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UniCraft: Exploring the impact of asynchronous multiplayer game elements in gamification

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Abstract

This paper describes the development and evaluation of UniCraft: a gamified mobile app designed to increase the engagement of undergraduate students with the content and delivery of their course. Gamification projects rely on extrinsic motivators to encourage participants to engage, such as compulsory participation or real-world rewards. UniCraft incorporates an asynchronous multiplayer battle game that uses constructive competition to motivate students, without using motivational levers that may reduce intrinsic motivation. The novel battle game employed by UniCraft employs Player vs Environment (Shafer, 2012) and Player Matching (Jennings, 2014) to ensure students work together in similarly ranked small groups as a team against a shared enemy. A study was undertaken which examined students' long-term engagement with UniCraft within the context of a 12-week long undergraduate programming course. The app was initially provided with the battle feature disabled, so that the effect on motivation and engagement could be studied when it was introduced during the intervention. Detailed interaction data recorded by the app was augmented by semi-structured interviews in order to provide a richer perspective on its effect at an individual and group level. The interaction data revealed convincing evidence for the increased motivational power of the battle feature, and this was supported by the interview data. Although no direct negative effects of competition were observed, interviews revealed that cheating was prevalent and this could in turn have unintended negative side-effects on motivation. Full results are presented and case studies are described for three of the participants, giving an insight into the different styles of interaction and motivation experienced by students in this study.

Keywords: gamification, competition, mobile, virtual, avatar, video game

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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 (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.

Educational games are designed to embed specific educational content within a fun 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. It 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.

Production values can be another issue for educational games. Video games are a popular pastime amongst a wide sector of society, so it's likely that users will have already experienced commercial blockbuster video games created with million-pound budgets and Hollywood production values. It's unsurprising that educational games are often judged harshly in comparison. Nonetheless, even with the highest budget and production values, it is notoriously difficult to embed educational content within a game without compromising a 'fun' design, and the educational aspects can easily end up feeling 'tacked on' (Habgood and Ainsworth, 2011). It's also difficult to create an educational game for which it can be proven that the educational content transfers into real world skills and knowledge (Van Eck, 2006). Without great care the students will simply learn the skills and knowledge to improve their performance in the game, not the real world (Baker et al., 2009).

Gamification has the potential to avoid many of the problems faced by educational games. Much of a game's motivational appeal is often attributed to behaviouristic reward (Hopson, 2001), as an explanation for why common game activities are inherently enjoyable and compulsive: 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. Unlike educational games, gamification projects can therefore be more general in nature, applicable to a range of activities. This makes them cheaper 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 (Skinner, 1963) perspective. They often rely on motivational tools like monetary rewards, prescribed measures of progress and compulsory participation, which can reduce the individual's sense of agency. Intrinsic motivation is an extremely important feature of good learning environments. When 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 (Chen, 2007). Nonetheless, modern theories of game design can draw upon a much wider range of motivational design principles than just behaviourism (Crawford, 2003; Koster, 2013; Schell, 2008).

The central role of competition in the design of many gamification environments can also be particularly problematic. Early research into the motivational potential of games was quick to identify the potential of competition to both increase and decrease motivation (Lepper and 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 and Fox, 2015). The role of competition in the classroom has also been questioned more generally (Reeve and Deci, 1996). Within the field of psychology it has been shown that rewards tend to reduce intrinsic motivation and lower performance (Deci and Ryan, 2000). Both competition and rewards are seen as core levers within gamification as it attempts to capture gaming's intrinsic motivation and refocus it on some other activity.

If gamification results in lower intrinsic motivation, then its educational value is questionable. Yet it would be confounding if this was true as gaming culture is full of competition and rewards, and is undeniably motivating. Could it be that unsuccessful gamification projects aren't capturing the right gaming elements when they gamify a non-gaming activity? In

particular, are designers giving enough attention to producing constructive, rather than destructive competitive environments (Fülöp, 2009) for gamification systems? This question provides a key motivation behind the UniCraft project described in this paper.

