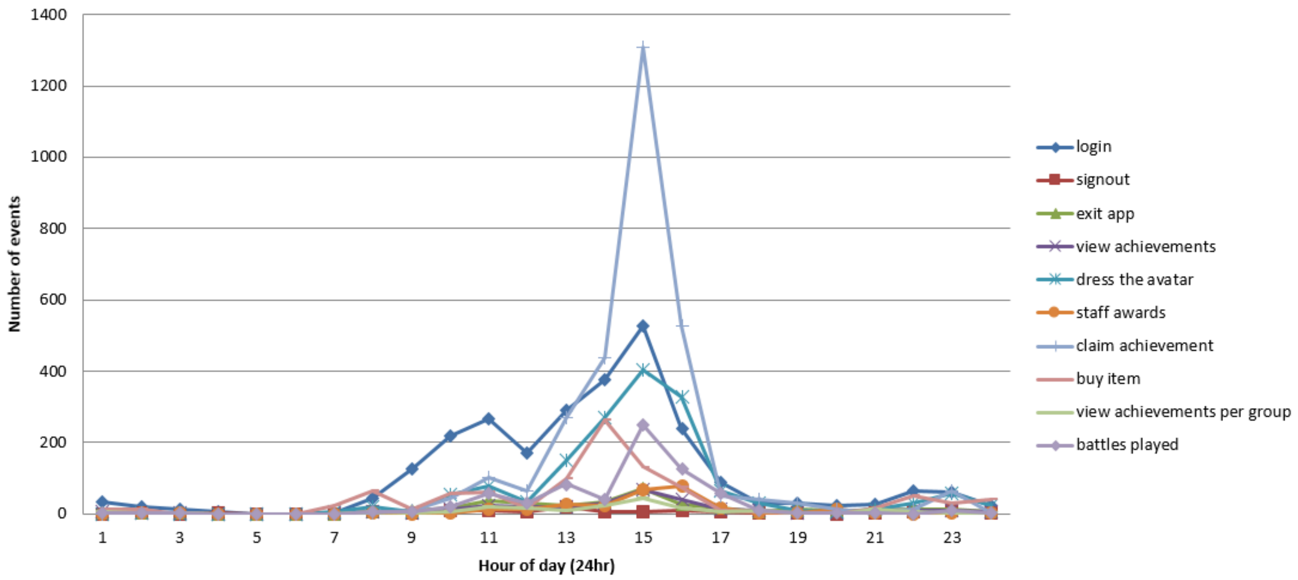


Figure 109. Unicraft2 usage patterns by time of day (Featherstone, 2022)

When comparing usage patterns pre battle gaming (see Figure 111) and post battle gaming (see Figure 110), they are similar, but overall activity is much higher when battle games are active. Activities related to claiming achievements spike, this is because students need credits to upgrade their avatars and increase their power in battles. The only way to earn extra credits is to claim more achievements i.e. attendance, quizzes, completing tutorials and ad-hoc staff awards.

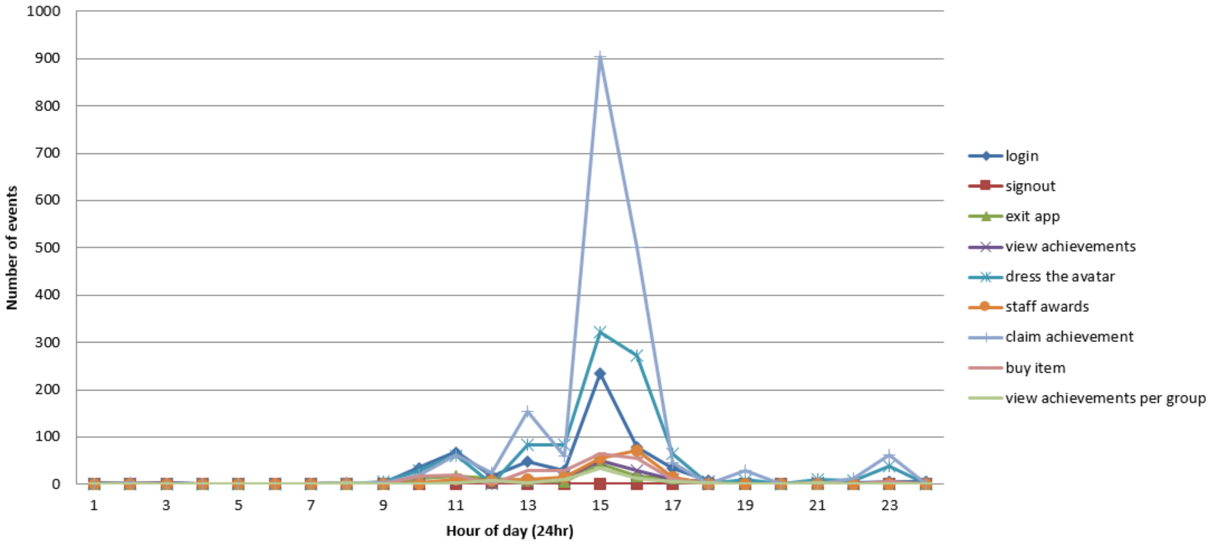


Figure 110. Unicraft2 usage patterns by time of day, battle game active (Featherstone, 2022)

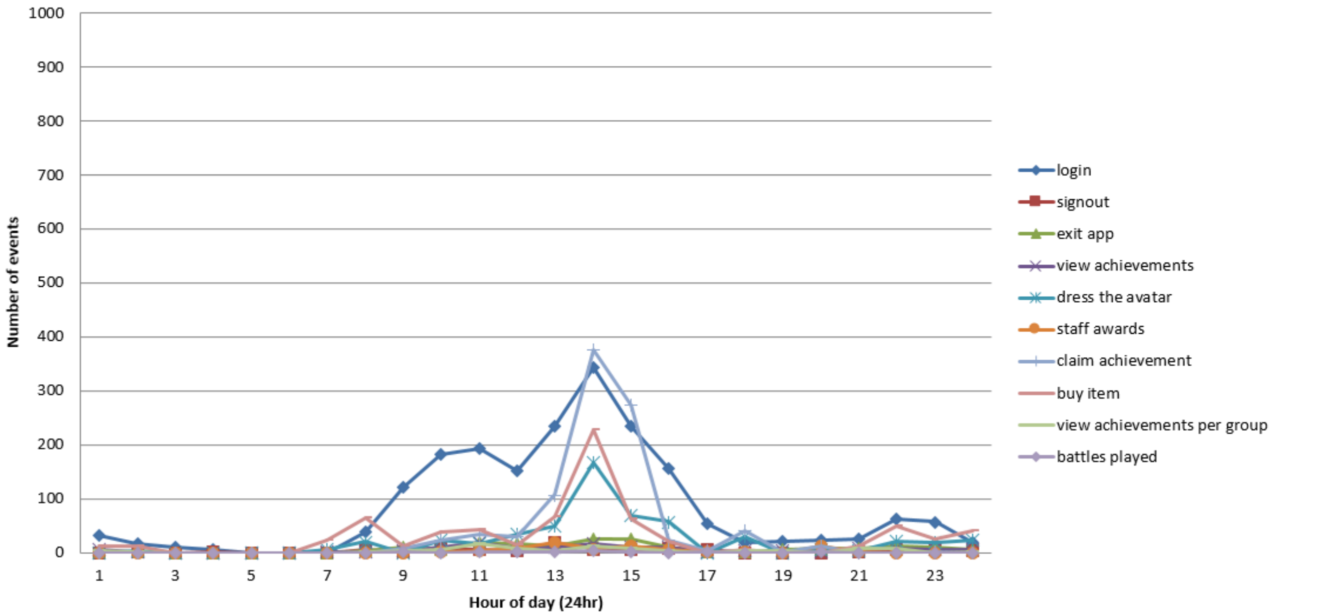


Figure 111. Unicraft2 usage patterns by time of day, battle game inactive (Featherstone, 2022)

Students were mainly using the app during the lectures on Mondays, to a lesser extent during tutorials and occasionally outside timetabled sessions for this subject at the weekend (see Figure 112).

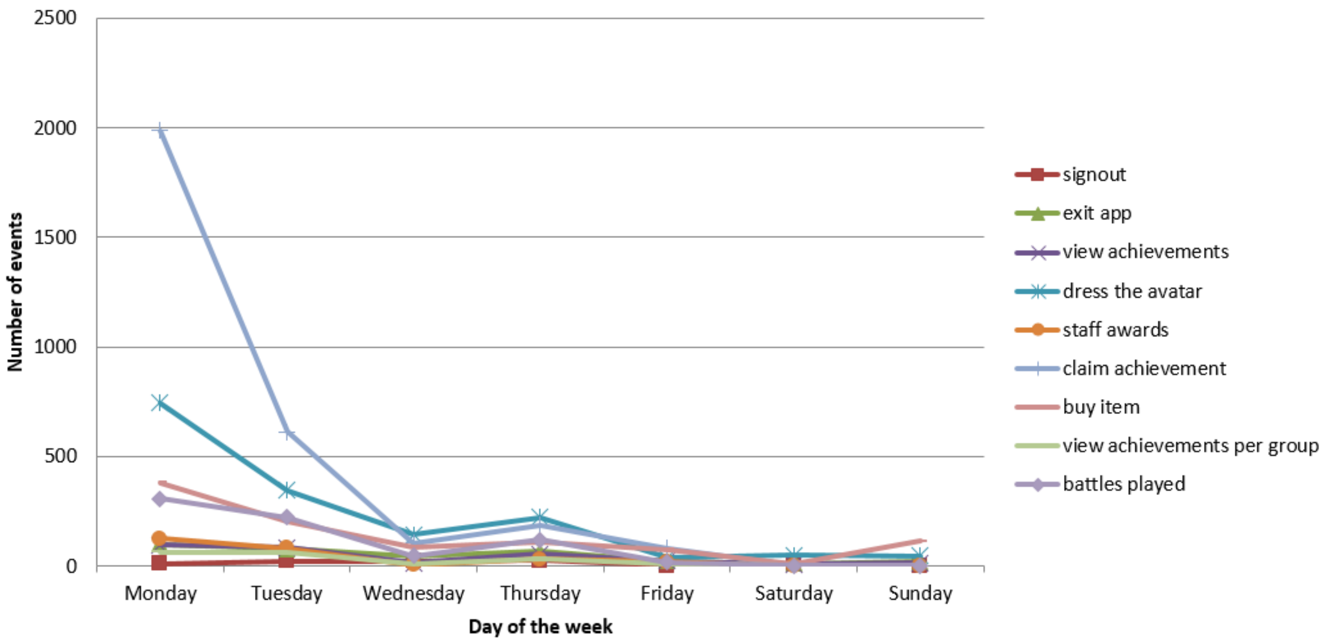


Figure 112. Unicraft2 usage per day of the week (Featherstone, 2022)

When comparing daily usage pre battle gaming (see Figure 114) and post battle gaming (see Figure 113), results are similar, but overall activity is much higher when battle games are active.

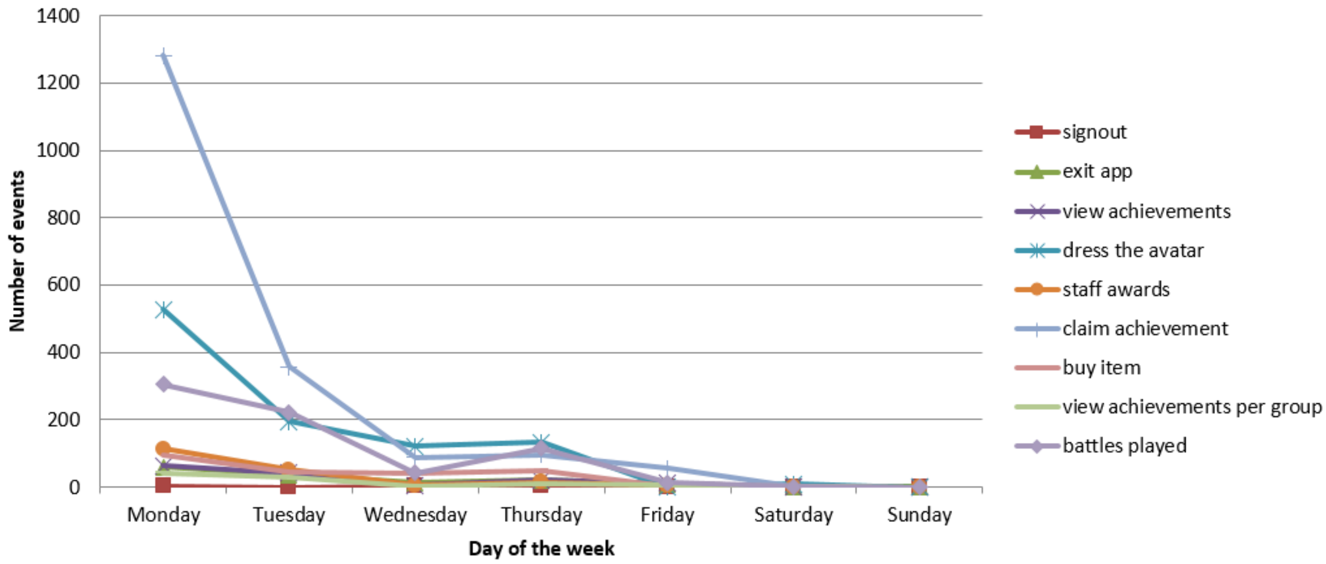


Figure 113. Unicraft2 usage per day of the week, battle game active (Featherstone, 2022)

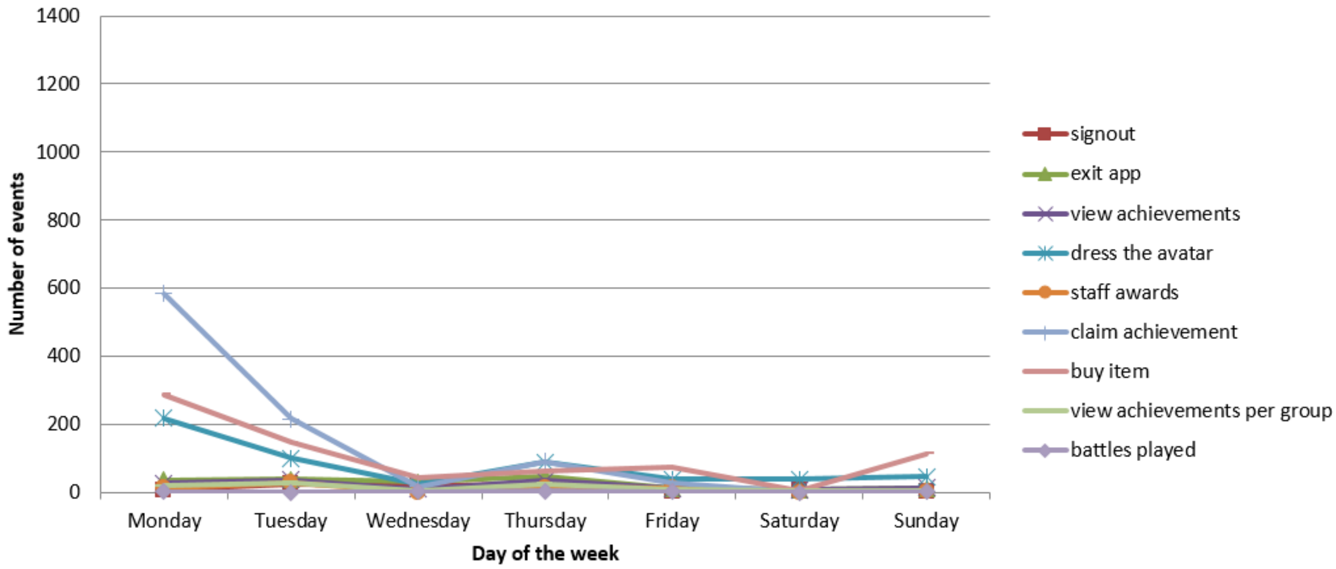


Figure 114. Unicraft2 usage per day of the week, battle game inactive (Featherstone, 2022)

7.5 How usage changed pre and post battle game activation

In Figure 115, there is a comparison between the most common Unicraft2 events before and after battle games were activated. Once battle games are activated there is an increase in triggered events as students increase their interactions with the app (185% higher). The exception is the “buy item” event, which is very high at the start of the study as all students customise their avatars for the first time using a small amount of gifted starting credits.

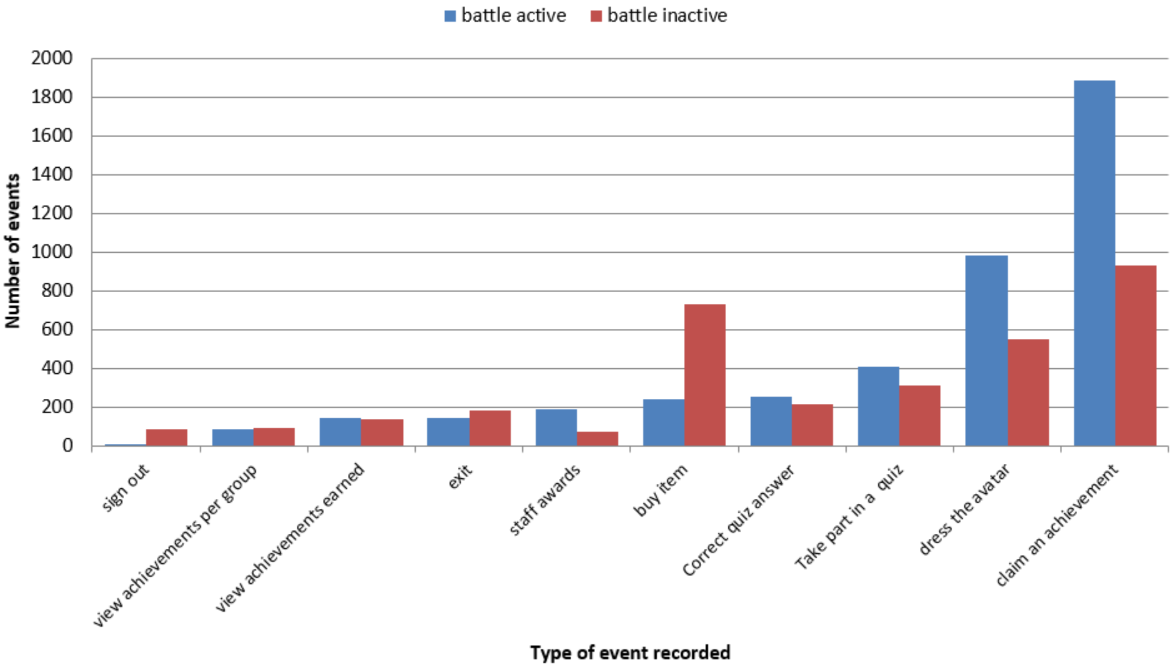


Figure 115. Unicraft2 pre and post battle game event counts (Featherstone, 2022)

The increase in usage is more obvious when tracked over time as in Figure 116. The trend line (see Figure 117) shows interest declining in semester1, then a spike as battle games are introduced at the halfway point, which alters the rate of decline and raises daily usage levels.

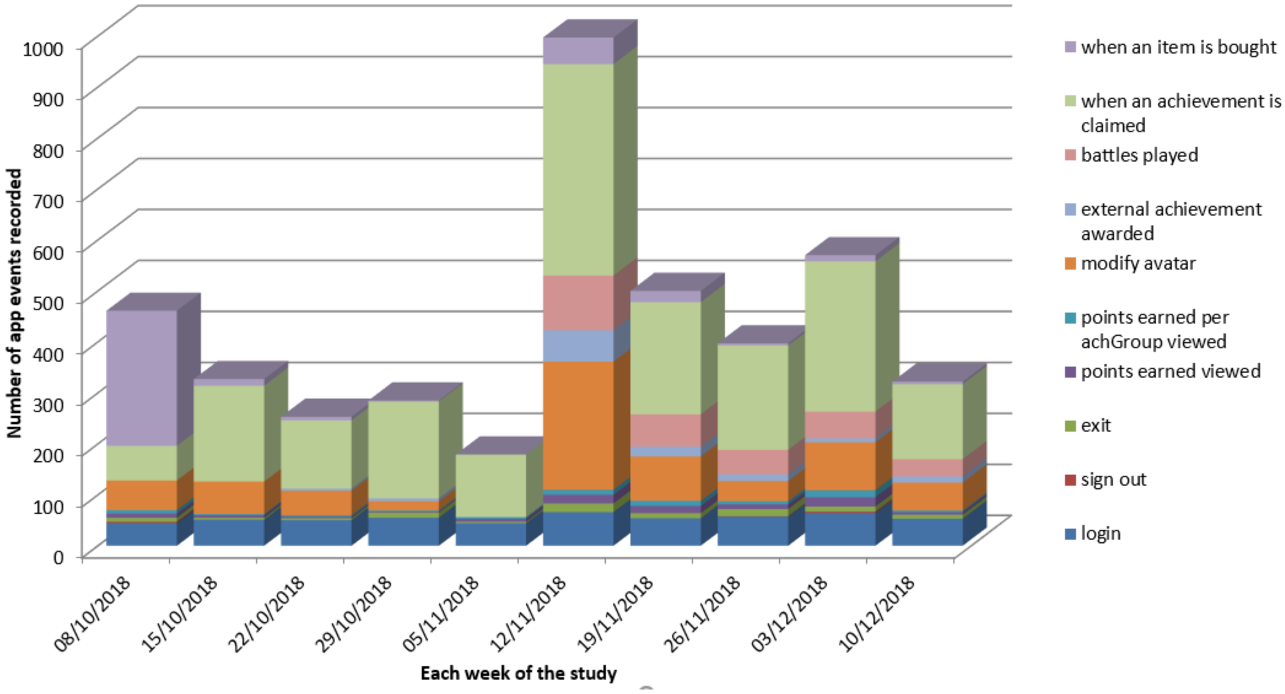


Figure 116. Total recorded events over time (Featherstone, 2022)

Looking at the underlying trends in usage (see Figure 117), before battle games are activated usage is following a near linear decline, after battle games are activated usage increases, but still starts to fall although no longer linearly. Unicraft2 is not compulsory and so to stay relevant it is therefore relying on students perceiving it as useful, fun and compulsive. Unicraft2 is seen as novel, interesting and fun in a similar way to any videogame, interest falls over time as the activity loses its novelty.

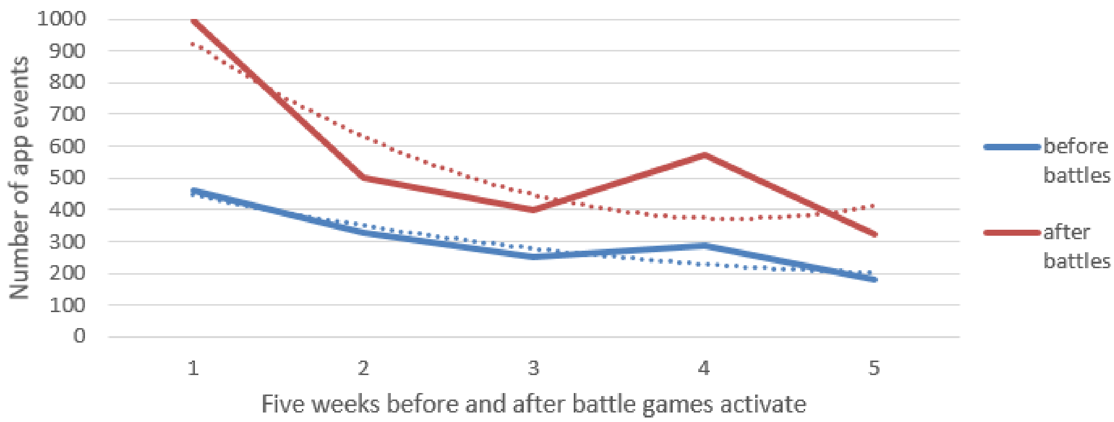


Figure 117. Usage trends pre and post battle game activation (Featherstone, 2022)

The interactivity of battle games and the compulsive competition introduced through battles and voting wagers reduces the rate of decline in usage by making the app 'stickier' for longer. Usage rates could be more predictably reinforced by making the app compulsory, but then there is an increased risk of loss of intrinsic motivation.

7.6 Impact on motivation

The ‘motivated strategies for learning’ questionnaire was used pre and post study to assess any change in motivation within the study group (Pintrich & De Groot, 1990). It is widely used to assess student attitudes and motivation to learning in educational institutions (Artino, 2005). Although this survey uses the Likert scale, the questions are grouped into related sets and a composite scale is applied, with the questions combined to describe student attitudes (Pintrich, 1991). Composite scores for Likert scales can be analysed at the interval measurement scale using means and T-tests (Boone & Boone, 2012).

7.6.1 Motivated strategies of learning questionnaire

The questionnaire has six groups of questions, each group relating to a different student attitude to learning:

1. Intrinsic goal orientation – is the student intrinsically motivated for reasons such as challenge, curiosity and mastery?
    a. In a class like this, I prefer course material that really challenges me so I can learn new things.
    b. In a class like this, I prefer course material that arouses my curiosity, even if it is difficult to learn.
    c. The most satisfying thing for me in this module is trying to understand the content as thoroughly as possible.
    d. When I have the opportunity in this class, I choose module assignments/tasks that I can learn from even if they don't guarantee a good grade.

2. Extrinsic goal orientation – is the student extrinsically motivated for reasons such as grades, rewards and competition?
    a. Getting a good grade in this class is the most satisfying thing for me right now.
    b. The most important thing for me right now is improving my overall grade point average, so my main concern in this class is getting a good grade.
    c. If I can, I want to get better grades in this class than most of the other students.
    d. I want to do well in this class because it is important to show my ability to my family, friends, employer, or others.
3. Task value – are these activities interesting, important or useful?
    a. I think I will be able to use what I learn in this module in other modules.
    b. It is my own fault if I don't learn the material in this class.
    c. I am very interested in the content of this module.
    d. I think the course material in this class is useful for me to learn.
    e. I like the subject matter of this module.
    f. Understanding the subject matter of this module is very important to me.
4. Self-efficacy for learning and performance – does the student believe they will perform well and be successful?
    a. I believe I will receive an excellent grade in this class.
    b. I'm certain I can understand the most difficult material presented in the reading material for this course.

c. I'm confident I can learn the basic concepts taught in this module.
d. I'm confident I can understand the most complex material presented by the lecturer in this module.
e. I'm confident I can do an excellent job on the assignments and tests in this module.
f. I expect to do well in this class.
g. I'm certain I can master the skills being taught in this class.
h. Considering the difficulty of this module, the lecturer, and my skills, I think I will do well in this class.

5. Test anxiety – does the student feel anxious or worried about upcoming test and exams?
    a. When I take a test I think about how poorly I am doing compared with other students.
    b. When I take a test I think about items on other parts of the test I can't answer.
    c. When I take tests I think of the consequences of failing.
    d. I have an uneasy, upset feeling when I take a test or exam.
    e. I feel my heart beating fast when I take a test or exam.
6. Control of learning beliefs – does the student believe positive outcomes are related to their own efforts? Do they feel in control of their performance?
    a. If I study in appropriate ways, then I will be able to learn the material in this course.
    b. It is my own fault if I don't learn the material in this course.
    c. If I try hard enough, then I will understand the module material.

d. If I don't understand the module material, it is because I didn't try hard enough.

All questions use a seven point Likert scale.

7.6.2 Data analysis

In this study the student scores are not of interest, it is the comparison of scores between groups, both pre and post experiment that is of interest. It is desirable that gamification should make lessons more fun and thereby increase student engagement with their studies and encourage behaviour the teacher deems appropriate. However, it should not negatively change how the student feels about their learning, this is often measured as a drop in intrinsic motivation.

Results were tested for variance in four groups:

1. Variance within experimental group – do the members of the experimental group share similar attitudes to learning?
2. Variance within control group – do the members of the control group share similar attitudes to learning?
3. Variance between experimental and control group pre-test – comparing the experimental and control groups, did they share similar attitudes to learning before the experiment began?
4. Variance between experimental and control group post-test – comparing the experimental and control groups, did the share similar attitudes to learning after the experiment finished?

If the control and experimental groups consist of participants with similar attitudes and those attitudes do not change over the course of the experiment then it would be possible to claim that the gamification intervention did alter how students feel about their learning. If students reported more enjoyment of lessons, better attendance and higher attainment, while not changing their attitudes to learning then that would support the hypothesis.

7.6.3 Motivation results

Questionnaire answers were tested to see if there was any variance in results between the experimental and control groups (see Table 11). Any increase refers to the control group mean response to questions.

Questionnaire section	Variance within experimental group	Variance within control group	Variance between experimental and control group – pre test	Variance between experimental and control group – post test
Intrinsic goal orientation	M=2% t(58) = 0.62, p=0.5	M=0% t(19) = -0.06, p=0.96	M=1% t(28) = 0.33, p=0.7	M=4% t(14) = 1.07, p=0.3
Extrinsic goal orientation	M=5% t(58) = 1.1, p=0.3	M=3% t(14) = 0.58, p=0.6	M=6% t(40) = 1.3, p=0.2	M=4% t(14) = 0.81, p=0.4
Task value	M=0% t(54) = 0.09, p=0.9	M=1% t(16) = 0.24, p=0.8	M=1% t(32) = 0.42, p=0.7	M=3% t(15) = 0.71, p=0.5
Self-efficacy for learning and performance	M=3% t(57) = 0.68, p=0.5	M=5% t(17) = 1.22, p=0.2	M=1% t(32) = 0.14, p=0.9	M=1% t(31) = 0.43, p=0.7
Test anxiety	M=1% t(45) = 0.13, p=0.9	M=8% t(15) = 0.63, p=0.5	M=0% t(22) = 0.04, p=0.96	M=7% t(13) = 0.62, p=0.6
Control of learning beliefs	M=1% t(50) = 0.38, p=0.7	M=3% t(15) = 1.04, p=0.3	M=4% t(39) = 1.25, p=0.2	M=8% t(22) = 2.27, p=0.033

Table 11. Motivated strategies of learning results (Featherstone, 2022)

M	Difference in means
t(X) = Y	X = Degrees of freedom Y = the t statistic
p	Power value, values below 0.006 indicate statistical significance when multiple measures are taken

Variances were checked for statistically significant differences using two sample t-tests, it was expected that there would be no statistical differences in responses within the experimental group or within the control group and this was confirmed. It was expected that there would be no statistical differences between the experimental and control groups before the study began and this was confirmed. The main area of interest was if the responses diverged after the study completed, between the experimental and control groups (right-most column).

The questionnaire sub-section “control of learning beliefs” was the part of the questionnaire measuring the largest change in student’s perceptions. This section of the questionnaire refers to the student’s beliefs that their engagement with learning will lead to positive outcomes. Higher scores implying the student believes that outcomes are related to their own efforts and not extrinsic factors. When students believe their own efforts make a difference to learning outcomes they are more likely to study effectively. However, as six groups of measurements were taken, if the Bonferroni correction is applied, then the power value of 0.033 is not significant (target p0=.006).

7.6.4 Summary

The survey showed no statistically significant changes in student attitudes to learning before or after the experiment. Combined with increases in attainment and attendance, these results support the hypothesis.

7.7 Sensitivity to delivery

Unicraft2 was used in the FoP subject, which had one subject leader and two support tutors who administered, promoted and delivered the gamification project via Unicraft2. From the data (see Table 11), it is clear that the subject leader's groups outperformed all other groups.

Final score	Tutorial group	Course	Tutor
856	7	Computer science for games	Subject leader
755	8		
631	9		
484	1	Software Engineering	Tutor A
417	3		
286	2		
495	5	Computer Science	Tutor B
446	4		
267	6		

Table 12. Final scores per tutor, course and group (Featherstone, 2022)

This could be as a result of the high performing groups being part of a videogame development course and therefore being more familiar with videogame type content and more likely to engage with the study. However, it's also possible that the subject leader was better at promoting, explaining and administrating Unicraft2. It can certainly be seen that there were differences in the groups, in Table 13, it is clear that the subject leader was far more likely to give out ad-hoc achievement rewards in tutorials.

Tutor	Course	Total ad-hoc awards given	Number of students	Awards per student
Subject leader	CS4G	205	52	3.94
Tutor B	CS	107	64	1.67
Tutor A	SE	61	66	0.92

Table 13. Ad-hoc awards given by staff in Unicraft2 (Featherstone, 2022)

Cross analysis

Comparing the quantitative data from the analytics software with the interview responses it can be seen that the subject leader is generally more positive about the gamification project than the other two tutors and engages with the gamification software more readily. The subject leader has given out more than twice as many ad-hoc rewards as tutor B, and more than four times as many as tutor A.

7.7.1 Summary

This suggests the effectiveness of any project like this is dependent on the enthusiasm, experience and understanding of those administering the activity (teaching staff in this case). It is therefore very important to include them in the design, development and testing phases, provide adequate training, ongoing support and ensure gamification aligns with teaching activity to minimise any additional time burden or pedagogical changes.

7.8 Interviews

7.8.1 Staff interviews

Throughout the study feedback was sought from the three staff delivering the subject, as they were the ones explaining, administrating and promoting the gamification project.

Subject leader

- Week 1 - “I’m very nervous about using the voting system as if it fails it will undermine student confidence in my lectures. Similarly, when the app is used in tutorials to register attendance and award points for engagement, I'm just worried about how much time that will take and if it doesn't work due to technical problems."

- Week 2 – "Yes some cheated. The tutorials haven't been made available yet! I think they just wanted the kits! [virtual clothing] At least they were intrigued. It took a bit of doing to get them to do it but now one of them even emailed me to remind me that he had forgotten his tablet, but I owed him a coin!"
- Week 2: "In class voting is working which is a relief, but adds a small time overhead and requires me to shift from power point to Unicraft2 and back, it adds a small amount of stress when I'm trying to project a professional confident approach. I only have 60mins, so I'm really pushed for time. It doesn't work quite as I'd like."
- Week 4 - "Getting the hang of running quizzes and tutorials now, it's working well. The students do need guidance and regular reminders to actually stay involved though."
- Week 6 – "The battle game definitely got students talking and piqued their interest."
- Week 8 – "You can see they are buying items for their avatars and interest peaks when the battle royale is shown at the start of a lecture. Currently the students only have 3 quiz questions a week in the lecture, it's a shame they aren't getting quiz questions in the tutorials too as it would help embed the app in their week more."

Tutor A

- Week 1 – “It’s easy to forget to start a session when you know that it isn’t compulsory, students don’t have to use it so it’s awkward to remind students about it.”
- Week 2 – “It takes a long time to learn student names, but the process of handing out credits means I now HAVE to know the student’s name which puts me into an awkward position.”
- Week 4 – “Not sure how many students are engaged with this, which makes it feel awkward to keep mentioning it.”
- Week 6 – “The battle game activating did seem to wake people up, both in terms of remembering the app, but also being a bit more switched on at the start of a tutorial in general.”
- Week 8 – “More students appear to be interested in the app since battles became active and I started showing it at the start of tutorials. I don’t always get to the tutorial in time to show a battle resolve [it takes 3 mins] so sometimes I don’t show it or cut it short before there’s a winner.”

Tutor B

- Week1 – “This looks like a really fun app, very interesting, I would hope the students would find it fun and useful.”
- Week2 - “Handing out credits to students in class is awkward as I don’t know the student’s names and I have to say, “Hi, that’s a great question you asked earlier, what’s your name so I can give you a credit?”. The way I work I avoid interactions that explicitly require using a student’s name, at least for quite a few weeks until I’ve learnt them, so “do you need a hand

with that" type approach. Having to admit I don't know a student's name, who I may have interacted with multiple times previously, is embarrassing and means students lose confidence in you just a little. I think later when I've learned more of their names then it won't be a problem.

- Week4 – "There aren't that many students engaged with using it, I do try and mention it, but I don't think that many are interested."
- Week6 – "The battle game did make the students sit up and take notice, maybe they are interested."
- Week8 – "Same issue as [Tutor A], I don't always get to the tutorial in time to show the battle resolve properly, but the students seem more interested in the app now battles are active anyway. Quizzes in tutorials would definitely increase engagement with the app, currently some see it as just for voting in the lecture only, I think this is partly because I don't hand out many coins as I'm still learning names."
- Week9 – "It's like some students are embarrassed to admit they're using it. So if I call out "are you taking part", "who's number 1", "are we all registered", "who wants to earn a coin", etc. - I don't get any response and so I assume nobody is using it, but then when I look at the progress screen I can see that actually lots of people are using it. Frustrating."
- Wk10: "I'm not sure if it will have any effect on their marks, it's a good idea, but it just needs to work more transparently, easily in the class. Handing out credits is too awkward, maybe if their app showed a QR code and everyone knew that when I walked over they should press their "show my QR code button" and then I could use my app and the camera to ID them automatically? Then there's no remembering names bit, I don't know,

would that be less awkward or more awkward? It needs integrating into the tutorials better, quizzes would help, then maybe some Hackerrank type content or them peer reviewing their work through it perhaps."

7.8.2 Student interviews

At the end of the study, semi structured interviews were conducted with volunteer student participants. A semi-structured approach was used to provide some consistent topics of conversation (see Table 14):

1	How did you feel when using Unicraft2?
2	What was the feature you liked best?
3	What was the feature you liked least?
4	What would you change about the app or add to it?
5	Did the app ever behave incorrectly?
6	What purpose do you think the app serves?
7	How do you feel about the competition aspects – the points, leader boards, etc.?

Table 14. Semi structured interview topics (Featherstone, 2022)

These interviews were conducted with multiple small groups of students at the end of the study. Unlike the first study, small groups were randomly selected, due to the increased number of participants making it impractical to interview everyone at the same time. Also, in the first study two small random groups were used in the experiment, each group using Unicraft2's battle competition at different times, therefore the interviews occurred at different times. In the second study, practical constraints meant all participants using Unicraft2 finished at the same time, so they were all interviewed within the same week at the end of the study.

Compatible devices

Many students complained the app wasn’t available on iOS, even though they were offered an Android device to borrow, student 1: “I want to use it, but I have an iPhone and I don’t want to carry two devices.”

Feeling left behind

Some students felt they were falling behind though, either through a lack of understanding or a hardware problem. Student 5: “I ran out of space on my phone, so I uninstalled it, but then I saw others using it, so later I freed up some space and put it back. But then I was too far behind, the voting and coins for attendance and stuff, I couldn’t catch up.” From the metrics data (See Figure 118) it can be seen that students who started to play later in the experiment tended to not progress as far in the game. The chart shows students grouped by when they started to try and make progress in the game by playing battles, by week 6 all participants had taken part in battles, but some started in week 1, others in week 2, etc. For each group the min, average and max battle level reached is shown, the trend is for those who started later not to progress as far as those who start in week 1, 2 or 3.

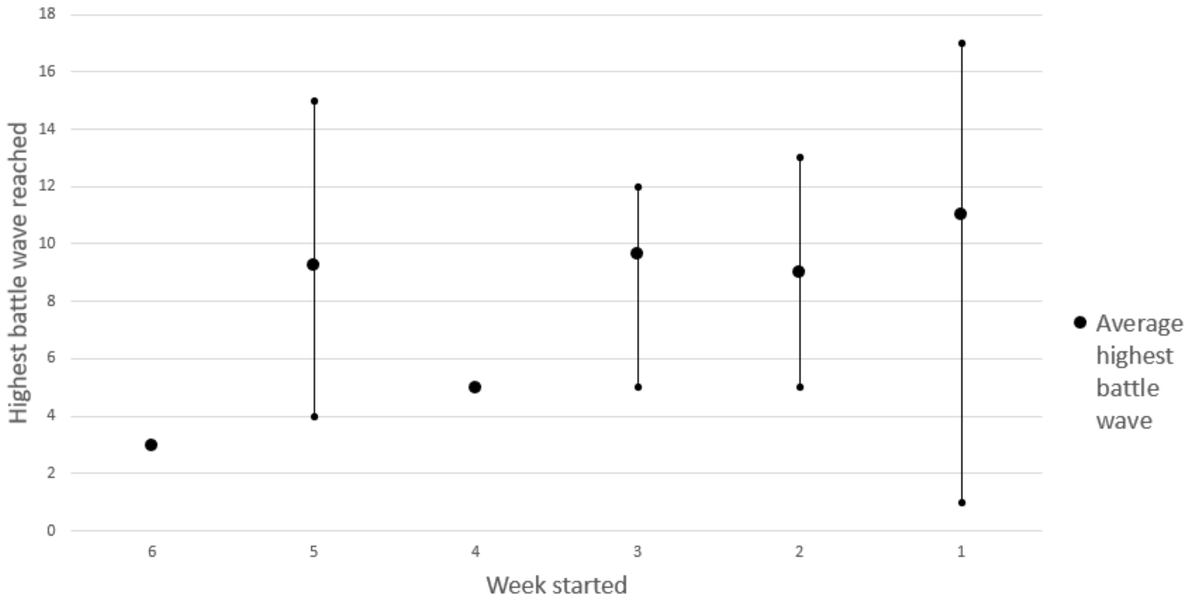


Figure 118. Late start progress lag (Featherstone, 2022)

Voting and wagers are key features

Many students valued the in-class multi choice voting and enjoyed making wagers on the outcomes of their choices, student 3: “Voting and wagering were great, there was no stress to it.” Student 47: “I can’t get enough cash. I wish I could make bigger bets, then I could make more money, I’m a high stakes gambler [grin] and I should be supported.” Student 7: “voting made lectures more fun, more interactive”. From the metrics data (see Figure 119) it can be seen that around half of users took part in voting and wagers.

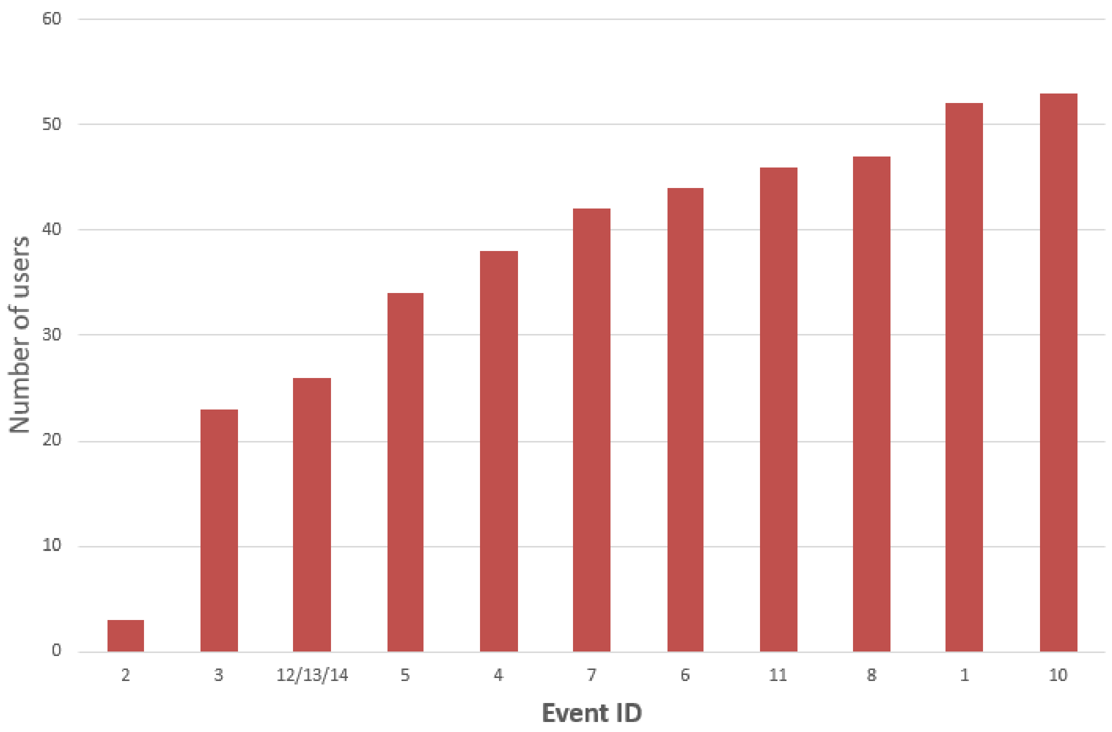


Figure 119. Number of users engaging in specific events (Featherstone, 2022)

Event ID	Description
1	Log in
2	Sign out
3	Exit
4	Points earned screen viewed
5	Pointer earner per achievement group screen viewed
6	Modify avatar
7	External achievement award
8	Battles played
10	Achievement claimed
11	Item bought
12/13/14	Events relating to voting and wagers

The danger of competition

Some students were aware of the potential dangers of competition, but nobody expressed any negative impact. Student 10: "I like the voting bit, I'm 6th on the leaderboard [grins]. I'm not sure about the other features though, I can't see how they make any difference to me, but I saw other people using it and it bugged me, so I joined in. Are my friends using it because they like it or the competition stuff making them do it? It doesn't bother me." From the metrics data (see Figure 120) it can be seen that some students completely avoided voting and wagering activities (shown in blue), while for those who did compete there was a tendency for that activity to dominate.

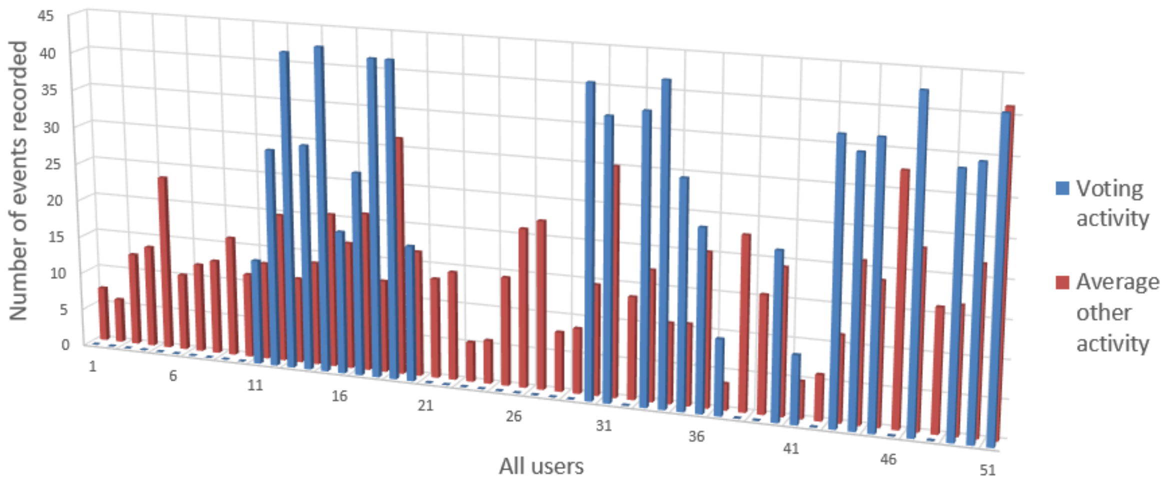


Figure 120. Voting activity compared to all other activities (Featherstone, 2022)

Flexibility is desirable

Some students preferred different parts of the app or interacted with it in atypical ways and appreciated the flexibility to do this and still make progress, student 8: “I prefer face to face conversation, so I ended up getting my friend to register me and then I’d get him to put my name in as his teammate when we did the quiz bit”. From the metrics data (see Figure 121) it can be seen that different groups of users would engage in different numbers of app activities. The majority of users would use most of the application features (groups to the left) while some users would use only a small number of application features (groups to the right).

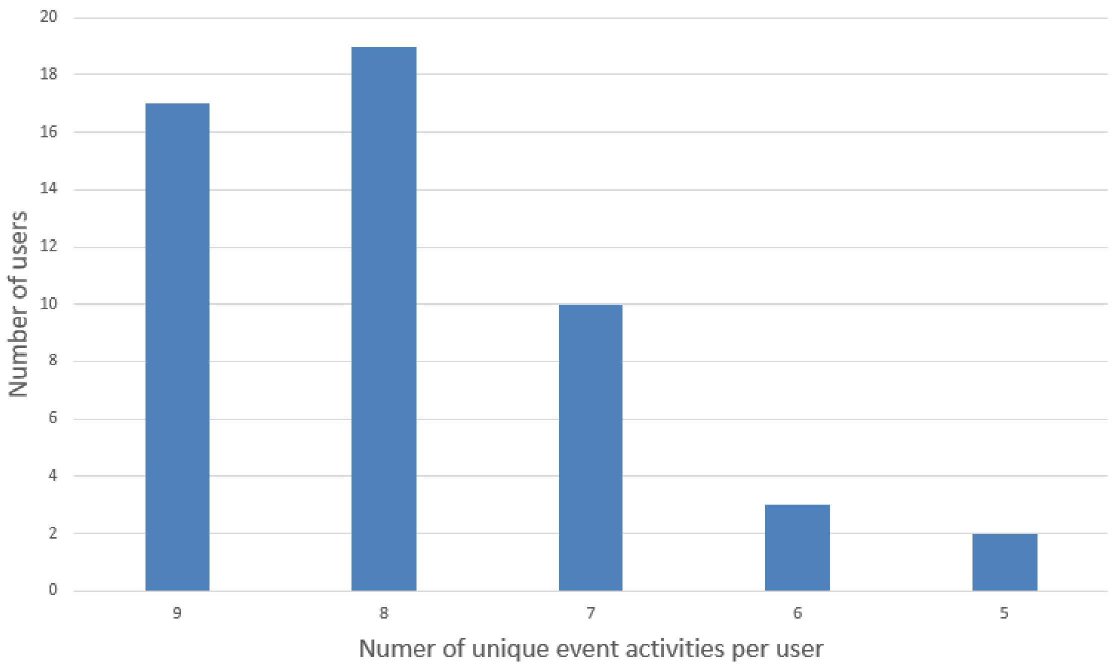


Figure 121. Number of unique activities different groups of users engaged in (Featherstone, 2022)

Don’t assume everyone understands

A minority didn’t understand why the app had game-like features, student 9: “I just used it for the voting and attendance, couldn’t see the point of the rest of it. I don’t understand why the battles are there, seems weird to me, but it was easy to use. I’m already motivated and I don’t need those kinds of features”. From the metrics data (see Figure 122) it can be seen that user behaviour varies, some take part in votes, but play few if any battles, others take part in battles, but may not vote, others do both. This may be a conscious choice or it may be as this students says, parts of the application may not be understood.

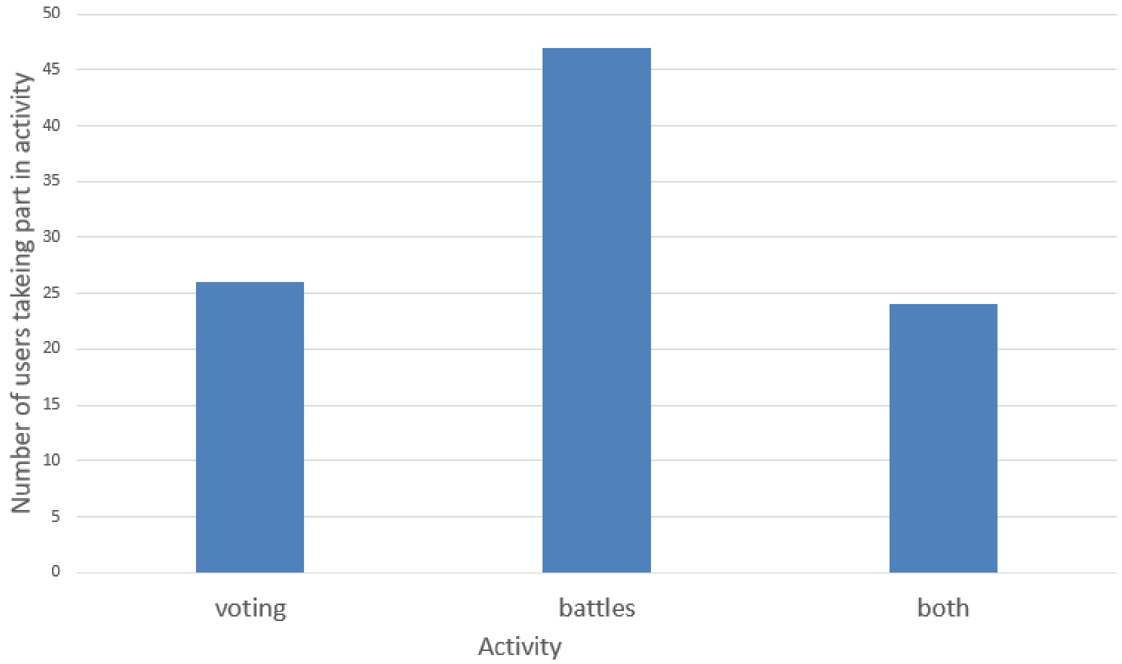


Figure 122. Users taking part in votes, battles and both (Featherstone, 2022)

Bugs and the expectation of high production values

Some students' encountered bugs, but it did not seem to prevent anyone engaging, student 13: "I used it a lot, I liked it. I like the game integration and I always wagered in lecture quizzes. I'd like to have more control in battles though, so I can control where the avatar goes. Customising the avatars is good, I like that. There were bugs though, sometimes I'd buy something and then it wouldn't refresh the items list right away. It can be distracting in tutorials, but it helps focus attention in the quizzes. My progress graphs weren't updating properly, I couldn't find my name in the progress screens. The competition is good and not stressful at all."

Voting and gamification

The university and many of its feeder schools use software from TurningPoint for multi-choice quizzes, it's not used widely in the university yet, but some students had used it previously. It is simple and has very limited gamification features, no persistence in scoring. Student 16: "I'm top 5 on the leader board, so yes I like it. It adds a bit of substance to lectures and I normally struggle in lectures to remain engaged. I don't like being talked at. Avatar customisation is good, made me want more points. Gambling bit was cool. No bad features really. It helped me with learning as I was engaged more in lectures. Game bit makes it more interactive, more substance, more personality, better than TurningPoint which is cold."

Admitting you like playing games can be embarrassing

Students' behaviour was sometimes at odds with their comments, as if they were embarrassed to admit using "a game", this was also commented on by staff. Student 14: "it was good, but what's the point? The quizzes are obviously relevant to the subject, but that's it, although I did play battles anyway as I wanted to make progress and my friends were using it. Actually, battles are the best feature." Student 18: "I don't like it, too many bugs. OK for quizzes though. TurningPoint is better though as it's less cluttered and simpler. I meant to track my progress, but couldn't get past the clutter. [smiled] I am at the top of the list though, I claimed everything straight away, everyone was using it, so I had no choice. I guess I'm competitive, I like competitive games." Student 26: "I don't see the point of it, but I'm the highest scorer in my tutorial group [grins]." From the metrics data (see Table 15) it can be seen that the majority of users played battle games, with an average of 14 separate games. It shows that the game is compulsive for the majority even if some users deny wanting to play.

Users never playing a battle game	8%
Users who did play battle games	92%
Min battles played	1
Average battles played	14
Max battles played	88

Table 15. Battle game statistics (Featherstone, 2022)

More features and content please

Students often wanted more complex features, student 17: “people could fill in whatever answer they want, that way it wouldn’t have to be just multi-choice, you could write stuff down. Plus, there should be web version so I can use my laptop”. More customisation options for the avatar was a common request, student 19: “Game should be developed a bit more, more variety in unlockable items would be good, I don’t like it when everyone looks the same.”

Even the perception of cheating is damaging

Some students suspected cheating, student 19: “cheating must be possible though, I mean I looked at the leader board and thought certain people must be cheating.” To save administration time, students could self-claim achievement rewards when they completed tutorials. Only one student admitted doing this fraudulently and the level of reward that could be “gamed” this way was very limited, but many students were aware that this could be a potential exploit. Even though it wouldn’t make a great deal of difference to the final scores, it still annoyed or played on the minds of some students.

Understanding requires time and effort

Some students didn’t understand what we were doing, even though they’d given their consent to participate, listened to explanations and been given instructions, then they felt awkward about asking for help or weren’t sufficiently motivated to get help when they had other things to do. Student 54: “I wanted to use it, but I missed the session where my tutor explained how it worked and then I couldn’t figure it out. Didn't want to ask people." Student 57: "I missed the explanation of how it all worked and didn't want to ask, so I missed out on all the attendance monitoring, ad-hoc awards, achievements stuff until recently, so I didn't get anywhere near enough coins and I couldn't catch up." Students are often embarrassed about lapses in understanding or feel responsible if those gaps are due to poor attendance.

It felt like it made a real difference

Many students felt it had helped their engagement with the subject, student 19: "voting made a difference to me, it was a better experience." Student 23: "It helped me engage more with lectures". Student 25:"It might have made my learning easier, but I really prefer reading. You can get a good estimation of where you are in your studies with it though, I like the stats, it's useful." Student 29: "I like that you get points, it's motivating and makes the quizzes more interesting." Student 38: "A good idea, it helps engage people more and keeps them on target." Student 40: "It helps make the lesson more fun for me, I zone out less."

7.9 Student Attainment

Over the course of the investigation the students were asked to complete four assessments, these were standard homework assignments that have been used for the previous two years. This subject had enrolled students from three different courses: computer science, computer science for games and software engineering. All three courses showed increased average attainment compared to the previous two-year average (see Figure 123), with students from Software Engineering experiencing the largest gain (see Table 16).

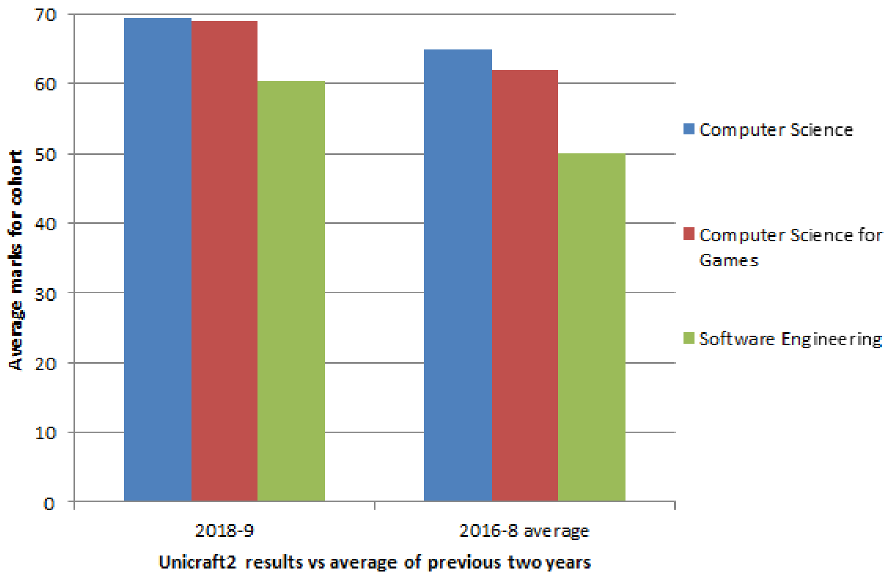


Figure 123. Student attainment over three years (Featherstone, 2022)

Course	2016-7	2017-8	Average 2016-8	2018-9	Change
C.S.	63%	67%	65%	69%	4%
C.S.F.G	61%	63%	62%	69%	7%
S.E.	50%	50%	50%	60%	10%

Table 16. Average mark for fundamentals of programming subject in semester 1 (Featherstone, 2022)

In interviews, many students said Unicraft2 made the lectures and tutorials more interesting, fun and interactive. The lowest impact was in the Computer Science cohort and this group, as a whole, scored lowest within Unicraft2 and had the lowest level of engagement of the three groups.

7.10 Summary

Unicraft2's extra videogame mechanics (battle games and wagering) caused engagement with the gamification app to increase significantly and reduced the rate at which student's lost interest in the app (see Figure 116), supporting our initial aims. There is no evidence that this gamification project negatively affected motivation (see Table 11), supporting the hypothesis. There is evidence that Unicraft2 increased attendance for the FoP subject compared to other subjects and by 11% compared to the same subject in the previous year (see Figure 107). There is evidence that interactive quizzes increase attendance and that Unicraft2 maximises that increase by embedding them within the app and its virtual economy. There is evidence that Unicraft2 caused an increase in student attainment of 7% (see Table 16). This supports the hypothesis that gamification can be effective and positive even without compulsory participation or physical reward.

8 Gamification and competition - design guidelines v2

8.1 Introduction

This chapter summarises the author's findings to create a 'best practice' guide to designing gamification systems in environments where videogames are used and maintaining intrinsic motivation is of paramount importance (such as educational settings). The author is not aware of any other similar guidelines, although aspects of these ideas are touched upon in other sources (Alsawaier, 2017; A Mora et al., 2015; Zainuddin, Chu, Shujahat, & Perera, 2020). These guidelines were developed, tested and refined with two versions of the gamification application Unicraft used within an educational context in a higher education environment, but there is nothing specific that limits their application to this setting.

8.2 Guidelines

The guidelines are a set of best practice issues with brief descriptions to help guide designers when planning gamification interventions. The guidelines are grouped into related phases of development, but range across topics, with each item explained and then a justification given.

As set out in chapter 3 and V1 of the guidelines, it's important to stress that designing videogame-based gamification is similar to designing videogames in that it is a creative process, there is no agreed ideal design and development method. Success depends largely on the experience and skill of the designer, but these guidelines should increase the probability of success.

These guidelines refer to the whole design and development process and were developed organically during the production of Unicraft 1 and 2. They are also distilled from many years of experience working in the games industry. Therefore, some are collections of existing best practice approaches and not directly linked to the hypothesis i.e. 1.1, 2.1, 2.2, 3.2, 3.3, 3.4, 4.3. While others emerged more directly from this specific research, such as group 6 and 7.

Scope

If intrinsic motivation is not important, such as with rote learning of tasks, then using this approach within a professional development context is not appropriate. If intrinsic motivation is important then these guidelines should help. The guidelines are presented in terms of an educational context and they assume:

1. Learners are familiar with videogames.
2. Adequate provision and familiarity with suitable mobile devices.
3. Learners are familiar with gaming terminology, themes and imagery.
4. Voluntary participation is appropriate.

If items 1 or 2 or 3 are not true then these guidelines are still appropriate, but learners will need more introductory support. If item 4 is not true, for example, there's a requirement to use the same software to monitor attendance, this approach is not appropriate. Voluntary participation is crucial to avoid negatively impacting intrinsic motivation.

1. **Before you begin development**

    1.1. **Use an experienced designer with game development experience**

    Making gamification close to a videogame requires a designer with videogame development experience and gamification experience.

    Why?

    Although there is a great deal of literature on both gamification and videogame design, it is a creative process that is context sensitive. There is no single set of instructions that can be followed that will guarantee success. Using an experienced designer increases the probability of success.

    1.2. **Understand the problem from the users' perspective**

    Consult with potential users and facilitators to identify real problems and goals. Be prepared to build multiple prototypes for users to test. It is often important to make an activity more fun, to teach users how to do it more accurately, to encourage them to do it faster and to get them to attend. What is it that would help your particular users, let that guide gamification design.

    Why?

    Gamification tries to make real-world tasks more fun and sometimes there's an assumption that points, leaderboards and badges will achieve that regardless of the context. However, facilitators and users will have differing needs depending on context. When this is understood, it will also be easier to identify if intrinsic motivation is actually important and requires protection.

1.3. Specify in detail what will be measured

Specify early in the design phase what will be measured in detail. Users should be able to see the connection between the measure and the real world activity they are attempting to improve. Users will then use this measure to compete and compare progress. Users should not be able to exploit or cheat using the measure.

Why?

For users to take part in competition, to compare progress, to understand their progress, to willingly accept judgements made about their progress (or quality or speed), they must understand and agree with measurements that are made about them. When measurement is clear, it is easier to understand if and how it relates to the factors we are attempting to improve. Identifying measures early ensures there is time to consider how users might attempt to exploit those measures. This guideline links to 4.2 Use metrics to monitor **users**.

1.4. Match the production values of contemporary videogames

It is important that gamification software looks and feels like a videogame. This requires more complex game design and higher production values, both of which increase costs. This can be offset by ensuring the application remains applicable to multiple domains.

Why?

It's possible to increase engagement by increasing relevance, which can be done by embedding learning activities within the application. However, ultimately this would result in an educational game applicable to a single domain. Where gamification is more generic, it is more flexible and more easily applied to many domains, justifying higher development costs. For example, quizzes in Unicraft2 embed learning, but are domain specific. However, they are easily modified to apply to another domain.

2. Maximise buy-in of players

2.1. Minimise administration burden

Consult teaching staff facilitating the educational activity early in the design process. They will need to instruct new users, register them, ensure they can participate, support them. This all needs to fit alongside existing practice with minimal disruption and time overhead. Any desired changes in the activity should not be blocked or delayed by gamification issues.

Why?

Staff administering or monitoring the real-world activity will be hesitant in taking on yet more administrative burden with a gamification intervention. Once they can see the benefit in their users then they will be more enthusiastic, but this can be optimised if the application has minimal management overhead and is flexible to accommodate existing practice.

2.2. Maximise device compatibility

Mobile devices are ubiquitous in society now and can be cheap to provide for those who lack a suitable device. As they are handheld and portable they are very flexible in terms of when and where they can be used. Any application developed should work with as wide a range of devices and screen sizes as possible without over taxing potentially aging batteries.

Why?

Users don't like carrying around special devices, they want to use their own device, which could be a laptop, PC or tablet – but is more likely to be a mobile phone. Mobile phones come in many different configurations, some iOS, some Android, some powerful with large screens, some old and less powerful. Where a user will tolerate being given a device, applications can be developed to work on basic hardware that is cheap for an institution to provide, but only if this is a development requirement.

3. Make it attractive to new players

3.1. Let users create their ideal virtual representation

If a user can customise an avatar, personalise it, and get close to their ideal image/fantasy they are more likely to care about what happens to that avatar and want it to make progress.

Why?

The more customisation is available to avatars the more users respond to the 'game' as they can better personalise the avatar to represent their ideal image. They project value onto an avatar they see as closely resembling themselves and this makes the virtual rewards also have value, even though they are outside the real world.

3.2. Focus on the aesthetics

Skilled artistic and design involvement is necessary to create something that is aesthetically pleasing, as is extra design and development time. Videogames look cool and fun, it is a major part of their appeal, whether it's science fiction, modern day, historical settings or medieval fantasy. However, videogame technology is constantly advancing and the gamification project must avoid looking outdated or old fashioned.

Why?

If we create a gamification app that convincingly looks and sounds like a videogame then it will be more attractive to a wider range of users. When something is inherently attractive people are more likely to try to engage with it. This is particularly important with gamification projects that are trying to protect intrinsic motivation and taking a 'light weight' approach and therefore need to be as attractive as possible (as users are not forced to take part). The pace of technological change within videogames means people are likely to react negatively to something that looks outdated and old fashioned.

3.3. Present it in terms of videogame themes

Use common videogame genres and metaphors when designing gamification applications. Videogames are so widespread in society and so recognisable to users that they can immediately signal that an activity should be enjoyable and not stressful. Videogame genres can also link into the activity in a non-patronising way to signal that the activity is designed in a non-aggressive and non-threatening way (e.g. Animal Crossing, Super Mario, etc.).

Why?

Correct use of common videogame genres and design metaphors can immediately signal to users that something is meant to be fun, inclusive and non-threatening.

3.4. Craft a cohesive story

Create a narrative, a fiction, that binds the gamification experience together and justifies how the game looks and works.

Why?

Most videogames rely on story to create atmosphere, belonging and motivation to complete. Even when there isn't an explicit story, careful narrative design creates a sense of place and cohesive logic to the themes and rules. A cohesive narrative, look and theme can help users understand their place in the game and how things work. For example, dragons love gold, sci-fi settings don't usually feature magic, immortal beings can't die, heroes battle monsters, etc.

4. Monitor and support your players

4.1. Specify your anti-cheating measures

Consider how you will authenticate user progress and favour human validation by authorised staff. Check game designs for dominant strategies and the potential for exploitation. Use metrics to check live systems and detect any users who are cheating as early as possible.

Why?

Users will soon lose faith in a gamification application if they believe others are cheating, even if they aren't. A sudden and unexplained increase in progress on a leaderboard or battle game will raise suspicion. If measures of progress don't really align well with the real-world activity and a user that is perceived as weak by their cohort suddenly makes great progress – this will be suspicious. Users will be quick to assume exploits or cheating are occurring and then they will be less likely to engage. Nobody enjoys comparison that is perceived to be unfair. Software quality assurance often relies on post release updates, if users find an exploitable bug and faith in the robustness of your system is lost, an update may be too late.

4.2. Use metrics to monitor users

Once you begin using a gamification application you have to record basic data on progress to be able to interactively display that to users. Therefore, it's only a small step to include administrative data, as many videogames do, especially in the mobile sector, that is only visible to administrators. This guideline links to 4.1, but is an important facility beyond just cheat detection as it also supports optimisation. Always follow GDPR best practice.

Why?

With public and private metrics you can answer questions such as: how many people are actually engaging right now, which parts of the gamification application are most or least popular, what aspects are never used (perhaps because users don't understand), is there any atypical behaviour which might suggest cheating, etc. With metrics you can spot problems and opportunities early and take advantage of them. This guideline also links to 1.3 Specify in detail what will be measured.

4.3. Provide offline and online help

Where users are free to participate as they like, start and stop, use some gamification features and not others, they need on demand access to instructions and help. You should consider:

- Context sensitive help within the software for users who have forgotten how it works.
- Offline video tutorials to refresh users' memories.
- Support drop-in sessions.

Why?

Users soon forget what they are meant to do or are too embarrassed to tell an administrator that they do not understand. When participation is not compulsory, even small obstacles can be enough to prevent engagement. A mix of in-app help, offline documentation, support drop-ins and clear communication can minimise drop-out.

5. Protect intrinsic motivation

5.1. Avoid real-world reward

Users must feel free to express their imaginations and independence in the real-world activity, so every care must be taken to avoid the gamification intervention being perceived as controlling or inappropriately coercive. Users must genuinely believe they don’t have to participate if they don’t want to. Removing physical reward is an important step, but more difficult is ensuring there is no perceived real-world reward (which connects to the importance of anonymity 7.1).

Why?

When a user feels constrained or controlled within some real-world activity, then their intrinsic motivation for that activity can fall. With activities like education, intrinsic motivation is key to maximise learning. The more valuable a reward is in the real world the more important that reward becomes to the user, to the extent the activity becomes secondary to the reward.

5.2. Do not force users to participate

Similar to (5.1) users cannot maintain a sense of independence and agency if they are forced to take part in gamification, it should be optional.

Why?

It’s often difficult to have some users taking part and not others, especially as those not taking part must feel no disadvantage. However, this is key to maintaining intrinsic motivation. Mechanisms that allow a user to ‘catch up’ with their peers helps facilitate engagement when participation is not compulsory. This is an important part of a ‘light touch’ gamification design.

5.3. Encourage flexible user participation

Remove all barriers to participation. Users are not being coerced into taking part, therefore it’s very easy for any kind of barrier to end their participation. They should be able to take part at any time or in any place, their choice. Also, gamification that offers rich participation will inevitably offer multiple ways to engage, there shouldn't be an assumption that the user will engage equally with all of them. For example, if a user wishes to monitor the cohort's progress, but not take part in battles, that should be allowed.

Why?

People have overlapping, but different likes and dislikes as described in 'Player typologies'. Gamification should be designed in a way that facilitates users to engage with the aspects of the design they like and ignore those they do not like while still being able to participate meaningfully.

5.4. Use gambling wisely

Ensure virtual rewards (wagers) are capped low and used sparingly, for example, getting a quiz question correct might only double the 'pay out' on a virtual currency bet that itself is limited to a low maximum value.

Why?

Gambling is so powerful that it can easily become addictive and destructive. If a user's maximum bet and winnings are limited, then gambling's negative potential is minimised (this complements 'no real-world reward' 5.1 and anonymity 7.1).

6. Keep players interested

6.1. Give users rich feedback on progress

Feedback should be given regularly and make use of sound, icons, text, video to coach users into making the desired choices e.g. handing in work on time, regular attendance, etc.

Why?

Good videogames provide reach feedback to users on what they are doing correctly and incorrectly. People are often presented with problems in the real world that have no correct or incorrect answer, no feedback on the decisions made (e.g. should I take out a mortgage and buy that house?). One of the attractions of videogame-like experiences is decisions can have instant right/wrong feedback, resulting in quick, satisfying progress.

6.2. Maintain awareness of fun, compulsive, enjoyable elements

If users are free to engage or not at any time then expect their participation to vary, they may forget about the gamification project unless they are gently reminded. For example, showing animated battles on communal area monitors. This is more powerful than a simple leaderboard, which is quite a static display. A 3D battle featuring cartoon like avatars and monsters looks visually rich and dynamic and attracts people’s attention. This should be done without forcing anyone to pay attention, for example, having the battle play out at the start of a lesson while people settle in.

Why?

Users have real lives and conflicting varying demands on their time. Expect them to forget to bring a device, not update the software, forget to use it, be off ill when something is explained, etc. Gentle reminders help maintain engagement by reinforcing desired behaviour and prompting those who may have simply forgotten.

6.3. Present meaningful choices

Users need to maintain their feelings of agency and independence so must be presented with meaningful choices that influence outcomes. For example, buying a virtual item to make their avatar more attractive verses an item that makes their avatar more powerful.

Why?

Gamification seeks to reward real-world activity, but allowing users more choice over the experience reinforces intrinsic motivation and delays fatigue. In terms of the real-world activity that means letting the user decide when and what do from a range of valid alternatives that all result in in-game progress. Similarly, in the virtual world of the game, allowing the user to make decisions that have genuine impact on game progress or their avatar.

6.4. Reward users often

Although rewards must be purely virtual, they are still powerful extrinsic motivators and should be given in line with positive reinforcement theory – regular but random times (see ‘6.1.3.2 Are rewards addictive?’).

Why?

We are purposefully removing a lot of 'heavy weight' extrinsic motivators i.e. compulsory participation, real-world reward and PvP competition. Therefore, we need to ensure we still have a compulsive experience without them. Regular rewards are still very compulsive even when the reward has no real-world value.

6.5. Vary reward value

Reward value should vary slightly randomly, very occasionally being of great value.

Why?

Usually in a gamification system, the user does something positive in the real-world activity and receives a virtual gamified reward. Videogames often use positive reinforcement reward cycles to make progress more exciting. Making progress should always trigger reward, but slightly unpredictable rewards are more exciting and compulsive (Taneja, 2020).

6.6. Reward users with something to collect

Let users collect progress badges and virtual items for their avatars to increase the compulsiveness of the gamification. A reward should be related to collectable virtual items, i.e. a reward of virtual currency to buy collectible items, a reward of unlocking (opening) access to new collectible items.

Why?

Collecting and displaying your collection is a powerful compulsive extrinsic motivator and collecting badges to signpost progress is a classic gamification trope that does work. However, if users are presenting themselves via anonymous 3D avatars then there is an opportunity to collect virtual outfits and equipment to decorate those avatars and then show that avatar to peers. This mechanic has been used successfully in many videogames and makes 'collecting' even more compulsive.

6.7. Add content to maintain interest over time

Hint at new content that will be available if progress is made, for example, describing in detail all the activities, badges and achievements available in level 1, but showing the user there is a level 2 and only hinting at what new things might be available. Tell the user there are new enemies, equipment and decorative items once a certain amount of progress is made.

Why?

All videogames add content incrementally otherwise users are likely to become bored and stop playing. Often new future content is only hinted at to add an element of curiosity and surprise. Gamification through videogame themes has the same requirement. When a user gets to a new level there should be new things to see, enemies to fight, new virtual items to buy. Demonstrating your mastery via the public display of virtual equipment and trinkets is compulsive, especially when those items are rare or represent advanced progress.

7. Make it compulsive in a positive and constructive way

7.1. Enable anonymity, but allow comparison

The use of avatars and nicknames gives users something they can identify with and project onto, but no other user should be able to identify them. Once users are aware of each other's progress they will obviously talk to each other and try to identify participants, this should be discouraged, but is the user's choice.

Why?

If a user cannot be identified then they can feel comfortable to experiment with participation, to drop out and re-enter later. This flexibility is important in scaffolding intrinsic motivation. However, it's important that users can see the progress and decisions other users are making and hopefully be influenced to engage.

7.2. Let users influence the outcome

Where actual game play exists within gamification applications (like the battle game in Unicraft2) it must not detract excessively from the real-world activity, it cannot take excessive amounts of user time. However, it's an important intrinsic motivator to have influence over game outcomes directly, just like an actual videogame. Ensure game play is designed to be time limited.

Why?

When a user feels they have influence over a reward, the experience becomes more compulsive. In a basic sense this is obvious, the user performs the real-world activity correctly, faster or to a higher standard of quality – they get more rewards. However, the compulsive power of rewards can be magnified if users can gamble their virtual winnings and if elements of gaming that requires skill are used (e.g. manually clicking on hearts in battle games in Unicraft2). However, you are not making a standalone videogame, you are gamifying a real world activity, so time away from that activity should be limited.

7.3. Create compulsion via constructive competition

There must still be compulsive extrinsic motivators within gamification, such as competition or making wagers. Where we seek to reduce negative motivators (e.g. PvP competition, compulsory participation, real-world reward) we must have others to keep gamification compulsive. Competition is a very powerful tool and can be designed in a constructive way:

- Winning has no real-world benefit.
- Not compulsory.
- Fights are PvE, not PvP.
- Play in teams.
- Use player matching.
- Game death or failure is not wasted time as progress is still made.
- Participant avatars are anonymous, customisable and look like videogame characters.
- Wagers provide limited extra rewards.

Why?

Competition is highly compulsive. It is such a powerful motivator that it can overwhelm the user and become a very negative experience. This is why competition should be used only when it can be implemented constructively, but it is important if you want users to remain engaged for as long as possible.

7.4. Create compulsion via embedded learning activities

If part of the real-world activity can be embedded within the game-like elements of the intervention then users will be more likely to engage and stay engaged. However, this must be balanced with item 1.4 Match the production values of contemporary videogames.

Why?

Traditional gamification was often perceived as separate from the real-world activity and of no actual value in itself. Users will perceive the gamification elements as having intrinsic worth if they are more directly connected to the real world activity. For example, in an education environment, if the gamification application involves a quiz based on the subject being studied.

8.2.1 Adopting the guidelines

It's not effective to take a small number of these guidelines and apply them in isolation, it could even be problematic, for example, using gambling or competition without safeguarding their implementation through the other principles mentioned. Videogame design is a holistic process and as gamification becomes more videogame-like then the design process becomes increasingly similar. The most optimal game design could easily be ruined if just one element was poorly implemented e.g. the perfect game, but with a poorly implemented difficulty curve.

Although presented and evidenced within an educational context, the guidelines are quite generic with a wide variety of possible applications within and outside educational environments. However, repeating this experiment within non-educational contexts would be required to develop good evidence for its use outside education.

8.2.2 Guideline references

These guidelines refine and expand those in version one.

1.1 Use an experienced designer with game development experience

Although not mentioned in the original guidelines, as it became clear how closely good gamification applications match the design of videogames (see 2.11.1 Successful gamification case studies) there was greater reliance on the author's own industrial game design and development experience.

1.2 Understand the problem from the users' perspective

It became clear in the second experiment that staff facilitating the project had a variety of concerns and requirements that needed to be considered 7.8.1 Staff interviews, and that success was heavily dependent on the confidence and engagement of those staff.

1.3 Specify in detail what will be measured

As gamification uses measurements of progress or quality within the real-world task to allow players to compare performance, there is a need for a formal approach to specification, see 5.1.1 An iterative design process. Measurement decisions also affect player behaviour, see 5.4.3 Cheating.

1.4 Match the production values of contemporary videogames

This matches item (2) in the original V1 guidelines as discussed in 4.1.3 Production values and 4.1.4 Matching mobile user expectations.

2.1 Minimise administration burden

To limit negative player behaviours (see 5.4.3 Cheating) there is a tendency to require administrators to authorise progress, but this can create an excessive time overhead (see 7.8.1 Staff interviews).

2.2 Maximise device compatibility

Interviews with players showed how important it was that they could use their own personal devices, even when alternates are provided, see 7.8.2 Student interviews.

3.1 Let users create their ideal virtual representation

As players project their identity onto an anonymous avatar they begin to care about their representation and it provides value to the virtual items they are trying to buy, see 4.1.5 Avatars.

3.2

Focus on the aesthetics

The importance of players perceiving the gamification software to be cool, fun and videogame-like was discussed in 4.1.3 Production values and 4.1.4 Matching mobile user expectations.

3.3 Present it in terms of videogame themes

In 2.3 Videogames, the history and widespread social acceptance of videogames as fun activities is explained. Common videogame themes can be seen in successful gamification applications, see 2.11.1 Successful gamification case studies.

3.4 Craft a cohesive story

Well-designed themes that link to a strong narrative promote understanding and increase compulsion. Stories that reinforce and explain a game's rules and aesthetics are common in videogames, educational games (see 2.5.1 The challenge of Intrinsic Integration) and successful gamification applications, see 2.11.1 Successful gamification case studies.

4.1 Specify your anti-cheating measures

It was clear from the literature that cheating is an important issue requiring mitigation (see 2.7 Cheating) and it soon became a problem in these experiments, see 5.4.3 Cheating and 7.8.2 Student interviews.

4.2 Use metrics to monitor users

Live data collection in videogames (to aid testing, optimisation of game play and cheat detection) is commonplace and equally applicable to gamification software where it allows more detailed and varied comparisons of player progress (see 5.3.2 Metrics, monitoring and cheating) and was instrumental in quickly identifying cheating resulting from exploits (see 5.4.3 Cheating).

4.3 Provide offline and online help
It was noted in the interviews with players (see 7.8.2 Student interviews) that some people did not understand how to use Unicraft or the overarching goals of gamification and so we were unknowingly excluded. The introductory talk explaining the project and software should have been videoed, and the software should have contained context sensitive help.

5.1 Avoid real-world reward
This matches item (3) in the original V1 guidelines and is a common weakness in traditional gamification as discussed in 2.12.1 Avoiding negative side-effects.

5.2 Do not force users to participate

This matches item (4) in the original V1 guidelines and is a common factor in 2.11.1 Successful gamification case studies.

5.3 Encourage flexible user participation
The interviews (see 5.3.4 Interview analysis and 7.8.2 Student interviews) and metrics (see chapter 7 Study 2: Evaluating Motivation) showed that players vary in how they want to use gamification software and so this should be supported.

5.4 Use gambling wisely
Wagers were introduced to Unicraft2 to increase compulsion, but this had to be balanced against the danger of addiction (see 6.1.3 Virtual currency) and players did indeed report it was very compulsive, see 7.8.2 Student interviews.

6.1 Give users rich feedback on progress
The importance of giving players rich feedback has long been understand in videogame design and comes up repeatedly in this dissertation, see 2.2, 2.4.2 and 2.5.

6.1 Maintain awareness of fun, compulsive, enjoyable elements
From the interviews with players (see 5.3.4 Interview analysis) and administrators (see 7.8.1 Staff interviews) it was clear that players needed regular reminders of the positive elements of gamification. Without compulsory participation and with busy timetables, their attention would naturally shift to other things.

6.3 Present meaningful choices

This matches item (1) in the original V1 guidelines and is an established aspect of traditional game design theory. It can be seen as a common factor in 2.11.1 Successful gamification case studies.

6.4 Reward users often
This matches item (5.1) and (5.3) in the original V1 guidelines and increases compulsion in line with 6.1.3.2 Are rewards addictive? and mitigates the disappointment that failure can bring as discussed in 2.12.2 The Potential of Competitive Challenges.

6.5 Vary reward value
Varying reward value increases compulsion and is part of operant conditioning, see 6.1.3 Virtual currency.

6.6 Reward users with something to collect
Collecting is a naturally compelling activity for many people (see Player typologies) and was a popular feature in Unicraft1 (see 5.3.1 Group Results) and Unicraft2, see 7.5 How usage changed pre and post battle game activation.

6.7 Add content to maintain interest over time
People naturally lose interest in playful activities over time, see 2.9 The long tail. Unicraft2's large selection of virtual items, some not available at the start of the

game and weekly quizzes, kept players engaged for longer (see 7.5 How usage changed pre and post battle game activation and 7.8.2 Student interviews).

7.1 Enable anonymity, but allow comparison

Gamification relies on people's inherent desire to compete once comparison between participants is facilitated, see 2.5 Features of Gamification. However, to increase the chance of constructive competition, participants must be allowed to remain anonymous, see 2.12.2 The Potential of Competitive Challenges.

7.2 Let users influence the outcome

In traditional gamification the only way to influence your rank is to perform the underlying real-world task, but where an actual videogame is used (as with Unicraft) a player would expect to be able to play directly, see 2.3 Videogames. Gambling allows players to amplify the results of performing the underlying task making it more compulsive, see 6.1.3.4 Safer gambling and education and 7.8.2 Student interviews.

7.3 Create compulsion via constructive competition

This matches items (5.2, 5.4, 5.5 and 5.6) in the original V1 guidelines and was confirmed in the results in 5.4.4 Competition is compelling and can be constructive. It draws on a wide range of traditional game design theory as discussed in 2.12.2 The Potential of Competitive Challenges.

7.4 Create compulsion via embedded learning activities

Gamification provides a more flexible solution than an educational game (see 2.4.2 Gamification or educational game?), but feedback from the first experiment showed engagement could be enhanced by some level of integration within the learning activity (see 5.4.5 Engagement) even though that reduces flexibility. A balance must be achieved.

8.3 Summary

These guidelines provide a useful template for developing constructive gamification projects in situations where it is important to maintain levels of intrinsic motivation. The importance of involving experienced designers cannot be understated due to the creative nature of videogame-like gamification projects and the limitations of gamification when it only uses a small subset of game design principles.

8.3.1 The transition from V1 to V2

V1 of the guidelines was driven by some key insights drawn from the literature on gamification and the author's experience as a game designer and developer. Namely that:

- Gamification doesn't go far enough in resembling a videogame and so has to rely on real-world rewards and compulsory participation to try to force engagement.
- It is often seen as a clumsy, manipulative attempt to make the real-world activity fun.
- If gamification were closer to a fun modern videogame, people would be more inclined to engage with it and there'd be no need for the coercive elements.

The results of the first experiment indicated that these ideas had merit. However, without the more coercive elements it became clear that a fine balance was needed to maintain the correct level of player engagement. In flow (see 2.4.2

Gamification or educational game?), the game designer attempts to keep the player in an optimal state of engagement, not too easy or they become bored, not too challenging or they become stressed. A similar problem faces the gamification designer. With participation optional and no real-world reward, the designer must use constructive competition to maintain engagement, but cannot allow gamification itself to become too compulsive. The player must be kept in the ideal state of engagement:

- If gamification becomes boring the player is quick to stop playing and therefore the game has no chance to influence the player's engagement with the real-world task.
- If gamification becomes too compulsive the player loses intrinsic motivation, is tempted to cheat, spends time away from the real-world task or becomes stressed.

V2 guidelines therefore expand to cover more subtle aspects of game design:

- Removing any obstacles to engagement that might easily disrupt play for someone who has no investment in the game (i.e. there is no real reward, they don't have to take part).
- Nurturing player interest via:
    - Supporting a wide range of personal hardware.
    - Providing a range of channels to access help and support.
    - Reminding players of the fun they could be having.
- Maintaining player interest over time with new content to prevent their inevitable fatigue.

It became clear that compulsion is nurtured in many ways, some with far greater potential (and hence danger) than others. Listed here in order of compulsive power, low to high:

1. Presenting the software as something that looks and feels like a videogame.
2. Replacing real-world reward with virtual currency.
3. Allowing players to customise virtual avatars.
4. Collecting virtual items of decoration to enhance their avatars.
5. Viewing their avatars in a shared tournament, a gladiatorial spectacle where they are both the crowd and virtual participant.
6. Competing with their peers in battle.

After the first experiment the metrics showed that Unicraft needed to be more compulsive to maintain engagement for longer, but increasing the compulsiveness of the battle competition put the constructive approach at risk. It was also apparent that players could see this game was too remote from the underlying real-world task and this was also increasing drop out.

These two issues were addressed directly in the second experiment and therefore influenced V2 of the guidelines. Gambling was introduced, a very powerful extrinsic motivator, but it was felt that a similar constructive design approach, which had moderated the inherent compulsiveness of competition could also be applied to wagers. Quizzes were introduced, tying Unicraft more closely to the real-world learning activity without losing the flexibility of gamification.

Many of these issues resemble common problems faced by mobile game designers. Mobile games were initially selected as inspiration, because:

- They are commonplace in wider society (Clement, 2022).
- They are seen as fun.
- They use the same platform as Unicraft, the tablet or mobile phone.
- They are recognisable as videogames.
- They are usually not as technically complex as other types of videogame and so it's easier to match their production values.
- They usually do not contain deep gameplay and tend towards short play sessions.

However, the experiments revealed other similarities that required consideration within the guidelines:

- Mobile games are usually initially free and so players have no great compulsion to play.
- Players are quick to stop playing something that they have no commitment to, if it contains any obstacles to engagement (i.e. too complex, too boring) or doesn't work on their favourite device.
- Some have generated a lot of negative press by leaning too heavily on compulsive, addictive game design.

9 Conclusions and Reflections

Gamification has great potential, but its impact on settings where intrinsic motivation is important is problematic, “what if we can make learning as addictive as TikTok or Angry Birds. Wouldn’t it be incredible if kids were just on their smart phones and they were learning? It would be fantastic, but the jury is very much still out, and it hasn’t happened yet” (Rajan, Beard, Hood, Sheikh, & Gemmill, 2021). It would indeed be fantastic, but only if the kids were genuinely learning. This study has explored a gamification design approach that is more likely to maintain levels of intrinsic motivation while presenting an attractive compelling videogame-like experience.

9.1 Human vs automated assessment of progress

An iterative design process is needed to identify the tasks to be gamified and establish how progress, performance and quality can best be measured (see 5.1.1 An iterative design process). With each design cycle, the tasks being measured naturally become more prescribed, often modified to support 'cheat proof' measurement. Relying on humans to make the measurements and meet out the rewards is costly and time consuming, so there is an incentive to use automated testing, but that is more prone to cheating and therefore the task and its measurements become ever more prescriptive and 'machine friendly'. If creativity in the underlying task is valued then there is a trade-off to consider between the cost of human assessment and the prescriptive nature of automation.

9.2 Maintaining interest

As Unicraft2 is not compulsory, student interest, expressed through recorded interactions, can be seen to decline over time, with the extra videogame mechanics introduced at the mid-way point acting to reduce the rate of decline. Common reasons students use Unicraft2 are because they perceive it as fun and/or compulsive and/or useful. It must compete for the students' limited time with all the other fun, compulsive and useful activities that fill their day. Those perceptions decline over time and activities are often replaced by others seen as more fun, novel, compulsive or useful. Therefore, the decline is inevitable, usefulness has the biggest impact on slowing rate of decline and this was noted in the interactive quizzes and the students' ability to monitor progress through tutorial activities. For the app to be seen as useful it must have features students perceive as directly relating to improving their subject performance. There was evidence for this in the interviews where multiple students asked to be able to solve programming problems directly within the app or to have quizzes take place in tutorials as well as lectures. However, specificity reduces flexibility and moves a gamification application closer to an educational game (with the associated extra development costs). A balance must be maintained.

9.3 Sensitivity to delivery

Through staff interviews, it became clear that the subject leader, who was first approached about the study, felt most effective in explaining, motivating and engaging students with the app. The two supporting tutors felt less effective in promoting, explaining, managing and organising students' use of the app. The results show how sensitive non-compulsory gamification is to the confidence and effectiveness of those administrating, delivering and promoting it. The app itself must shoulder some of the blame for this, if it could have been more tightly integrated into learning, worked more reliably, been more flexible to fit within staff practice then delivery would have been more consistent.

Through student interviews, it was noted that the game development students were more interested and enthusiastic about Unicraft2, which is understandable considering they are attending a videogame development course. This shows how sensitive constructive competition is to the participants experiences and perceptions of its usefulness and value.

When an activity is not compulsory and there is no real-world reward, then it becomes very sensitive to participant (and administrator) perception of value, fun and usefulness. A whole range of factors influence the participant’s engagement and failure in just one can be detrimental.

9.4 Impact on motivation

By avoiding real-world reward and compulsory participation and relying on constructive competition, it was hoped that Unicraft2 would not have any negative effect on intrinsic motivation. The ‘motivated strategies of learning’ questionnaire was used to assess impact on motivation and no statistically significant change was measured. This shows it is possible that gamification can be implemented in situations where autonomy and creativity are valued, without reducing intrinsic motivation.

9.5 Attainment

Student attainment showed an increase, compared to the previous two years' worth of semester one marks, of 7% overall. The student cohort with the lowest engagement in the project, Computer Science, also showed the lowest increase in attainment (see Table 16). It wasn't possible to compare further back in time as assessments are periodically renewed, making comparison inappropriate. This does show that gamification can have a positive impact on attainment in an educational setting, but that impact is proportional to the student (and administrator) perception of the intervention.

9.6 Contribution to knowledge

In section 2.11.2 several examples of gamification projects are discussed that were perceived by users as controlling and unappealing. Then in section 2.11.1 positive case studies are presented that involved designs closer to 2D videogames, suggesting that emulating videogame design tropes aids the perception that these are fun activities. Unicraft2 takes this idea further, utilising 3D game environments, avatars, fantasy settings and simple game mechanics that are similar to popular 3D mobile games. The user interviews in chapter 7.8 indicated students did generally perceive the app as a fun activity.

9.6.1 Theory

This work helps confirm the positive impact of constructive competition theory in designing gamification interventions for educational settings. It identifies a range of existing theories, both within gamification and game design, with the contribution to knowledge focused in how they are used holistically to increase engagement without sacrificing intrinsic motivation. It develops the idea that there is no way to guarantee success in gamification, but a range of best practice is identified that will increase the probability of a successful gamification project that preserves intrinsic motivation, when skilled and experienced game designers are involved.

In section ‘7.3 Attendance’ it was shown that Unicraft2 increased attendance by 11% and section ‘7.9 Student Attainment’ showed an attainment increase of 7%. These results would be irrelevant within an educational setting if intrinsic motivation was negatively affected (as was often the case in traditional gamification), but section ‘7.6.3 Motivation results’ shows there was no statistically significant change in intrinsic motivation or any of the student attitude scores.

9.6.2 Practical guidance

These guidelines are written by a gaming/gamification designer and are for gaming/gamification designers. They are ready to be converted into practical teaching/training materials for professionals and could be used as part of professional training or certification courses.

Moving the design closer to that of a commercial videogame has a positive impact on the level of user engagement. Avoiding real-world reward or compulsory participation meant it was easy for users to disengage without any penalty. However, from the interviews and metrics in chapter 7 some students found the videogame elements compelling and remained engaged, partly to see their avatars develop and improve their performance in battles. This is similar to the factors driving engagement in commercial competitive videogames where participation is also voluntary.

Making the application compelling is key to maintaining levels of engagement and competition is one of the most effective ways to do that. However, section 2.5.1 discusses how potentially damaging this can be to intrinsic motivation, which is vital in an educational setting. In chapter 7, this study showed that compelling competitions can be designed constructively such that they engage users without damaging intrinsic motivation. These findings are generalised in chapter 8 into a set of guidelines for designing videogame-like gamification projects focused on constructive competition. These guidelines have application within educational settings, but are general enough to apply to any setting where autonomy and creativity are valued. They will increase the probability that participants' intrinsic motivation will be preserved.

9.6.3 Policy

These guidelines could have a positive impact on gaming industry gamification practitioners and educational institutions teaching gamification, as they define a design approach appropriate for situations where intrinsic motivation must be maintained. Where there is training or certification then these guidelines could form part of a standardised ethical approach to design and implementation. Gamification can have unwanted negative side-effects and certification would ensure commercial clients are confident that their training provider or implementor are appropriately trained game designers.

When gamification is applied to groups where intrinsic motivation, creativity and agency are not seen as important, then the guidelines developed here are not appropriate. Traditional approaches to gamification such as points, real-world reward, leaderboards, competition, etc., are easier and cheaper to implement without requiring specialist game designers.

9.7 Future work

The Unicraft2 app appears very promising, with no negative measures and the expected positive impacts on student experience and attainment recorded. This should be verified by repeating the experiment with a larger control group. Software development is an iterative process and no application can ever be perfect, Appendix F – Unicraft3 provides a specification for an improved Unicraft application.

9.7.1 Limitations of study

The studies discussed in the dissertation had a number of limitations:

- They were carried out in the author's university department and therefore participants were computing students who could be predisposed to enjoy games based technology. A study with non-computing students should be undertaken.
- The studies aligned with university timetables over a semester, a longer study should be undertaken to confirm the results.

- The students were mainly male due to the male gender bias of students generally within the computing department. A study with more female participants would be appropriate.
- Due to ethical and practical constraints, participants were drawn from pre-defined tutorial groups, with students grouped by surname, so it isn't a true random sample.

9.7.2 A reusable server structure

The web database backend could be extended to support multiple gamification projects and deployment of software in different institutions. This would allow Unicraft to be used in different settings with different groups of users and the concurrent deployment of new versions of the software, all sharing the same backend data service via unique accounts.

9.7.3 Adoption within higher education

Version three of Unicraft, with support for multiple deployments and administration via separate logins could be presented to other courses and other institutions as a way to increase student engagement.

9.7.4 Teaching material

Once the software is mature and there are multiple successful trials the guidelines could be expanded into teaching materials to train gamification designers. New software could be developed utilising the backend server structure to accelerate development time.

9.7.5 Adoption within wider industry

With multiple successful deployments, teaching materials and a generic server infrastructure an industrial partner could be identified and apply the guidelines and technology outside higher education and enter the private sector.

9.7.6 Summary

This study has shown that constructive competition and videogame mechanics can have a positive impact on student experience (in a higher education setting) that doesn't reduce intrinsic motivation, with evidence for increased attendance and attainment. Gamification can make lessons more fun and engaging, but voluntary participation is very sensitive to a whole range of measures (e.g. app sophistication, staff delivery, perceived usefulness, integration within the course and ease of use). The guidelines can be used to create gamification interventions that are likely to be perceived as constructive and appropriate for environments that favour creativity.

Gamification can energise creative environments and educational settings. We can bring the compulsive potential of videogames to real world activities and use constructive competition to engage participants and accelerate their learning in an inclusive, fun way. Unicraft can be seen as a template or proof of concept for the gamification design and development guidelines which can be applied to a wide range of real world tasks, enhancing the likelihood of positive and constructive outcomes that maintain intrinsic motivation.

References

Accor. (2016). ALL - Accor Live Limitless - Using points. Retrieved August 13, 2020, from https://all.accor.com/loyalty-program/use/index.en.shtml

Aldrich, C. (2004). *Simulations and the future of learning*. Pfeiffer.

Almarshedi, A., Wanick, V., Wills, G. B., & Ranchhod, A. (2015). SGI: A Framework for Increasing the Sustainability of Gamification Impact. *International Journal for Infonomics*, *8*(2), 1044–1051. https://doi.org/10.20533/IJI.1742.4712.2015.0123

Alsawaier, R. S. (2017). The effect of gamification on motivation and engagement. *International Journal of Information and Learning Technology*. https://doi.org/10.1108/IJILT-02-2017-0009

Amini, T. (2003). IGN. Retrieved November 14, 2021, from https://www.ign.com/uk

Anderson, J. R. (John R. (1995). Learning and memory : an integrated approach, 488.

Andronico, M. (2017). Star Wars Battlefront 2 Is a Great Game With One Big Problem. Retrieved May 8, 2019, from https://www.tomsguide.com/us/star-wars-battlefront-2-microtransactions,news-26110.html

Artino, A. R. . J. (2005). Review of the Motivated Strategies for Learning Questionnaire. *Online Submission*. Retrieved from https://eric.ed.gov/?id=ED499083

Atari. (1995). Pong. Retrieved July 4, 2021, from https://www.arcade-museum.com/game_detail.php?game_id=9074

Axon, S. (2016). Unity at 10: For better—or worse—game development has never been easier. Retrieved September 2, 2017, from https://arstechnica.co.uk/gaming/2016/09/unity-at-10-easy-game-development/

Baker, R. S. J. D., De Carvalho, A. M. J. B., Raspat, J., Aleven, V., Corbett, A. T., & Koedinger, K. R. (2009). Educational Software Features that Encourage and Discourage "Gaming the System." In *Proceedings of the 14th International Conference on Artificial Intelligence in Education* (Vol. 14, pp. 475–482). Retrieved from http://pact.cs.cmu.edu/koedinger/pubs/Baker%2C de Carvalho%2C Raspat%2C Aleven%2C Corbett Koedinger AIED09.pdf

Barr, M., Munro, K., & Hopfgartner, F. (2016). Increasing engagement with the library via gamification. *Proceedings of the GamifIR 2016 Workshop. Pisa, Italy*. Retrieved from http://eprints.gla.ac.uk/120392/

Bartle, R. (1996). Richard A. Bartle: Players Who Suit MUDs. Retrieved September 14, 2017, from http://mud.co.uk/richard/hcds.htm

Bartle R. (2002). MUD History, Who Invented MUD's, How MUD's Were Invented. Retrieved July 4, 2021, from https://www.livinginternet.com/d/di_major.htm

Bateman, C. (2018). Playing work, or gamification as stultification. *Information Communication and Society*, *21*(9), 1193–1203. https://doi.org/10.1080/1369118X.2018.1450435

Bateman, C., Lowenhaupt, R., & Lennart, N. (2011). Player Typology in Theory and Practice. *Hcigames.Com*. Retrieved from https://hcigames.com/wp-content/uploads/2015/01/Player-Typology-in-Theory-and-Practice.pdf

BBC. (2020). Play Earth Squad, Go! | Free Online KS2 Science Game for Kids - BBC Bitesize. Retrieved April 9, 2020, from https://www.bbc.co.uk/bitesize/topics/z6bqkmn/articles/zj7s6v4

Behm-Morawitz, E. (2013). Mirrored selves: The influence of self-presence in a virtual world on health, appearance, and well-being. *Computers in Human Behavior*, *29*(1), 119–128.

Bethesda. (2011). The Elder Scrolls | Skyrim. Retrieved June 20, 2022, from https://elderscrolls.bethesda.net/en/skyrim

Blaschke, L. (2012). View of Heutagogy and lifelong learning: A review of heutagogical practice and self-determined learning. Retrieved June 15, 2022, from https://www.irrodl.org/index.php/irrodl/article/view/1076/2113

Blizzard Entertainment. (2000). Diablo® II. Retrieved March 10, 2021, from https://diablo2.blizzard.com/en-us/

Blizzard Entertainment. (2004). World of Warcraft. Retrieved June 22, 2017, from https://worldofwarcraft.com/en-us/

Blue Flame Labs. (2021). Video Games Database - MobyGames. Retrieved June 24, 2021, from https://www.mobygames.com/

Bogost, I. (2011). Persuasive Games: Exploitationware. Retrieved August 4, 2017, from http://www.gamasutra.com/view/feature/134735/persuasive_games_exploitationware.php

Boone, H., & Boone, D. (2012). Analyzing likert data. *Journam of Extension*, *50*. Retrieved from https://www.researchgate.net/profile/Mahdi-Safarpour-2/post/what_is_a_logistic_regression_analysis/attachment/59d622fb79197b8077981513/AS%3A304626539139073%401449640034657/download/Likert+Scale+vs+Likert+Item+%28Good+Source%29.pdf

Brand, J; Brooker, J; Versik, M. (2013). Kahoot! | Learning Games | Make

Learning Awesome! Kahoot! Retrieved from https://kahoot.com/

Brathwaite, B., & Schreiber, I. (2009). *challenges for game designers*. Nelson Education. Retrieved from https://scholar.google.com/scholar?hl=en&as_sdt=0,5&q=challenges+for+game+designers

Bruckman, A. (1999). Can educational be fun. In *Game developer conference* (pp. 75–79). Retrieved from https://www.cc.gatech.edu/fac/Amy.Bruckman/papers/bruckman-gdc99.pdf

Brustein, J; Novy-Williams, E. (2016, April 20). Virtual weapons are turning teen gamers into serious gamblers. *Bloomberg*. Retrieved from https://www.bloomberg.com/features/2016-virtual-guns-counterstrike-gambling/

Brynjolfsson, E., Hu, Y. J., & Smith, M. D. (2006). From Niches to Riches: Anatomy of the Long Tail. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=918142

Bungie. (2017). Destiny 2. Retrieved March 10, 2021, from https://www.bungie.net/7/en/Destiny/NewLight

C.C.H. (2020). Pong. Retrieved August 3, 2020, from http://www.computinghistory.org.uk/det/4007/Atari-PONG/

Caillois, R., & Barash, M. (2001). *Man, play, and games*. University of Illinois Press. Retrieved from https://books.google.com/books/about/Man_Play_and_Games.html?id=mQfIAAAACAAJ

Carmichael, S. (2018). Assassin’s Creed educational mode, Discovery Tour. Retrieved June 21, 2021, from https://www.classcraft.com/blog/assassinscreed-discovery-tour-education-research/

Cerasoli, C. P., Nicklin, J. M., & Ford, M. T. (2014). Intrinsic Motivation and Extrinsic Incentives Jointly Predict Performance: A 40-Year Meta-Analysis. *Psychological Bulletin*, *140*(4), 980–1008. https://doi.org/10.1037/a0035661

Chen, J. (2007). Flow in games (and everything else). *Communications of the ACM*, *50*(4), 31. https://doi.org/10.1145/1232743.1232769

Cheong, C., Cheong, F., & Filippou, J. (2013). *Quick Quiz: A Gamified Approach for Enhancing Learning*. Retrieved from http://aisel.aisnet.org/pacis2013/206

Clark, R. (2007). Learning from Serious Games? Arguments, Evidence, and Research Suggestions. *Educational Technology*, *47*(3), 56–59. Retrieved from https://www.jstor.org/stable/44429512?casa_token=x3WjQWSbl7UAAAAA%3AWFajeP-AvaAA4JylTg7urLWtIu-uLvcBiWQIUDDM_ZjUiFtEAw98KGuM9OTur0U0wlb8unp4iyfh2Db2WqwWyjuiUO5xJoGhQLx1U1ZfW3m_CpqSvh0#metadata_info_tab_contents

Classcraft Studios Inc. (2017). Classcraft - All-in-One Education Gamification Platform. Classcraft Studios Inc. Retrieved from https://www.classcraft.com/

Clement, J. (2022). Global gaming penetration by country 2021. Retrieved July 13, 2022, from https://www.statista.com/statistics/195768/global-gaming-reach-by-country/

Cohen, A. (2011). The Gamification of Education. *The Futurist*, *45*(5), 16–17. Retrieved from https://search.proquest.com/docview/884627174/fulltext/88B17796EAD44F

A7PQ/1?accountid=13827

Cohen, L., Manion, L., & Morrison, K. (2002). Research Methods in Education. *Research Methods in Education*. https://doi.org/10.4324/9780203224342

Consalvo, M. (2009). *Cheating: Gaining Advantage in Videogames*. MIT Press. Retrieved from https://is.muni.cz/el/1421/podzim2014/IM082/um/Consalvo__Cheating__Gaining_Advantage_in_Videogames.pdf

Crawford, C. (1984). *The art of computer game design*. Osborne/McGraw-Hill. Retrieved from http://dl.acm.org/citation.cfm?id=538111

Crawford, C. (2003). *Chris Crawford on game design*. New Riders.

Crecente, B. (2004). Kotaku. Retrieved November 14, 2021, from https://kotaku.com/

Csikszentmihalyi, M. (2014). Flow and the foundations of positive psychology: The collected works of Mihaly Csikszentmihalyi. *Flow and the Foundations of Positive Psychology: The Collected Works of Mihaly Csikszentmihalyi*, 1–298. https://doi.org/10.1007/978-94-017-9088-8

Dale, S. (2014). Gamification Making work fun, or making fun of work? *Business Information Review*, *31*(2), 82–90.

Danner, F. W., & Lonky, E. (1981). A Cognitive-Developmental Approach to the Effects of Rewards on Intrinsic Motivation. *Child Development*, *52*(3), 1043. https://doi.org/10.2307/1129110

DDRCommunity. (2020). DDR A20 PLUS Launched! What’s New? Retrieved July 5, 2021, from https://ddrcommunity.com/ddr-a20-plus-launched-whats-new/

Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic rewards and intrinsic motivation in education: Reconsidered once again. *Review of Educational Research*, *71*(1), 1–27.

Deci, E. L., & Ryan, R. M. (1985). Cognitive Evaluation Theory. In *Intrinsic Motivation and Self-Determination in Human Behavior* (pp. 87–112). Springer. https://doi.org/10.1007/978-1-4899-2271-7_4

Deci, E. L., & Ryan, R. M. (2000). The “What” and “Why” of Goal Pursuits: Human Needs and the Self-Determination of Behavior. *Psychological Inquiry*, *11*(4), 227–268. Retrieved from http://www.jstor.org/stable/1449618

Deci, E. L., & Ryan, R. M. (2002). *Handbook of self-determination research*. University Rochester Press.

Deci, E. L., Ryan, R. M., & Koestner, R. (1999). A Meta-Analytic Review of Experiments Examining the Effects of Extrinsic Rewards on Intrinsic Motivation. *Psychological Bulletin*, *125*(6), 627–6. Retrieved from https://search-proquest-com.lcproxy.shu.ac.uk/docview/614332167/fulltextPDF/FCC1880DB7541B3PQ/1?accountid=13827

Deemer, P., Broady, V., & Epstein, J. (1996). GameSpot. Retrieved November 14, 2021, from https://www.gamespot.com/

DeKoven, B. (2002). *The well-played game: a playful path to wholeness*. iUniverse.

Dellos, R. (2015). Kahoot! A digital game resource for learning. *Instructional Technology*, 49.

Delta air lines. (2017). Earn Frequent Flyer Miles : Delta Air Lines. Retrieved August 16, 2017, from https://www.delta.com/content/www/en_US/skymiles/earn-miles.html

Deterding, S. (2015). The lens of intrinsic skill atoms: A method for gameful design. *Human–Computer Interaction*. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/07370024.2014.993471

Deterding, Sebastian, Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: defining gamification. In *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments* (pp. 9–15). ACM.

Deterding, Sebastian, Sicart, M., Nacke, L., O'Hara, K., & Dixon, D. (2011). Gamification. using game-design elements in non-gaming contexts. In *CHI'11 Extended Abstracts on Human Factors in Computing Systems* (pp. 2425–2428). ACM.

Dietz, J., Doyle, M., & Doyle-Roberts, J. (1999). Metacritic. Retrieved November 14, 2021, from https://www.metacritic.com/

DigiBarn Games. (2004). Maze War Retrospective. Retrieved July 4, 2021, from https://www.digibarn.com/collections/games/xerox-maze-war/index.html

DigitalExtremes. (2013). Warframe. Retrieved March 10, 2021, from https://www.warframe.com/landing

Dredge, S. (2015). Zombies, Run! goes freemium after 1m sales to attract hordes of new players. Retrieved August 16, 2017, from https://www.theguardian.com/technology/2015/may/14/zombies-run-freemium-1m-sales-apple-watch

Duggan, K., & Shoup, K. (2013). *Business gamification for dummies*. John Wiley & Sons.

DumplingDesign. (2015). Dashy Crashy. Retrieved September 2, 2017, from http://dumplingdesign.com/press/sheet.php?p=dashy_crashy

Duolingo. (2011). Duolingo - The world's best way to learn a language. Duolingo. Retrieved from https://www.duolingo.com/

Egenfeldt-Nielsen, S. (2005). *Beyond edutainment: Exploring the educational potential of computer games*. IT University of Copenhagen, Department of Innovation.

Electronic Arts. (2018). Battlefield V. Electronic Arts. Retrieved from https://www.ea.com/games/battlefield/battlefield-5/about

Entegy. (2019). Entegy CMS. Entegy. Retrieved from https://support.entegy.com.au/hc/en-us/articles/115002673268-Gamification

Faulkner, S. (2011). Bringing games to enterprise (Microsoft's Ribbon Hero). Retrieved September 15, 2017, from http://library.fora.tv/2011/09/15/Sarah_Faulkner_Bringing_Games_to_the_Enterprise

Featherstone, M. (2017). Unicraft. Retrieved February 28, 2018, from https://play.google.com/store/apps/details?id=com.SHU.UniCraft&hl=en

Ferro, L. S., Walz, S. P., & Greuter, S. (2013). Towards personalised, gamified systems: An investigation into game design, personality and player typologies. *ACM International Conference Proceeding Series*. https://doi.org/10.1145/2513002.2513024

Firme, M., & Lahti, E. (1993). PC Gamer. Retrieved November 14, 2021, from https://www.pcgamer.com/uk/

Freedman, A. (2018). What Are Loot Boxes? Gaming's Big New Problem, Explained. Retrieved May 8, 2019, from https://www.tomsguide.com/us/what-are-loot-boxesmicrotransactions,news-26161.html

Fuchs, M., Fizek, S., Ruffino, P., & Schrape, N. (2014). *Rethinking gamification*. Meson Press. Retrieved from https://repository.abertay.ac.uk/jspui/bitstream/handle/10373/2451/Fizek_RethinkingGamification_Published_2014.pdf?sequence=1

Fuller, D. (2017). Google Maps' Local Guides Gets New Rewards. Retrieved September 2, 2017, from https://www.androidheadlines.com/2017/06/google-maps-local-guides-gets-new-rewards-features.html

Fullerton, T., & Swain, C. (2008). *Game Design Workshop* (2nd ed.). Morgan Kaufmann. Retrieved from https://www.sciencedirect.com/book/9780240809748/game-design-workshop

Fülöp, M. (2009). Psihologijske teme. In *Psihologijske teme* (Vol. 18, pp. 345–367). Odsjek za psihologiju, Filozofski fakultet u Rijeci. Retrieved from http://hrcak.srce.hr/48218

Fulton M. (2021). Pros and Cons of Minecraft: Pocket Edition. Retrieved July 5, 2021, from https://www.lifewire.com/positives-and-negatives-of-minecraft-pocket-edition-3863634

Gamespot. (2017). Super Deformation Games - Giant Bomb. Retrieved July 24, 2017, from https://www.giantbomb.com/super-deformation/3015-1196/games/

Garriott, R. (1997). Ultima Online. Electronic Arts. Retrieved from https://uo.com/

Gee, J. P. (2003). What video games have to teach us about learning and literacy. *Computers in Entertainment (CIE)*, *1*(1), 20.

Gov.uk. (2018). Data protection. Retrieved March 8, 2021, from https://www.gov.uk/data-protection

Graft, K., & McAloon, A. (1997). Game Developer. Retrieved November 14, 2021, from https://www.gamedeveloper.com/

Grego, J. (2012). *Duolingo Effectiveness Study*. *duolingo.com*. Retrieved from https://static.duolingo.com/s3/DuolingoReport_Final.pdf

Gualeni, S. (2019). How to Reference a Digital Game.

Guillén-Nieto, V., & Aleson-Carbonell, M. (2012). Serious games and learning effectiveness: The case of It's a Deal! *Computers & Education*, *58*(1), 435–448. https://doi.org/10.1016/j.compedu.2011.07.015

György Kende, B., Bjkmk, Z., & Kmdi, Seres Zmne, G. (2006). *Use of chess in military education*. *ZMNDU*. Retrieved from http://www.eruditio.hu/zrinyi3d/bz/hist_eng.html

Habgood, M. P. J., & Ainsworth, S. E. (2011). Motivating children to learn effectively: Exploring the value of intrinsic integration in educational games. *The Journal of the Learning Sciences*, *20*(2), 169–206.

Habgood, M. P. J., Ainsworth, S. E., & Benford, S. (2005). Endogenous fantasy and learning in digital games. *Simulation and Gaming*, *36*(4), 483–498. https://doi.org/10.1177/1046878105282276

Halfbrick. (2011). Jetpack Joyride. Retrieved March 10, 2021, from https://www.halfbrick.com/games/jetpack-joyride

Hamari, J., & Tuunanen, J. (2014). Player types: A meta-synthesis. Retrieved from https://trepo.tuni.fi/bitstream/handle/10024/99064/player_types_a_meta_sy nthesis.pdf

Hanus, M. D., & Fox, J. (2015). Assessing the effects of gamification in the classroom: A longitudinal study on intrinsic motivation, social comparison, satisfaction, effort, and academic performance. *Computers & Education*, *80*, 152–161. https://doi.org/10.1016/j.compedu.2014.08.019

Herger, M. (2012). Roadwarrior: How SAP Trains Its Sales People on Mobility. Retrieved August 16, 2017, from http://enterprise-gamification.com/index.php?option=com_content&view=article&id=71:roadwarrior-how-sap-trains-its-sales-people-on-mobility&catid=13&Itemid=17&lang=en

Herzig, P., Ameling, M., Wolf, B., & Schill, A. (2015). Implementing Gamification: Requirements and Gamification Platforms. *Gamification in Education and Business*, 431–450. https://doi.org/10.1007/978-3-319-10208-5_22/COVER/

Hill, N. (2017, December 5). The Overwatch Videogame League Aims to Become the New NFL. *Wired*. Retrieved from https://www.wired.com/story/overwatch-videogame-league-aims-to-become-new-nfl/

HipsterWhale. (2014). Crossy Road - Endless Arcade Hopper Game. Retrieved September 2, 2017, from http://www.crossyroad.com/

Holden, J. T., Rodenberg, R. M., & Kaburakis, A. (2017). *Esports Corruption: Gambling, Doping, and Global Governance*. *Maryland Journal of International Law* (Vol. 32). Retrieved from http://digitalcommons.law.umaryland.edu/mjil/vol32/iss1/10

Hopson, J. (2001). Behavioral Game Design. Retrieved September 8, 2017, from https://www.gamasutra.com/view/feature/131494/behavioral_game_design.php

Hunicke, R., Leblanc, M., & Zubek, R. (2004). *MDA: A Formal Approach to Game Design and Game Research*.

ImangiStudios. (2013). Temple Run 2. *Imangi Studios*. Retrieved from http://imangistudios.com/

Jagneaux D. (2018). PUBG Mobile Review . Retrieved July 5, 2021, from https://www.ign.com/articles/2018/03/24/pubg-mobile-review

Jakubowski, M. (2014). Gamification in Business and Education - Project of Gamified Course For University Students. *Developments in Business Simulation and Experiential Learning*, *41*(0). Retrieved from https://journals.tdl.org/absel/index.php/absel/article/view/2137

Kafai, Y. (1995). *Minds in play: Computer game design as a context for children's learning*. Retrieved from https://books.google.com/books?hl=en&lr=&id=Ocyllxa8ZjkC&oi=fnd&pg=PR2&dq=kafai+minds+in+play&ots=0zyiCLF_h4&sig=AOJdzNmbVXGenf0aMOagKaHoz7w

Keith, C. (2010). *Agile Game Development with Scrum*. Addison-Wesley. Retrieved from https://books.google.co.uk/books?hl=en&lr=&id=OYWWRFFc29gC&oi=fnd&pg=PT22&dq=agile+game+development+with+scrum&ots=xszuIT2j8w&sig=1hDRjtG8dUFovObk8HrCcwOspRo

Kiili, K. (2005). Digital game-based learning: Towards an experiential gaming model. *The Internet and Higher Education*, *8*(1), 13–24.

https://doi.org/10.1016/j.iheduc.2004.12.001

Kim, T. W., & Werbach, K. (2016). More than just a game: ethical issues in gamification. *Ethics and Information Technology*, *18*(2), 157–173. https://doi.org/10.1007/s10676-016-9401-5

Kleinberg, A. (2012). Brands that failed with gamification. Retrieved September 8, 2017, from http://www.imediaconnection.com/articles/ported-articles/red-dot-articles/2012/jul/brands-that-failed-with-gamification/

Koster, R. (2013). *Theory of fun for game design*. O’Reilly Media, Inc.

Krajnc, A. (1989). Andragogy. *Lifelong Education for Adults*, 19–21. https://doi.org/10.1016/B978-0-08-030851-7.50012-6

Kuchinskas, S. (2013). Gamification and telematics | TU-Automotive. Retrieved August 22, 2017, from http://analysis.tu-auto.com/infotainment/gamification-and-telematics

Kurian, N. (2019). Creative Quiz Ideas: Reinventing Classroom Assessment - Fractus Learning. Retrieved May 8, 2019, from https://www.fractuslearning.com/creative-quiz-ideas/

Laird, S. (2017). Top 10 Enterprise Gamification Cases That Will Make Employees More Productive. Retrieved September 2, 2017, from http://yukaichou.com/gamification-examples/top-10-enterprise-gamification-cases-employees-productive/

Leach, P. (1994). Children first : what our society must do--and is not doing--for our children today, 302.

Lehtiniemi, T. (2008). *Macroeconomic indicators in a virtual economy*.

Leonard, J., Hirt, B., & Berk, D. (1999). MobyGames. Retrieved November 14, 2021, from https://www.mobygames.com/

Lepper, M. R., & Malone, T. W. (1987). Intrinsic motivation and instructional effectiveness in computer-based education. *Aptitude, Learning, and Instruction*.

Lithium. (2017). *Giffgaff case study using community to build an entirely new kind of company*. Retrieved from https://www.lithium.com/pdfs/casestudies/Lithium-giffgaff-Case-Study.pdf

Lockey, A., Conaghan, P., Bland, A., & Astin, F. (2021). Educational theory and its application to advanced life support courses: a narrative review. *Resuscitation Plus*, *5*, 100053. https://doi.org/10.1016/J.RESPLU.2020.100053

Lopez, S. (2011, November). Disneyland workers answer to “electronic whip” . Retrieved April 13, 2020, from https://www.latimes.com/health/la-xpm-2011-oct-19-la-me-1019-lopez-disney-20111018-story.html

M Dakka, S. (2015). Using Socrative to Enhance In-Class Student Engagement and Collaboration. *International Journal on Integrating Technology in Education*, *4*(3), 13–19. https://doi.org/10.5121/ijite.2015.4302

Macey, J., & Hamari, J. (2018). eSports, skins and loot boxes: Participants, practices and problematic behaviour associated with emergent forms of gambling. *New Media & Society*. https://doi.org/10.1177/1461444818786216

Maimon, A. (2010). Socrative. Boston: Mastery Connect. Retrieved from https://socrative.com/

Mak, J. (2008). Everyday Shooter by Jonathan Mak. Retrieved March 10, 2021, from https://www.everydayshooter.com/

Malone, T., & Lepper, M. (1987). Making Learning Fun: A Taxonomy of Intrinsic

Motivations for Learning. In *Aptitude, learning and instruction* (Vol. 3, pp. 223–253). Retrieved from https://ocw.metu.edu.tr/mod/resource/view.php?id=1311

Marczewski, A. (2017). A Revised Gamification Design Framework - Gamified UK - #Gamification Expert. Retrieved June 20, 2022, from https://www.gamified.uk/2017/04/06/revised-gamification-design-framework/

Mäyrä, F., & Costikyan, G. (2002). I Have No Words & I Must Design: Toward a Critical Vocabulary for Games. Tampere university press.

McDonnell, M. (2014). Flappy Bird. Retrieved March 10, 2021, from http://flappybird.io/

Mckeown, P., & Maclean, G. (2012). Is activity in online quizzes correlated with higher exam marks? https://doi.org/10.1080/00779954.2012.715826

Mecc. (1990). Number Munchers for DOS (1990) - MobyGames. Retrieved August 3, 2020, from https://www.mobygames.com/game/dos/number-munchers

Mekler, E. D., Brühlmann, F., Tuch, A. N., & Opwis, K. (2017). Towards understanding the effects of individual gamification elements on intrinsic motivation and performance. *Computers in Human Behavior*, *71*, 525–534. https://doi.org/10.1016/j.chb.2015.08.048

Metacritic. (2017). Fortnite for PC Reviews. Retrieved July 5, 2021, from https://www.metacritic.com/game/pc/fortnite

Microsoft. (2011). Ribbon Hero 2 for Word. Retrieved November 10, 2017, from https://www.microsoft.com/en-gb/download/details.aspx?id=26531

Microsoft. (2016). Xbox Live gaming service. Retrieved November 10, 2017, from http://www.xbox.com/en-gb/live/

Mitchell, A., & Cisic, D. (2006). Using mobile game-based technologies to engage young adults in lifelong learning. MIPRO.

Mora, A, Riera, D., & Gonzalez, C. (2015). A literature review of gamification design frameworks. *Games and Virtual*. Retrieved from http://ieeexplore.ieee.org/abstract/document/7295760/

Mora, Alberto, Zaharias, P., González, C., & Arnedo-Moreno, J. (2016). FRAGGLE: A framework for agile gamification of learning experiences. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *9599*, 530–539. https://doi.org/10.1007/978-3-319-40216-1_57/COVER/

Mortimore, P. (2012). Understanding Pedagogy and its Impact on Learning. *Understanding Pedagogy and Its Impact on Learning*. https://doi.org/10.4135/9781446219454

Mott, T. (2013). *1001 Video Games You Must Play Before You Die*. Cassell.

Munday, P. (2016). The case for using DUOLINGO as part of the language classroom experience Duolingo como parte del curriculum de las clases de lengua extranjera. *E-Spacio.Uned.Es*, *19*(1), 83–101. Retrieved from http://e-spacio.uned.es/fez/view/bibliuned:revistaRied-2016-19-1-7040

Myers, I. B. (2014). The Myers-Briggs Type Indicator: Manual (1962). *The Myers-Briggs Type Indicator: Manual (1962).* https://doi.org/10.1037/14404-000

Nah, F. F. H., Telaprolu, V. R., Rallapalli, S., & Venkata, P. R. (2013). Gamification of education using computer games. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial*

Intelligence and Lecture Notes in Bioinformatics), *8018 LNCS*(PART 3), 99–107. https://doi.org/10.1007/978-3-642-39226-9_12/COVER/

Nintendo. (2016). SUPER MARIO RUN. Retrieved June 20, 2022, from https://supermariorun.com/en/index.html

Nintendo. (2020). Animal Crossing: New Horizons for Nintendo Switch - Nintendo Game Details. Retrieved April 15, 2020, from https://www.nintendo.com/games/detail/animal-crossing-new-horizons-switch/

Oppenheim, J. (1984). Kids and play, 308.

Pad and Pixel. (2020). A History of Handheld Gaming. Retrieved July 4, 2021, from https://padandpixel.com/a-history-of-handheld-gaming-in-one-photo/

Paisey, C., & Nicholas, J. (2004). Student attendance in an accounting module – reasons for non-attendance and the effect on academic performance at a Scottish University. *Accounting Education*, *13*(sup1), 39–53. https://doi.org/10.1080/0963928042000310788

Pearson. (2013). Learning Catalytics product details. Retrieved from https://www.pearsonhighered.com/products-and-services/course-content-and-digital-resources/learning-applications/learning-catalytics/learning-catalytics.html

Pettey, C., & Van def Meulen, R. (2012). By 2014, 80 Percent of Current Gamified Applications Will Fail to Meet Business Objectives Primarily Due to Poor Design. Retrieved August 21, 2017, from http://www.gartner.com/newsroom/id/2251015

Pintrich, P. (1991). A Manual for the Use of the Motivated Strategies for Learning Questionnaire (MSLQ). Retrieved from https://eric.ed.gov/?id=ED338122

Pintrich, P., & De Groot, E. (1990). Motivated Strategies for Learning Questionnaire -. Retrieved July 9, 2022, from https://psycnet.apa.org/doiLanding?doi=10.1037%2Ft09161-000

Plante, C., & McElroy, G. (2012). Polygon. Retrieved November 14, 2021, from https://www.polygon.com/

Pound, L. (2008). *How children learn*. Practical Pre-School Books. Retrieved from www.practicalpreschoolbooks.com

Powell, S. (2012). Froebel's Gifts. Retrieved January 26, 2022, from https://www.froebel.org.uk/training-and-resources/froebels-gifts

Raczkowski, F. (2013). It's all fun and games... A history of ideas concerning gamification. *DiGRA Conference*. Retrieved from https://pdfs.semanticscholar.org/67c5/3977bd45f772b56b37830c6deded99d108ab.pdf

Raftopoulos, M., Walz, S., & Greuter, S. (2015). How enterprises play: Towards a taxonomy for enterprise gamification. *Conference: Diversity of Play:* Retrieved from https://www.researchgate.net/profile/Marigo_Raftopoulos/publication/274963385_How_enterprises_play_Towards_a_taxonomy_for_enterprise_gamification/links/552de2610cf2e089a3ad9200.pdf

Rajan, A., Beard, A., Hood, M., Sheikh, D., & Gemmill, E. (2021). Rethink Education - Technology and Education - BBC Sounds. Retrieved July 13, 2021, from https://www.bbc.co.uk/sounds/play/m000xmyz

Ranj. (1999). Dé studio voor serious games, gamification en game thinking. Retrieved April 13, 2020, from https://www.ranj.com/

Red Ventures. (2021). Aggregate game reviews - Metacritic. Retrieved June 24, 2021, from https://www.metacritic.com/game

Reeve, J., & Deci, E. (1996). Elements of the competitive situation that affect intrinsic motivation. *Personality and Social Psychology*. Retrieved from http://journals.sagepub.com/doi/abs/10.1177/0146167296221003

Reis, A. (2019). View of Sesame Credit: Social Compliance Gamification in China. *Journal of Games, Game Art and Gamification*. Retrieved from https://journal.binus.ac.id/index.php/jggag/article/view/7239/4129

Reitman, J. G., Anderson-Coto, M. J., Wu, M., Lee, J. S., & Steinkuehler, C. (2019). Esports Research: A Literature Review: *Games and Culture*, *15*(1), 32–50. https://doi.org/10.1177/1555412019840892

Rigsby, J. (2012). Yammer, Badgeville Join to Bring Gamification to Enterprise Social. Retrieved September 2, 2017, from http://www.cmswire.com/cms/social-business/yammer-badgeville-join-to-bring-gamification-to-enterprise-social-015629.php

Rockstar Games. (2013). Grand Theft Auto V. Retrieved June 15, 2017, from http://www.rockstargames.com/grandtheftauto3/html/info.html

Royle, K. (2009). Computer Games and Realising Their Learning Potential: Crossing Borders, Blurring Boundaries and Taking Action. *Gamebasedlearning.Org.Uk*, *8*.

Ryan, R. M., Rigby, C. S., & Przybylski, A. (2006). The motivational pull of video games: A self-determination theory approach. *Motivation and Emotion*, *30*(4), 344–360.

Salen, K., & Zimmerman, E. (2003). *Rules of Play*. *MIT Press*. Retrieved from https://mitpress.mit.edu/9780262240451/rules-of-play/

Sanchez, E., Young, S., & Jouneau-Sion, C. (2017). Classcraft: from gamification to ludicization of classroom management. *Education and Information Technologies*, *22*(2), 497–513. https://doi.org/10.1007/s10639-016-9489-6

Saunders, M., Lewis, P., & Thornhill, A. (2007). Understanding research philosophy and approaches to theory development -. In *Research Methods for Business Students*. Pearson Education. Retrieved from http://oro.open.ac.uk/53393/

Schell, J. (2008). *The Art of Game Design: A book of lenses*. CRC Press.

Schöber, T., & Stadtmann, G. (2020). *Fortnite: The Business Model Pattern Behind the Scene*.

Sevcenko, N., Ninaus, M., Wortha, F., Moeller, K., & Gerjets, P. (2021). Measuring Cognitive Load Using In-Game Metrics of a Serious Simulation Game. *Frontiers in Psychology*, *12*, 906. https://doi.org/10.3389/FPSYG.2021.572437/BIBTEX

Shafer, D. M. (2012). Causes of State Hostility and Enjoyment in Player Versus Player and Player Versus Environment Video Games. *Journal of Communication*, *62*(4), 719–737. https://doi.org/10.1111/j.1460-2466.2012.01654.x

Simões, J., Redondo, R. D., & Vilas, A. F. (2013). A social gamification framework for a K-6 learning platform. *Computers in Human Behavior*, *29*(2), 345–353. https://doi.org/10.1016/J.CHB.2012.06.007

Six to Start. (2012). Zombies, Run! Retrieved August 4, 2017, from https://zombiesrungame.com/

Skinner, B. F. (1963). Operant behavior. *American Psychologist*, *18*(8), 503.

Smith, P. K. (1982). Does play matter? Functional and evolutionary aspects of animal and human play. *Behavioral and Brain Sciences*, *5*(1), 139–155. https://doi.org/10.1017/S0140525X0001092X

Sony. (2020). PlayStation®5 | Play Has No Limits | PlayStation UK. Retrieved July 5, 2021, from https://www.playstation.com/en-gb/ps5/

Stellify Media. (2019). Who Wants to Be a Millionaire? Retrieved February 20, 2019, from https://www.stellifymedia.com/millionaire

Supercell. (2012). Clash of Clans. Retrieved June 22, 2017, from http://supercell.com/en/games/clashofclans/

Taneja, S. (2020). Operant Conditioning Learning. Retrieved January 8, 2022, from https://www.psychologynext.com/operant-conditioning-learning/

Thanh, M. (2019). Ace Multiple-Choice Questions in Stimulating Ways. Retrieved May 20, 2019, from https://busyteacher.org/16700-multiple-choice-question-activities.html

TopMarks. (2020). Rocket Rounding. Retrieved April 9, 2020, from https://www.topmarks.co.uk/maths-games/rocket-rounding

Turning technologies. (2015). Turning Technologies: Interactive Learning; Audience Response Technology. Turning technologies. Retrieved from https://www.turningtechnologies.eu/

United States Army. (2020). Proving grounds. Retrieved May 29, 2020, from https://www.americasarmy.com/

Valle, R. (2017). Gamifying My Language Classroom with Classcraft - EdTechReview™ (ETR). Retrieved February 28, 2018, from http://edtechreview.in/trends-insights/trends/2963-gamifying-my-language-classroom-with-classcraft

Vallerand, R. J., Gauvin, L. I., & Halliwell, W. R. (1986). Negative effects of competition on children's intrinsic motivation. *The Journal of Social Psychology*, *126*(5), 649–656.

Valve. (2012). Counter-Strike: Global Offensive. Retrieved June 20, 2022, from https://blog.counter-strike.net/

Valve. (2017). Valve Anti-Cheat System (VAC) - Valve Anti-Cheat (VAC) System - Knowledge Base - Steam Support. Retrieved August 30, 2017, from https://support.steampowered.com/kb_article.php?ref=7849-Radz-6869

Van Eck, R. (2006). Digital game-based learning: It's not just the digital natives who are restless. *EDUCAUSE Review*, *41*(2), 16.

Vegt, Niko; Visch, Valentijn; Vermeeren, Arnold; de Ridder, H. (2018). A Case study on gamified interventions for team cohesion in factory work. *EBSCO Information Services*. Retrieved from https://web.b.ebscohost.com/abstract?direct=true&profile=ehost&scope=site&authtype=crawler&jrnl=17956889&AN=132957253&h=4Mn1RSU3G0zp34RoOWsDvsYxmgpHEWKLDrGKbAhKzzzSjWQt39fv0QRSH4CTBOpCKfdm%2BlAFcUrBDdyEAVenMA%3D%3D&crl=c&resultNs=AdminWebAuth&resultLocal=

Vyduna, J; Gessler B; Eby, S. (2007). Live interactive audience participation. PollEverywhere Inc. Retrieved from https://www.polleverywhere.com/

Whitson, J. R. (2013). Gaming the quantified self. *Surveillance & Society*, *11*(12), 163–176. Retrieved from http://www.surveillance-and-society.org

Wright C. (2016). A Brief History of Mobile Games: In the beginning, there was Snake . Retrieved July 4, 2021, from https://www.pocketgamer.biz/feature/10619/a-brief-history-of-mobile-games-in-the-beginning-there-was-snake/

Wupperman. (1872). Wuppermann AG. *WuppermanAG*. Retrieved from https://www.wuppermann.com/

Yanev, V. (2022). Video Game Demographics - Who Plays Games in 2022? Retrieved July 13, 2022, from https://techjury.net/blog/video-game-demographics/#gref

Yee, N. (2006). The labor of fun how video games blur the boundaries of work and play. *Games and Culture*, *1*(1), 68–71.

Yu, D. (2008). Spelunky World. Retrieved March 10, 2021, from https://spelunkyworld.com/original.html

Zagal, J. P., Nussbaum, M., & Rosas, R. (2000). A Model to Support the Design of Multiplayer Games. *Presence: Teleoperators and Virtual Environments*, *9*(5), 448–462. https://doi.org/10.1162/105474600566943

Zainuddin, Z., Chu, S. K. W., Shujahat, M., & Perera, C. J. (2020). The impact of gamification on learning and instruction: A systematic review of empirical evidence. *Educational Research Review*, *30*(February). https://doi.org/10.1016/j.edurev.2020.100326

Zichermann, G., & Linder, J. (2010). *Game-based marketing : inspire customer loyalty through rewards, challenges, and contests*. Retrieved from https://books.google.co.uk/books?hl=en&lr=&id=4Emhp4lGRgIC&oi=fnd&pg=PR13&dq=supermarket+loyalty+cards+gamification&ots=Uo3aGkRl5n&sig=uNo4VxEi8QfEcXcxyV9hbY34q2s#v=onepage&q&f=false

Appendices

Appendix A – ethical approval study1

Mark Featherstone ethics application

Saatchi, Reza on behalf of Saatchi, Reza

Sent: Mon 22/08/2016 18:26

To: Featherstone, Mark

Cc: Featherstone, Mark; ! ACES Research Ethics Committee (FREC)

Message | Head of Department research authorisation.txt (3 KB) | Mark Featherstone ethics v5.docx (670 KB) | Mark Featherstone Participant Information Sheet.docx (19 KB) | MarkFeatherstoneparticipant-consent-form.docx.docx (40 KB) | programme leader research authorisation.txt (4 KB) | Subject group leader authorisation.txt (2 KB)

Dear Mark

Thank you for your revised Ethics application.

I am pleased to inform you of favourable opinion (approval) for your research ethics.

The final version of your ethics documents listed below are attached for your safekeeping.

- Head of department research authorisation
- SHUREC1
- Participant information sheet
- Participant consent form
- Programme leader research authorisation
- Subject group leader research authorisation.

I would like to emphasise the points that your study should have a detrimental effect on the study of those students that took part and should not disadvantage the study of those students that did not take part. Also your study should not reveal the identity of any student in such a way that causes concern.

I wish the best in your study.

Reza.

Participant Information Sheet

Title of research study: Using gamification to enhance self-directed, open learning in higher education.

You are invited to take part in a research study. Before you decide, please take the time to read the following information carefully so that you understand why the research is being done and what it would involve for you. This consent form may contain words that you do not understand. Please ask me to stop as we go through the information, and I will take the time to explain. Do ask questions if anything you read is not clear or you would like more information before deciding if you wish to take part. Participation is completely voluntary, and you can withdraw at any time without reason.

Gamification is a process whereby aspects of game design are applied to systems outside traditional gaming. In this study students access a smart device app and web technologies to earn points by engaging in normal university activities. For example, common activities might include: attending lectures and tutorials, answering questions, completing tutorial exercises and working on assignments. Students would need to use a smart phone, tablet, or website to take part in these activities and log any points earned. Along with points, students buy credits which can be spent acquiring virtual items for the student's avatar. This would be displayed on the smart device and website, both for the student and publicly. Progress could be measured and compared with other students using points, avatars and medals. The ability to compare progress between students allows a form of competition to emerge, just like videogame systems such as Xbox Live. This friendly competition should motivate students to engage with the subject to earn more credits.

You are being invited to take part in this study because I feel that your experience as students who already have an interest in gaming can contribute much to understanding how games might contribute to learning. There will be no direct benefit to you, but your participation is likely to assist in finding out more about how gaming can be used to improve teaching and the overall student experience.

The software will be used with your Programming for Games module only. Participants are required to bring a suitable smart device with them, with the app installed, to each session throughout one academic year. The software would be used periodically to record progress in each weekly session and optionally outside the session too. There will also be a brief questionnaire to fill in and an interview. Information about avatars, points and progress medals will be visible to all the students taking part, although you can opt to not share progress with others if you wish. Progress with the software will have ZERO impact on your official assessment.

Information about you will not be shared with anyone outside the research team. The information collected from this research project will be kept private. The final set of results will use random numbers instead of names so you cannot be identified and only the researchers will know who the numbers refer to. The study will last all academic year, after this the original data will be destroyed. You are entitled to see the published results, when available.

Mark Featherstone
m.featherstone@shu.ac.uk

Sheffield Hallam University

PARTICIPANT CONSENT FORM

TITLE OF RESEARCH STUDY: Using gamification to enhance self-directed, open learning in higher education

Please answer the following questions by ticking the response that applies

		YES	NO
1.	I have read the Information Sheet for this study and have had details of the study explained to me.	☐	☐
2.	My questions about the study have been answered to my satisfaction and I understand that I may ask further questions at any point.	☐	☐
3.	I understand that I am free to withdraw from the study within the time limits outlined in the Information Sheet, without giving a reason for my withdrawal or to decline to answer any particular questions in the study without any consequences to my future treatment by the researcher.	☐	☐
4.	I agree to provide information to the researchers under the conditions of confidentiality set out in the Information Sheet.	☐	☐
5.	I wish to participate in the study under the conditions set out in the Information Sheet.	☐	☐
6.	I consent to the information collected for the purposes of this research study, once anonymised (so that I cannot be identified), to be used for any other research purposes.	☐	☐

Participant's Signature: ______________________________ **Date:** ________

Participant's Name (Printed): ___________________________

Contact details: ____

____

Researcher's Name (Printed): Mark Featherstone

Researcher's Signature: ____________________________

Researcher's contact details: Mark Featherstone, m.featherstone@shu.ac.uk
Please keep your copy of the consent form and the information sheet together.

Participant Consent Form 1 V1

Appendix B – ethical approval study2

From: Saatchi, Reza on behalf of ! ACES Research Ethics Committee (FREC)
To: Featherstone, Mark; ! ACES Research Ethics Committee (FREC)
Subject: ref: Evaluating a Mobile Gamification App for Higher Education Students
Date: 22 July 2017 11:45:22

Dear Mark,

ref: Evaluating a Mobile Gamification App for Higher Education Students

We have considered your submission for ethics approval and found the documents in good order.

Your application is thus, approved under Chair's action.

Best wishes with your research.

Regards

Reza

FREC Joint Chair

Participant Information Sheet

Title of research study: Evaluating a Mobile Gamification App for Higher Education Students

You are invited to take part in a research study. Before you decide, please take the time to read the following information carefully so that you understand why the research is being done and what it would involve for you. This consent form may contain words that you do not understand. Please ask me to stop as we go through the information and I will take the time to explain. Do ask questions if anything you read is not clear or you would like more information before deciding if you wish to take part. Participation is completely voluntary and you can withdraw at any time without reason.

Gamification is a process whereby aspects of game design are applied to systems outside traditional gaming. In this study students access a smart device app and web technologies to earn points by engaging in normal university activities. For example, common activities might include: attending lectures and tutorials, answering questions, completing tutorial exercises and working on assignments. Students would need to use a smart phone, tablet or website to take part in these activities and log any points earned. Along with points, students buy credits which can be spent acquiring virtual items for the student's avatar. This would be displayed on the smart device and website, both for the student and publicly. Progress could be measured and compared with other students using points, avatars and medals. The ability to compare progress between students allows a form of competition to emerge, just like videogame systems such as Xbox Live. This friendly competition should motivate students to engage with the subject to earn more credits.

There will be no direct benefit to you, but your participation is likely to assist in finding out more about how gaming can be used to improve teaching and the overall student experience.

The software will be used with your Fundamentals of Programming module only. Participants are required to bring a suitable smart device with them, with the app installed, to each session throughout one academic year. The software would be used periodically to record progress in each weekly session and optionally outside the session too. There will also be a brief questionnaire to fill in and an interview. Information about avatars, points and progress medals will be visible to all the students taking part, although you can opt out of the experiment at any time if you wish. Progress with the software will have ZERO impact on your official assessment.

Information about you will not be shared with anyone outside the research team. The information collected from this research project will be kept private. The final set of results will use random numbers instead of names so you cannot be identified and only the researchers will know who the numbers refer to. The study will last all academic year, after this the original data will be destroyed. You are entitled to see the published results, when available.

Mark Featherstone
m.featherstone@shu.ac.uk

Sheffield Hallam University

PARTICIPANT CONSENT FORM

TITLE OF RESEARCH STUDY: Evaluating a Mobile Gamification App for Higher Education Students

Please answer the following questions by ticking the response that applies

		YES	NO
1.	I have read the Information Sheet for this study and have had details of the study explained to me.	☐	☐
2.	My questions about the study have been answered to my satisfaction and I understand that I may ask further questions at any point.	☐	☐
3.	I understand that I am free to withdraw from the study within the time limits outlined in the Information Sheet, without giving a reason for my withdrawal or to decline to answer any particular questions in the study without any consequences to my future treatment by the researcher.	☐	☐
4.	I agree to provide information to the researchers under the conditions of confidentiality set out in the Information Sheet.	☐	☐
5.	I wish to participate in the study under the conditions set out in the Information Sheet.	☐	☐
6.	I consent to the information collected for the purposes of this research study, once anonymised (so that I cannot be identified), to be used for any other research purposes.	☐	☐

Participant's Signature: ______________________________ **Date:** ________

Participant's Name (Printed): __________________________

Contact details: ____

____

Researcher's Name (Printed): Mark Featherstone

Researcher's Signature: ____________________________

Researcher's contact details: Mark Featherstone, m.featherstone@shu.ac.uk
Please keep your copy of the consent form and the information sheet together.

Participant Consent Form2V1

Appendix C – data experiment 1+2

Link to the data source for experiment 1 and 2:

https://zendto.shu.ac.uk/pickup?claimID=pH8vgtXM94FenNQh&claimPasscode=8ruX7iPXnKjgsDnn

Claim ID: pH8vgtXM94FenNQh

Claim Passcode: 8ruX7iPXnKjgsDnn

Data Management Plan

Admin details

Project name	
Research funder	None
Grant number	None
Project start and end	September 2016 to October 2019
Principle investigator	Mark Featherstone
Institution	Sheffield Hallam

Data collection

a) What data will you collect or create?

- Are there existing data you can re-use?
- What type, volume and format of data will you collect?
- Do your chosen formats and software enable sharing and long term sustainability of data?

There are no existing data sources. Data will be electronically recovered in real time from a mobile application and stored on a database centrally. Data will be stored in SQL before being exported to excel format, which is open and accessible.

b) How will the data be collected or created?

- Are you using standardized and consistent procedures to collect, process, transcribe, check, validate and verify data, such as standard protocols, templates or input forms? What quality assurance processes will you adopt?
- How will you organise data, records, and files (file naming, folder structures)?
- How will you handle versioning?

Electronic data is stored automatically, verified using test plans. Interviews are recorded electronically, then transcribed by the author. Interviews are transcribed to a single word document. Electronic data is exported to a single Excel spreadsheet. Data has time and date stamps. The two versions are stored in two separate folders.

Documentation and metadata

a) What documentation and metadata will accompany the data?

- What documentation and metadata explain what your data mean, so that it can be read and interpreted in the future? Is this sufficient for others to understand your data and use them properly?
- How will you capture / create this documentation and metadata?
- Which metadata standards will you use?

The thesis explains the format of the data and the Excel spreadsheet contains titles and descriptions. No metadata required other than exporting the database into an Excel spreadsheet.

Ethics and legal compliance

a) How will you manage any ethical issues?

- Do your data contain confidential or sensitive information? If so, are you gaining written consent from respondents to preserve and share data beyond your research?
- How will you protect the identity of participants if required? Do you need to anonymise data, for example by removing identifying information or personal data, during research or in preparation for sharing?
- How will sensitive data be handled to ensure it is stored and transferred securely?

Only the author can access the password protected industry standard encrypted database and spreadsheets. Once the metrics data has been gathered it will be anonymised to remove student names. Local data is saved on a SHU password protected encrypted cloud server.

b) How will you manage copyright and IPR issues?

All the software is either written by the author or open source. There are no copyright or IPR issues.

Storage and backup

a) How will data be stored and backed up during the research?

The database is held within a secure Azure cloud that is automatically backed up. Local files are held on a secure cloud that is automatically backed up.

b) How will you manage access and security?

- What are the risks to data security and how will these be managed?
- Do you need to securely store personal or sensitive data? If so, are they properly protected?
- Do you need to transfer personal or sensitive data? If so, how will you ensure that they are transferred securely?
- If data are collected with mobile devices, how will you transfer the data into your main secured storage?
- Who has access to which data during and after research? How will you ensure that any collaborators can access your data securely?

The database could be hacked, revealing student names, but it is an industry standard secure azure cloud hosted SQL server with PHP front end, so all appropriate protections are in place. Export to Excel spreadsheet for analysis is via a secure connection. Mobile data transfers are anonymised. Only the author and three administrators have access to the data while the experiment runs. After the experiment the data is anonymised and will be held on an open access SHU server.

Selection and preservation

a) Which data are of long-term value and should be preserved and shared?

- What data must be retained or destroyed for contractual, legal or regulatory purposes?
- How will you select which other data to preserve and/or share and which data to destroy?
- What are the foreseeable research uses for the data?
- How long will you preserve your data for?

All data can be retained, spreadsheet presented mobile metrics data and interview transcripts. The data could be useful in developing future versions of the software. Once the data is anonymised then it can be kept indefinitely.

b) What is the long term preservation plan for the dataset?

- How and where will you preserve your research data for the longer term? Does your repository of choice charge any costs?
- How will you prepare and document the data for preservation and sharing? Have you costed in time and effort to do this?

Long term the data will be kept on a SHU open research server with no costs.

Data sharing

a) How will you share the data?

- When will you make the data available?
- Will you share via a repository, handle requests directly, or use another mechanism?
- With whom will you share the data, and under what conditions? Is there a need for access restrictions?
- How will potential users find out about your data?

Data will be available once the PhD exam is complete. Shared via SHU open research server with no restrictions. Users will find out about the experiments via publications.

b) Are any restrictions on data sharing required?

No restrictions.

Responsibilities and resources

a) Who will be responsible for data management?

The author.

b) What resources will you require to deliver your plan?

Azure cloud hosting costs covered by author.

Appendix D – interview transcripts study 1

Group A

[2mins]
MF - did anyone have any problems using the software
P1 - I did, I don't know if you fixed those login bugs, where I created an account and couldn't login?
MF - Yes, I did
P2 - basically if you put an underscore in your name then you couldn't enter that in the login page, but you could in the sign up page
MF - yes, fixed
P1 - also the empty username
MF - yes, you could leave it blank, yes, I think I did. Did that stop anyone using it?
P1 - er, I can't remember, I don't think it let me log in.
MF - so you never used it?
P1 - no, I ended up with a different name [so did manage to login]
MF - so we all eventually used, nobody was stopped from using it?
[general nods confirming everyone was using it OK]
P1 - I missed a couple of sessions, but it was OK

[3.10]
MF - some of the things I did notice, the battle game, it got turned on half way through. The experiment was looking at what difference that made, before it was turned on it was a straightforward aid to understanding progress, but that made it more of a game.
P3 - I played it
P2 - mm, yes
P4 - it wasn't much of a game, I was clicking the hearts, but I couldn't tell what difference the weapons made, what was the point of buying the weapons
P5 - some stats perhaps.
MF - so you think it would have made a difference if there was more information?
P1 - some details about weapons, like what the stats were
P4 - or what you could eventually unlock
P1 - you could have lots of different weapons and wouldn't know which does what to your stats
MF - what impact did that have, did it put you off or persevere anyway?
P4 - with the game, I don't know, I didn't see the point of changing weapons, or earning coins if they don't make a difference
MF - the metrics say that when the game was activated, usage seemed to go up, so if the point of it was to make the app stickier??
P1 - it definitely works, just needs to be a bit clearer
P3 - it wasn't very clear that there were many items, if there was some way of seeing what is coming
MF - so signpost it more
P3 - yes

P4 - was the unlock random? Some people said they started with different hair colour than me?
P6 - yeh, also the weapons, I got the golden axe really early, others got it really late and the swords and what not
P2 - some people got the shovels before the golden axe
P1 - I still don't have a sword (laugh)
MF - so what was actually happening was when you complete certain academic tasks, unlocks certain things, so if people claim different work they get different stuff. So it wasn't random, but different people would have different things.

[7]
P4 - I sort of did that glitch at the beginning and it seemed to unlock something completely random. It was just the same glitch. Did you mean it was different actual tasks belonging to different weapons or something?
MF - yes
P4 - you still get all the weapons though, just clicking? Even though it was fixed.
MF - there was an exploit there. There were 120 different activities, but it was cool, because you found the one that wasn't set correctly. So some used an exploit?
[lots of laughs]
MF - I suppose if that had the impact of using it more then was that a bad thing?
P1 - but if you're using the game and not doing work?
MF - good point.

[8.30]
MF - the metrics say most people used it in the lesson
P4 - yes, you'd see a battle on the big screen and everyone would use it.
MF - so seeing that made you use it?
P4 - yes
MF - the metrics say some people kept using at after the lesson, in the two or three hours after, is that true?
P3 - I think after the exploit, I think we used it a little bit afterwards
P2 - yeh, to get those additional credits we used it after the lesson
MF - so you think it was the exploit that was triggering extra use, but there were spikes in the middle of the night.
P1 - that was when I was bored after doing some work, when I'm most productive [at night], not that it was necessarily Prog4Games at that time, there were other assignments
P3 - yes
P4 - there's no way to check you're doing the work though, you can collect the stuff in tutorial, but you don't have to.
MF - there's an element of trust there
P1 - I don't think anybody abused it though
P2 - other than the exploit
P1 - yes, other than nobody abused it
P3 - yeh, me and X did, we just thought "ooh look, credits, press the button and get all these credits" [laughs]
MF - I was interested to know if trust works, is the game that makes you think you need to game this system.
P8 - it was the scoreboard

P2 - the exploit ruined that scoreboard
P5 - I was at the top for ages, a good few weeks
MF - what happened when you realised you were no longer at the top?
P5 - I was on top until the exploit, but then forgot a few time to bring the iPad
MF - did you know people shot past due to an exploit?
P5 - no [laughs all round]
P1 - I know the way I work, it wasn't anything to do with the exploit, the way I work I do all these other assignment, when I've got more time later I'll come back to it.
MF - why would you use it like that?
P1 - chasing scores, the score board is motivating me. Scoreboards are a good motivator

[13]
MF - it seems like it sort of worked to motivate you from a game point of view, is that fair? [yes from everyone] but did it motivate you to do some work, was there an education benefit?
P7 - good to-do list
P1 - we didn't use it for long enough
P9 - I don't think it had an educational effect
P3 - I didn't even know there was a link between claiming credits
MF - at the start there was a manual? Did you look at it?
[NO from all participants]
MF - so it acts as a to-do list, but only P5 mentioned that practical aspect of it?
P10 - for me there wasn't enough competition, there was only the leaderboard. Just what credits people have. Maybe if you could directly control the character and move around and see people.
P4 - if teachers had an admin mode and battles could be turned off during lessons that would be better. On one lessons I sat playing battles for a while.
P9 - or a multiplayer game PVP
P3 - it's cooperative so it doesn't matter if someone is higher level, they are going to get you further through the battle. It's not versus anyone, so it's not competition.
MF - it's tricky, it feels like 90% interesting because it's a game, 10% because it's academically useful? Is it? So to make it more game-like, more sticky, wouldn't that make it worse?
P4 - but if you could stop people playing in lesson
P1 - if you go PVP, you've got wins+losses, when you challenge someone it might encourage them to do work sooner, as they'd stack up more losses until they did something.
MF - are you saying if the game was more interesting it might motivate you to do more work in class?
P4 - did the original version not have battles then?
MF - for the first 3 weeks there was no battle mode
P4 - ah, right
P9 - the user interface should be drag and drop, easier to use
P1 - what difference does weapons on the belt make?
P2 - someone said if it's on your belt it doesn't do anything
P7 - it just makes it look different
P1 - it's not clear

MF - actually, the more expensive kit you had the tougher you were
P4 - oh, I didn't know that
P2 - so it made you stronger in defence on your belt?
MF - no, simpler than that. You do work, claim, buy stuff, the more blinged up your character the better you do. Interesting that you were trying to figure that out.

[20.30]
P10 - you trust us, but it's always in mind that people could be teaching. Before claiming you should be asked questions, not difficult, but something to ensure they've at least looked at the tutorial sheet. Multi choice.
MF - so even if you don't cheat, you're worried that others might be?
P10 - yes.
P1 - if you've been playing legitimately and someone shoots past you on the leaderboard, it's impossible to get it back
P9 - when I used the exploit I was just interested in breaking it to see what happened, not cheat, it needs to be more resilient
MF - some people said in survey they were interested in knowing their progress. Is that still the case, was it useful, were you interested.
P7 - just having it as an option, I was interested but not actively looking at it, just curious
MF - metrics show it used initially and then not, so once you looked it then wasn't interesting?
P3 - I wasn't interested in seeing others progress. I think it was just used a lot at the beginning as people just wanted to know what all the buttons did
P9 - progress should allow you to share work and offer more feedback
[all group agree]

[26]
MF - competition, some in the survey said it could be upsetting and stressful, hence it was implemented in a softer way on purpose not to stress anyone. Did anyone feel stressed.
P1 - it wasn't competitive enough!
P9 - it should be more educational, each task should show you code snippets, so you can create a small programs and unlock weapons
MF- that would be powerful, but would limit its use to this course
P4 - it's an excuse to go on your phone though
P1 - but it does keep them on the course specific app, plus the battle doesn't require interaction, battles can run on their own
MF - yes, you don't have to be actively involved, you can leave it and do some work. It's interesting to see mobile phone used constructively, have you seen them used as clickers?
P8 - I've seen it in other modules
P1 - yes
P3 - that kind of functionality should be part of this app, multi choice
P4 - in another course I did they used phones for multi choice
P1 - the same could be used in the tutorial
MF - yes, asking you questions live and you pressing buttons. Would that help it be more academically useful
P1 - it would reduce cheating

P3 - registering attendance should take you to the question clicker
P4 - just stop battles altogether in lessons, blocked for a certain time

[32]
P3 - the progress graphs weren't clear what they represented, just points, maybe if they were more visual
P7 - if you could click on the person and see what they've done
P3 - or a podium style representation
P4 - but that excludes people, was it just the top10?
MF - no, it was you and the people around you, it was meant to be somewhat vague as it's trying to be a light touch
P4 - we're an unfair group to ask about competitive gaming [laughs]
MF - it was assumed you'd be used to competitive play
P4 - I wasn't motivating as it didn't tell me what the points meant, I didn't know it boosted weapons. I never used the progress screens.

[34.30]
MF - can this kind of thing ever be educationally beneficial?
P4 - with a lot of tweaking
P1 - it has potential, it requires more testing with different groups of students, everyone will have a different experience
MF - would you suggest a top 3 improvements?
P9 - why would they want to upgrade their character?
MF - the idea is people innately want to do well in their studies and the game just aids that motivation you already should have
P9 - that doesn't encourage people to use it. It should be more relevant to the course.
P8 - but that's more work for lecturers
P1 - but that might be the only way it will work, people on each course are like minded but different from other courses.
P5 - the more you do, the better the items, show the stats
P10 - yes, the game should be more attractive/sticky
P9 - reward at the end of the year, a physical reward
[rest of group disagree with that]
P1 - physical rewards turn people off, it should be mental, a sense of accomplishment

[38.30]
MF - final comments?
P4 - using it as a register
P1 - only one credit for registering is not enough to motivate me to get it out
P9 - people could cheat and register at home
MF - the uni doesn't care if you work here or elsewhere, so that's not cheating. Did anyone do that.
P1 - yes
MF - so physical rewards, dangerous territory. What about connecting to actual assessment, earning points to the module.
P1 - that would be bad, lots of cheating. What if we don't have a smart phone.
MF - assuming everyone had a smartphone and only achievements I authorise count, would that be OK?

P8 - definitely motivating, a bit too far
P1 - would that allow us to progress at any time and just show you the work
MF - yes, in theory you could make out of order progress
P1 - some lecturers wouldn't have time
MF - does anyone think assessment would be good integrated?
P9 - no
P7 - if it was just a token amount, play around with the value
P1 - just link it to course work, they hand it in and you get points. Link the game to course work and exams, do better and get more points.
[agreement]
P8 - live questions linked to real points would be good, embedded in education.
[group agree the app is seen as separate to the module, the educational content]
P8 - I just did my work, this isn't related to app, it's a game, some live questions would help
MF - so tutorial claiming should involve answering simple questions properly to limit cheating, live questions should part of the lesson
P8 - use it as a refresher for last weeks lesson
P1 - constant piping up would be bad
MF - so a refresher at the start and then again at the end?
[groups say yes]
P1 - live questions would encourage people into the lesson so they don't miss out

Group B

[0.42]
P1 - first group go more out of it than us as we started later, we had to go back through what we did and mark things off we'd already done in the past, we could see there were things we might not have done and it could have helped with tutorials tasks, but we started just before beginning project work, which took most of your time. Probably didn't use it as much as we could have.
P2 - the only time I used it was in your lessons, I saw a lot of people using it in a maths lessons that followed yours, playing battles, but even though you don't do much, it's designed not to take up too much time, but I can imagine the lecturer being annoyed if he'd seen it. The students were all playing on their phones rather than doing maths work. I think it was a good idea though, better if it was applied to every module on the course. Attendance wasn't the way to get the most points, claiming achievements got the most points, you could do that without limitation, so people did that and cheated. I saw people cheating, claiming what they could, they saw the store and the shiny things and just claimed everything. If you played it properly, and didn't cheat, you wouldn't do well in battle.
[3.23]
P3 - it would be better if the teacher could put them up as when available.
MF - I have to authorise about half
P3 - My morals stopped me claiming things I shouldn't.
P1 - I went back and marked all the things I did, I didn't cheat.

P4 - I claimed everything straight away.
P2 - I claimed everything when those guys said you could, I was interested to see what exactly the app did. I cheated, but just to see what the app did. Looking at the store I seemed to have all the best gear, but then I realised you could unlock more by claiming achievements and I wanted to see how far the rabbit hole went, so I cheated.
P3 - I wouldn't cheat, it's just a mobile game, but I wouldn't cheat.
MF - so if there was some way to limit cheating?
P3 - yes.
MF - what about multichoice questions before you could claim something?
P3 - validation like that could work.
P2 - as soon as one person knows the answer, everyone will. The only way it would work is if I had to email your or something and you authorise it. It should all be authorised. You can't allow people to keep themselves away from cheating, someone needs to have their finger on the button in authority.
[6.36]
MF - how does it affect you to know someone might be cheating?
P1 - you can't compare yourself to other people if they're claiming they've done everything and you know they haven't
P2 - when you see people running around fighting, people who are surviving are probably not the ones playing it fairly. It used to be P3 winning but not any more
P3 - I remember at the start when I was the only one who'd figured out how it all worked and I was the first with proper gear, but then people started cheating and I wasn't winning anymore.
MF - did you ever had any technical problems
P1 - with battles it would just start different battles, I assumed we were all playing on the same server in the same game.
MF - no, this is asymmetric multiplayer, you don't all play together at the same time.
P1 - ah, so it's like your character, but in other people's games.
MF - did you notice battles getting turned off?
P3 - could you use Unicraft at home, I tried once and it couldn't connect.
MF - yes you could, it sounds like a simple temporary connection issue.
P3 - ah, I assumed it only worked at uni
P2 - I didn't play the battle game myself, I bought items for my avatar and watched him fight on the big screen, to judge my character. I found the point of Unicraft was to see your character on the big screen, so you could see all the people doing well. Fighting it out and, my character to be as cool as them and to be killing as fast as they are. It's a unique feature having it on the board, that's what defines it compared to any other educational game or app. So doing it at home or in lessons on my own, I didn't see the point, because nobody else was seeing how well I was doing. It felt like I might as well be doing work.
MF - did you see it on the big screen in the Atrium?
P2 - yes, I did
MF - did everyone use it in class or outside?
P3 - I didn't realise you could use it at home
P1 - I did sometime forget to claim something in class and did it outside
P3 - yes, I'd forget and then claim it after
MF - metrics say some people did use it outside the lesson until 7pm?

P2 - they are still at uni though even at that time. Even though we aren't doing it in your class they are doing it in someone's class
MF - metrics show people were playing battles, but when they got turned off, usage went down, but battles were still showing in class.
P3 - I think it's coincidence, at that time we got a lot of assignments
P1 - yes, four assignments
P2 - it could be the lifespan of the app, people liked it at first and then after a while it got samey samey
MF - metrics show it wasn't always used on the one day.
P3 - not sure, I used it in other classes
P2 - I used it when I saw others using, in maths straight after your lesson. When I saw others I thought I might as well join in. I didn't play battles myself, but I wanted to battle on the big screen
[15.00]
MF - metrics showed a big variation in time playing battles, the experiment was looking at the difference the battle game made, some 8mins some 82mins
P2 - that sounds like the time of a lesson to me
P4 - we were all playing it in maths together, we'd buy stuff then go straight into the battles
P2 - I had it running in maths, but I was doing work, I think it did become a distraction
P3 - at first I thought you just left it alone when battles were playing, but then I realised you do the heart thing
MF - so, that's looking at it from a game point of view, but was it useful to see your progress and compare it to others
P3 - I think so
P1 - it could be
P4 - I just cheated and claimed everything, tried to get as far as I could
P2 - that fact ruined it, because the progress was artificial, it wasn't a true representation. If it was connected to all other modules it would be better. Claiming attendance for everything. Take maths for instance, not many people go, numbers dwindled over the weeks and classes had to be combined. So you could even increase rewards for that lesson, offer more reward to get more people to attend.
MF - you can also use it to judge your own progress, it lists all the work
P4 - it split the work up in a really good way, even though I was cheating, I did read them and looked at what I should be doing. It was good little jumps in work.
P3 - it told you what to do
P4 - doing a tutorial, it let you focus on half an hours work, not just the three hours it would take do it all
MF - what about promoting competition?
P1 - as a concept it's good. It's not best when the lowest feel like they're being put down
P4 - if it's skill based, ability to do something, it's risky as obviously some people are better than others, it puts you down a bit more.
P2 - I think it's good, a double edged sword, seeing the worst makes you feel bad, but it's hard for us to say as we all do well, but I would say from other competitions that it can be inspiring

P3 - but this isn't related to our marks, it's a game and seeing our progress, it's not that damaging as it's linked to progress in tutorials, not our marks
MF - yes, this could have been linked to actual marks
P3 - yes, that would have been a bad way to do it, it would have humiliated some people, but I think doing it this way, claiming work done in tutorials, it shows people who are making the most effort and kind of, if you are going to lessons, you can compare progress to others and it might inspire you to go more.
[20.00]
P2 - it’s a good metaphor for seeing how badly you're doing, if you're dying all the time then obviously someone out there is putting in more time in than me, because it's not grade based you can't say for sure they're getting better grades than you, they're just putting more effort in. Sometimes that's all you need, that's all the motivation you need to bump up your grades.
MF - did you know it was peer matching the two who fought with you?
P3 - I like that, but didn't realise that's how it worked. It was fun to see them in your game.
P1 - I knew I wasn't getting put up with people with huge axes and big helms. I didn't know it was on purpose. Maybe the game could work better on a wider scale, say if it was in a secondary school, a big year group, where people are split into ability sets, it could work there and show who is putting the effort in.
MF - do you think it was any kind of impetus to do more work
P2 - It would be if people weren't cheating
P4 - I just cheated my way through it to see how it worked, as game devs it was interesting to try to break it
MF - could it be changed to be more effective?
P4 - not sure, it does work effectively, showing progression in that style works
P3 - at our age we do work because I want to, I don't need a game to motivate me to work. That would be more appropriate in primary/secondary school, but they'd have to do it at home, you don't want young kids at school with phones.
MF - so it's more just to track your progress and see what others are doing
P3 - a younger audience would be more inclined to be actually motivated by the game
MF - did this impact on module enjoyment?
P1 - it's fun to see the battles on the big screen, see yourself die over and over [laughs]
P3 - I think it brought people together a bit more in class. People would say to me, "look what you're doing" and I'd say "yeh, OK".
P2 - it wasn't about competing it was about what we can do as a group
P3 - yes
P2 - it would improve it if I could challenge other students to a battle. It would be fun to watch people beat each other up. Player versus monsters, it feels like you're working as a team. Maybe you could choose to create sub-teams. When doing group assignments, we could make teams that match and compare. When it's competing though, it's better as PVP, not on the big screens as people might not want to see that. It would be more fun to battle specific people.
P4 - seeing how far a specific sub-group could get together would be fun
MF - would you not feel bad, if X who was number1 all the time turned up with his gold gear and won all the time?
P4 - no I'd just fight him all the time

P2 - that might be an incentive, if you were so good everyone kept challenging you then you might want to boost your profile to stay popular. I mean I don't find in-app battles stimulating for me, but if I knew my character was popular with the class then that might motivate me anyway.
P1 - keep it player versus environment, but then the last two survivors battle each other
MF - could it be improved to help more academically?
P2 - if there was more interaction with the lecturer, it feels like it's all automated, like nobody is watching. If I've got a really good profile, it's meaningless if it nobody knows, that's why I like it on the screen at the front, if there was more interaction with you, like if you said "you did good work together he's some credits" or "here's an item". If you actually gave us all the achievements, like after a lesson, if you could mark people as doing good or exceptional work, give them an item, a title, it would motivate me more to please the teacher, I like doing good work to keep in good standing with the teacher, it helps you in the long run.
P4 - notifications, if half way between sessions it said "you haven't logged any work, you've got half a week left, you should do something" then that would motivate people into working rather than just sitting there. That would motivate people.
P3 - remind people, those who are stuck in their ways and can't be bothered it wouldn't help, but those who just forgot, for them it could work.
MF - first group suggested I asked multi choice questions at start and end of lessons
P3 - yes
P2 - I like that idea, more interaction with the teacher would make it feel like you wanted to do it, not just to please you, but it would make people feel like they ought to otherwise they aren't putting in as much effort as everyone else.
P3 - yes
[32.00]
P2 - an assignment tracker, notifications warning you it's coming up. Comments from other people telling you it's a hard one. Remind them to get started. It's hard to say how much time things takes unless others tell you it's a hard one. Like the blackboard app but simpler, pushing the information to you. You could rate assignments and show how many people think it's a tough one.
P3 - or like notify you how many people have started it and if they've not started it, notify them.
P2 - that would be good, comparing progress, which is one of the goals of Unicraft
P1 - after you could ask people how long it took them and report that to next year's students
P3 - pushing assignments is a good idea, you don't want to panic people, but there are people leaving it too late
P1 - I get a lot of messages from students struggling with assignments, this would help
P2 - if it was online again, I wouldn't delete it

Appendix E – interview transcripts study 2

Teaching staff

Note: With staff members I would come into lectures and tutorials at the start and after they'd finished and take down any thoughts on the app from staff.

Staff member 1

This is the subject leader who runs both tutorial workshops and lectures.
Wk1: I'm very nervous about using the voting system as if it fails it will undermine student confidence in my lectures. Similarly, when the app is used in tutorials to register attendance and award points for engagement, I'm just worried about how much time that will take and if it doesn't work due to technical problems.

Wk2: In class voting is working which is a relief, but adds a small time overhead and requires me to shift from PowerPoint to Unicraft2 and back, it adds a small amount of stress when I'm trying to project a professional confident approach. I only have 60mins so I'm really pushed for time. It doesn't work quite as I'd like, it should be embedded within the PowerPoint slide for convenience, like TurningPoint. It wouldn't be so bad if this room had two monitors and projectors, but it only has one. When moving from one question to another it should reset all the votes, I don't like that it remembers their last vote. In tutorials when I register a student it should only let them register within the classroom, in theory they could be registering from home and I wouldn't know [uni policy is that students don't have to attend in person and shouldn't be penalised for studying elsewhere, but this isn't popular with staff]. Yes some cheated. The tutorials haven't been made available yet! I think they just wanted the kits!!! At least they were intrigued. It took a bit of doing to get them to do it but now one of them even emails me to remind me that he had forgotten his tablet but I owed him a coin!

Wk4: Getting the hang of running quizzes and tutorials now, it's working well. The students do need guidance and regular reminders to actually stay involved though.

Wk6: The battle game definitely got students talking and piqued their interest.

Wk8: You can see they are buying items for their avatars and interest peaks when the battle royale is shown at the start of a lecture. Currently the students only have 3 quiz questions a week in the lecture, it's a shame they aren't getting quiz questions in the tutorials too as it would help embed the app in their week more.

Wk10: I liked using it and the students seemed to like it too. I can't wait to see if it affected their marks or attendance. Just needs to fit a bit better into how I work, so it takes less time.

Staff member 2

This staff member only takes tutorial workshops.
Wk1: Interesting app, but not everyone is using it, it should be available on Android/iOS so we can encourage or even insist everyone uses it. It's easy to forget to start a session when you know that it isn't compulsory, students don't have to use it so it's awkward to remind students about it.

Wk2: It takes a long time to learn student names, but the process of handing out credits means I now HAVE to know the student's name which puts me into an awkward position. It might be better for me and my standing with the students to just note down, using the register which has photos, people who do worthy things [questions, good work, etc] and just give them points after the session when I can take time to look them up. I understand that this isn't ideal as it would be best to use the app face-face immediately. Ad-hoc awards will ramp up later once I've learned more names.

Wk4: not sure how many students are engaged with this, which makes it feel awkward to keep mentioning it.

Wk6: the battle game did seem to wake people up, both in terms of remembering the app, but also being a bit more switched on at the start of a tutorial in general.

Wk8: more students appear to be interested in the app since battles became active and I started showing it at the start of tutorials. I don't always get to the tutorial in time to show a battle resolve [it takes 3 mins] so sometimes I don't show it or cut it short before there's a winner.

Wk10: I thought it was a great app, I mean it seemed like the students were enjoying it. Definitely needs PC and iOS support though, we don't want anyone excluded. It's a shame some of the students won't admit to using it though, especially when you just want to hand out a credit, but don't know if they want it or not.

Staff member 3

Note - this staff member only takes tutorial workshops.
Wk1: this looks like a really fun app, very interesting, I would hope the students would find it fun and useful.

Wk2: Handing out credits to students in class is awkward as I don't know the student's names and I have to say, "Hi, that's a great question you asked earlier, what's your name so I can give you a credit?". The way I work I avoid interactions that explicitly require using a student's name, at least for quite a few weeks until I've learnt them, so "do you need a hand with that" type approaches. Having to admit I don't know a student's name, who I may have interacted with multiple times previously, is embarrassing and means students lose confidence in you just a little. I think later when I've learned more of their names then it won't be a problem.

Wk4: there aren't that many students engaged with using it, I do try and mention it, but I don't think that many are interested.

Wk6: the battle game did make the students sit up and take notice.

Wk8: Same issue as staff2, I don't always get to the tutorial in time to show the battle resolve properly, but the students seem more interested in the app now battles are active anyway. Quizzes in tutorials would definitely increase engagement with the app, currently some see it as just for voting in the lecture only, I think this is partly because I don't hand out many coins as I'm still learning names.

Wk9: it's like some students are embarrassed to admit they're using it. So if I call out "are you taking part", "who's number 1", "are we all registered", "who wants to earn a coin", etc - I don't get any response and so I assume nobody is using it, but then when I look at the progress screen I can see that actually lots of people are using it. Frustrating.

Wk10: I'm not sure if will have any effect on their marks, it's a good idea, but it just needs to work more transparently, easily in the class. Handing out credits is too awkward, maybe if their app showed a QR code and everyone knew that when I walked over they should press their "show my QR code button" and then I could use my app and the camera to ID them automatically. Then there's no remembering names bit, I don't know, would that be less awkward or more awkward? It needs integrating into the tutorials better, quizzes would help, then maybe some Hackerrank type content or them peer reviewing their work through it perhaps.

Students

Student interview – structure (guided questions)

1. How did you feel when using Unicraft2?

2. What was the feature you liked best?

3. What was the feature you liked least?

4. What would you change about the app or add to it?

5. Did the app ever behave incorrectly? Give details.

6. What purpose do you think the app serves?

7. Did the app ever make you feel unhappy or stressed?

Group 1

P1 - I want to use it, but can’t as it isn’t iOS.

P2 - I would have liked to have a go, but won’t until it’s iOS

P2 - it was fun seeing the avatar killing stuff, nice answering questions.

P3 - I’d like to control the avatar. Too easy to cheat, staff authorisation would be better. Voting and wagering were great, there was no stress. The quizzes helped me understand the subject better.

P4 - I liked it, I wish I could control the characters. Getting coins, customising avatars, the variation in the different avatars - I liked all that. The quiz helps me do better on the course. I can’t think of anything I’d change and it didn’t stress me out. I’m third place in my tutorial group in Unicraft2.

P5 - I ran out of space on my phone so I deleted it, but later I freed up some space so I could reinstall it. I wanted to catch up, but got left behind due to deleting it. It’s really the voting and the scores that I like, that’s why I couldn’t catch up.

P2 - Not really aware of it, what is it? Do I have to use it? Should I have been using it?

P6 - I only use iOS stuff, would have liked to use it though.

P7 - wagering was good, it made lectures more fun with the voting. The competition and leaderboards are not interesting to me.

P8 - I used it a bit at the start, but I prefer face to face conversation. I ended up getting my friend to register me as his teammate for the lecture voting bit.

Group 2

P9 - used it for voting and nothing else as I couldn't see the point. Seems weird to me, I don't understand why the battles are there, but is easy to use. I'm already motivated and I don't need those features. Ranking people like that could stress people, but it didn't bother me.

P10 - I like voting, I've used all the features, I'm 6th on the leaderboard. Other than voting though, I'm not sure of the point of the other features. I can't see how it makes any difference. I did take part and joined in though, because my friends were. It bugged me that they were doing it and I wasn't so I joined in. Are my friends doing it because they want to or is the competition stuff making them?

P11 - I only used it because staff reminded me to. Don't see the point other than the voting and logging your attendance. Was there a competitive element to it, I didn't see that? Competitive coding like hackerrank, that would be good, not just clicking buttons to claim achievements.

P12 - I wanted to use it, but I only use iOS. I like the idea of voting and points and gaming.

P13 - Used it a lot, liked it. I like the game integration and I always wagered in lecture quizzes. I'd like to have more control in battles though, so I can control where the avatar goes. Customising the avatars is good, I like that. There were bugs though, sometimes I'd buy something and then it wouldn't refresh the items list right away. It can be distracting in tutorials, but it helps focus attention in the quizzes. My progress graphs weren't updating properly, I couldn't find my name in the progress screens. The competition is good and not stressful at all.

P14 - good, but what's the point, it's just quizzes and attendance. It would be nice to see live answers like in TurningPoint. Battles should be more interactive, I was tapping on the hearts, but nothing was happening, battles are the best feature though. I didn't realise the ad-hoc achievements were even happening. I'm not on the progress screen, I think that's a bug. The quizzes seemed relevant, but that's it, although I did play the battles anyway as I wanted to make progress. Shame I couldn't see myself and others on the progress screens. I did want to take part and join in, but I play like that normally anyway, I want to do well and complete everything.

P15 - I used it a few times and then forgot my password and forgot to mention it to staff. I was busy with other things anyway, although I did take part in the quizzes just by a mate adding me as a friend.

P16 - top 5 on the leaderboard, so yes I like it. It adds a bit of substance to lectures and I normally struggle in lectures to remain engaged. I don't like being talked at. Avatar customisation is good, made me want more points. Gambling bit was cool. No bad features really. It helped me with learning, I was engaged more in lectures. Game bit makes it more interactive, more substance, more personality, better than TurningPoint which is cold. Didn't understand what was happening with the team play and adding friend nicknames bit. I'd like to be able to battle with a specific person, fundamentally though it's fine, really good.

Group 3

P17 - I'm not normally a mobile user so borrowed a tablet. It needs too much setup; teachers were always waiting for responses in quizzes. In another lecture we just used google forms and then people could fill it in whenever and the tutor looks at it during free moments. That way it isn't just multi-choice, people can write stuff down. There should be a web version so I can do it on a laptop. I just used it to answer questions, not really interested in the leaderboard or competition, I don't like competitive games anyway and I didn't modify the avatar.

P18 - I don't like it, too many bugs. OK for quizzes though. TurningPoint is better though as it's less cluttered and simpler. I meant to track my progress, but couldn't get past the clutter. [smiled] I am at the top of the list though, I claimed everything straight away, everyone was using it so I had no choice. I guess I'm competitive, I like competitive games.

P19 - relatively fine app, I like the betting part and attendance rewards. Cheating must be possible though, I mean I looked at the leaderboard and thought certain people must be cheating. Voting is solid though. Game should be developed a bit more, more variety in unlockable items would be good, I don't like it when everyone looks the same. Voting made a difference to me, it was a better experience.

P20 - I forgot about it, I don't play mobile games anyway, not really bothered. I joined in with everyone else in quizzes, just in my own head.

P21 - I used it a bit and it was OK, I stopped though because it was an effort to get my phone out and start it up. It works OK, but I don't learn through interactive stuff like that, I prefer a proper tutorial with instructions and things to do. I like voting though, I like to think through it.

P22 - I used it and enjoyed it and found it easy to use. No problems and nothing needs changing. I like the quizzes and all the achievements. I'm not bothered by leaderboards though, but I'd like to see this used in all subjects.

P23 - I like the quiz bit of it, but I need to get into the routine of using it, there really should be more reminders on the projector. More and bigger betting, that's what I want. It lets me feel more involved. Not bothered about leaderboards though, I mean they work OK. There should be more choice in avatars though, they all look odd, I need more variation. It helped me engage more with lectures, I didn't need the achievements in tutorials though, I was already using a spreadsheet I made in Excel for that.

P24 - I'm quite high on the leaderboard, I like it, I'm more likely to vote with this than TurningPoint. I like the battles and it's good that it isn't too interactive. I often left battles running while working although sometimes it's hard clicking on the hearts. Teachers should unlock tutorial achievements though as others might be cheating. Not sure if it helped my studies, voting did I think.

P25 - I did use it, seemed to work OK, but got bored with it after a while. I can see the point of the game part, it's different, some people were motivated by it, but I'm aware of others cheating. The voting and the progress tracking are nice features, I like to see my progress on the graph. It might have made my learning easier, but I really prefer reading. You can get a good estimation of where you are in your studies, I like the stats, it's useful. I didn't always realise how I was doing in other subjects, but I wasn't aware I could see different categories.

P26 - I don't see the point of it, but I'm the highest scorer in my tutorial group. There is a bug when you close the app and it resets your items list to the basics, which is annoying. Before battles nobody was distracted, but afterwards it could be distracting. Weapons and gear should cosmetic, it should use levels instead. Another bug is the progress system that doesn't always show your own progress. I mainly like it for the quizzes.

P27 - I liked it, AI in the battles sometimes splits the team among different enemies, which can make you fail faster. Catching hearts is too hard as the camera is moving around erratically. Betting on quiz answers is the best feature. Although, there was no part of it I disliked. I like answering quiz questions with the app better than just shouting out, especially with the battles too. I like that it's competitive.

Group 4

P28 - The voting bit helps make the lecture more fun, not really interested in the rest of it.

P29 - the room code should be displayed on the projector as sometimes I miss it. I like that you get points, it's motivating and makes the quizzes more interesting. I like the avatars, but there should be more things to buy, more customisation. Seeing the group progress is good, I'm not bothered what position I'm in, but it's good that it's competitive.

P30 - I use it, but battles are a bit rubbish, could be more game like. I'm not bothered about looking at progress. I like battling though and I like the avatar customisation.

P31 - I use it regularly, I like the voting and enjoy battles and customisation, but there are some bugs. Competition is interesting, but it doesn't motivate me. The ability to look around in battles and control it more would be good. The competition parts don't stress me.

P32 - I used it recently, it's good fun. Battles are good fun. Sometimes I miss the room code though. I always gamble high on votes. I didn’t realise until recently there were new items being unlocked and the lack of items put me off originally. I think it’s fun and very good.

P33 - It’s too easy to cheat. Not enough to do. I’m not taking part in votes. Levelling up role playing game and mini games would be good.

P34 - sometimes I can’t login. I like the voting, not really interested in the game bits. Better than TurningPoint though, more interesting.

P35 - it’s OK, but I don’t use phones much.

P36 - it’s a bit laggy, I used it for voting. It’s not that bad, but heart collecting doesn’t work well enough. Customising avatars is good though. I’m not interested in competitions, but I didn’t even know about that bit until someone mentioned it recently.

P37 - A good idea, but too easy to cheat. Battles and progression are good, all gamers like that. It’s a unique way to register attendance, I like it. The ability to control your character in battles would be good. Choosing your own teammates would be good too. Hearts are too tricky to collect. Achievements should all be based on understanding not completion of tutorials, get tutors to award them, that would be more useful. I’d use it more if it worked that way.

P38 - A good idea, it helps engage people more and keeps them on target. Too hard to tap on the hearts though, too easy to cheat in tutorials too. Time gate the tutorial achievements and then at least you can’t claim them until the right day, then it would help prompt you as to what you should be doing that day too. Also, if you claim 75% complete on some work, don’t make me manually claim 25 and 50%, do that automatically.

P39 - It makes lectures more fun, but battles are strange, what do you get from the battles? What's the point of them?

P40 - battles help give it all a point, but I'd like it to be PVP and choosing your own teammates. I want the hearts to always go to me, don't send them to a teammate just because they have lower health. There should be more game modes like the battle game, like a battle royale on the phone, not just on the projector. It helps make the lesson more fun for me, I zone out less. It's too easy to cheat, I saw another group go up 200pts in two days, they have to be cheating. My device is too slow though.

Group 5

P41 - I used it, but didn't always get the group voting code. I liked the game bit, it felt like there was a purpose to the whole thing, the points were useful as I could see how I was doing compared to my mates, but it was too easy to cheat.

P42 - my device is too old, but I used it a bit, voting was good, other features don't care about.

P43 - Not bothered by this kind of thing, I just took part in the voting in my head, but my device was old anyway.

P44 - I had no device, but I liked what I saw, I like the idea of gamification, I'd be into that.

P45 - my device was old, but I joined in with the voting by registering as a friend on another device. I loved the personalisation and the currency thing is cool.

P46 - It should be on an iphone, I answered questions by registering as a friend. The game bit provides more incentive, especially when working with a friend betting

P47 - Good fun, but hard to progress in game, I can't get past level 9. I can't get enough cash. I wish I could make bigger bets, then I could make more money, I'm a high stakes gambler [grin] and I should be supported. I ended up registered in the wrong group for a while which was annoying. I like to see my progress, where I am on the leaderboard. I wish I got more cash from battles.

Group 6

P48 - I use it, it's a good incentive to try harder. My favourite bit is buying equipment, more customisation options would be good. Overall it's really good. I'm not bothered by the leaderboard stuff or my position though.

P49 - I used it, battle games are interesting, bit different, getting points and that, pretty funky. Adds a fun element to the subject, involves people doing something different, not every day in uni you can say "come on guys, let's get some points", like we are working together to be the best group. I wish you could sell old gear back to the system though. I'm top of my group on the leaderboard. I don't get stressed by the competition bits of it at all.

P50 – it's good, a different way of interacting with a lecture, I like the battle game bit. My favourite part is customising the avatar, there should be different styles of avatar and items though, so it's more unique. Also, the battle game should be more interactive. I'm 3rd on the leaderboard and I like the competition stuff.

P51 - I like it, it helped me feel more involved in lectures when voting. The battle game was interesting, but only when I saw others doing it in class and then

I joined in.

P52 - I like it, playing on your own you shouldn't get any points though, that's wrong. It should be all course related, that should be the only way you get a reward. I like the points system best, maybe it's because I'm a competitive person, it's nice to be able to visualise it. I love the betting, but I don't care about leaderboard positions, not bothered about that, not stressed.

Group 7

P53 - I liked the voting and became interested in the game side. Voting was best, but I didn't really understand how it worked or the game bits.

P54 - I wanted to use it, but I missed the session where my tutor explained how it worked and then I couldn't figure it out. Didn't want to ask people.

P55 - I was resitting the year and we didn't use it last year so I didn't see why we needed to use it this year so I didn't bother.

P56 - I thought it was OK, I found gambling when voting lots of fun, it made it exciting. I liked customising the character, he should jump around when I get a correct answer. I do like to look at the leaderboards too. Achievements should have been more automatic, like it's too many menus to sort out. The room code should just hook right into the lecture and tutorial so it tells you what work you are meant to be doing and prompts you to tick it off as you go.

P57 - I liked the voting bit, not too sure how the rest of it works though, the battles would have been better if they were more interactive in the game part. I missed the explanation of how it all worked and didn't want to ask, so I missed out on all the attendance monitoring, ad-hoc awards, achievements stuff until recently, so I didn't get anywhere near enough coins and I couldn't catch up.

P58 - I only used it once, it asked too many questions when signing up and I prefer to use pen and paper anyway.

P59 - It's cool and I used it a few times, it was easy to use. But then I hit a bug where it wouldn't sign in and as soon as somethings fails I just give up. It's better than TurningPoint though, clearer and easier to use, plus it's cool that you can run around in the game and it does it on its own.

Students were asked separately about the strange drop in attendance at the halfway point

It was suspected this was the predictable lull in engagement seen in all courses where students are becoming fatigued and most of the subject assessments are released. This was confirmed by the students:

1. "We had some assignments back and I realised I wasn't doing very well so I just felt bad about going to the classes. I figured I'd just work at home until I caught up".
2. "We had assignments due and there was a lot of work I had to do at home".
3. "I had tons of work to do so I just spent my time in the library getting on with it".
4. "I'd missed lots of assignment deadlines and I had to try and catch up at home".

Appendix F – Unicraft3

Software development is an iterative process and based on the experience of using Unicraft1+2 several further refinements are suggested for Unicraft3.

Key enhancements:

1. An iOS version, even if a free Android device is given to a student, they often prefer to use iOS devices and don't want to carry two phones/tablets.
2. More customisation options for avatars was something repeatedly mentioned in interviews.
3. More 'usefulness' was requested by students, which means tighter integration directly into studies, but without reducing application flexibility:
    - 3.1. Running quizzes in tutorials and lectures.
    - 3.2. Ability to write code in quiz answers rather than just simple multi-choice.
    - 3.3. Better error messages, bug fixing and usability improvements to the app. People expect high-quality user experience design in mobile applications.
    - 3.4. Control of teammate selection, making it easier to play with friends.
    - 3.5. Ability to create peer group 'clans' for more sophisticated competition.
    - 3.6. Easier, faster and simpler to use. People expect mobile applications to 'just work', with very low cognitive load.
4. Staff requested greater flexibility in administering the app:
    - 4.1. Create quizzes on the fly, faster.
    - 4.2. Easier and faster user management e.g. students often entered the wrong tutorial group numbers, forgot their passwords, etc.
    - 4.3. Ability to reconfigure the PC admin version of the app, used to administer and show a quiz. Some rooms have two screens and two projectors, some

have one screen and one projector, making running a quiz awkward. The ability to adjust the layout of the interface would help.

4.4. Ability to manage a user without having to ask their name, which can be socially awkward for staff. This could be done using QR codes on the student version of the app, which are scanned by the tutor's app to find the student:

4.4.1. Giving ad-hoc award.

4.4.2. Checking attendance and progress.

4.4.3. Giving tutorial completion awards – to stop students cheating and self-certifying their completion.

5. A more professional level of "polish" to match people's expectations of mobile applications:

5.1. More time testing and bug fixing on a wider variety of devices.

5.2. More time improving the user experience and interface design with user testing of the app.

5.3. More automated prompting, in-app explanations and error checking so there is less cognitive load on users, making it easier and faster to use.