1.1 UniCraft

This project involved the development of a gamified ‘meta-game’ for smart phones called UniCraft. The application uses competition and leaderboards to gamify a higher education course, with students, pursuing normal class activities to earn points in the game. The project attempts to apply more video game design principles and tropes than are typically used in gamification, so that it becomes closer to a recognisable video game cliché. It specifically includes a non-educational video game to act as a motivational focus for player competition. This Battle Game was designed to be recognisable as a modern, multi-player, team-orientated 3D video game. A player matching system groups students of similar ability levels into small teams, so that they can work cooperatively to fight computer controlled enemies, a design pattern known as Player vs Environment (PvE) (Adams, 2013). Participation in the study was flexible and not compulsory, with rewards taking the form of virtual credits, with no real-world importance. These credits were earned by engaging in a variety of class activities and they could be spent equipping anonymous virtual 3D avatars that represented each student in the game. UniCraft is designed to look and feel like a fun video game where participation is optional. The embedded video game mimics the design of popular commercial 'lightweight' one-button clicker mobile games (Unger and Novak, 2012) in an attempt to keep students interested in the app for longer.

It was hoped that this approach would produce a gamified system which would result in positive outcomes without any of the predicted negative impacts on intrinsic motivation associated with competition, points and rewards (Lepper and Malone, 1987).

1.2 Features of Gamification

Gamification refers to the "use of design elements characteristic for games in non-gaming contexts" (Deterding et al., 2011a). 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 (Deterding et al., 2011a). Gamification can be found in education, corporations and government programs (Deterding et al., 2011b), but its popularity and application to diverse processes means definitions need continually updating (Raftopoulos et al., 2015). There are examples of its use to label everything from game design influenced industrial applications like Badgeville (Laird, 2017; Rigsby, 2012), an ideal definition, to website interfaces with little or no game design principles (Kleinberg, 2012).

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) utilises an accurate simulation of driving and can be said to have gamified driving, turning it into a game. This is very different from using game design principles to make potentially mundane or complex every day activities feel compelling and game-like.

Unicraft 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 More et al in

their review of gamification 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 that specific guidelines or feature sets. Deterding's earlier definition of gamification (Deterding et al., 2011a) suggested that badges, leaderboards and levels were all design patterns characteristic to gamification. However, other authors have argued that basing definitions of gamification on a set of game elements is problematic (Fuchs et al., 2014) and some have suggested that game design is too complex an activity to be reduced to formal methods at all (Crawford, 1984). 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 (2011a) 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 1.

In line with Deterding (2011a), we see from Table 1, that leaderboards, points and rewards are a reoccurring design pattern within these examples, as to a lesser extent are video game imagery, competition, automated testing, real world rewards, badges and psychologically inspired 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 (Deterding et al., 2011a). 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 and 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.
- 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	LibraryTree 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 lending 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.	Video game imagery, social media display of rank.
Herger, 2012	Staff training programmes such as the 'Road Warrior' marketing training app by technology company SAP. Staff took part in fictitious sales scenarios to learn how to market SAP's products. This was gamified by automating the scenarios as videos followed by a quiz, with trainees earning points displayed on a leaderboard.	Automated evaluation using multiple choice tests and competition.

Table 1. Examples of gamification

1.2.1 Gamification's Unwanted Side-effects

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. Gamifications 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 (Dale, 2014), peer pressure, supervision, measurement and compulsion (Fuchs et al., 2014; Raczkowski, 2013). This then leads to users experiencing a lack of agency, creative control and intrinsic motivation.

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 and Ainsworth, 2011). A number of studies have suggested that extrinsic motivation damages retention, enjoyment, reflection and performance (Danner and Lonky, 1981; Dec et al., 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.

There appear to be four common weaknesses to failed gamification projects: the application of limited game design elements (Pettey and Van def Meulen, 2012), providing real world rewards (Deci and Ryan, 2000), prescriptive measurement (Cerasoli et al., 2014) and compulsory participation (Whitson, 2013). UniCraft's design must avoid these pitfalls if it is to be seen as a fun activity by students, and so it is informative to look more closely at the design of successful gamification projects which have achieved this.

'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, they've both achieved huge success (Dredge, 2015; Faulkner, 2011).

1.2.2 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 isn't compulsory, there is no real-world reward and it uses more game design principles than the usual points and competition (see Table 1). It was developed as a collaboration between Microsoft Game Studios and Microsoft Word's development team, and it has millions of users (Faulkner, 2011).

New users are presented with a familiar looking video game like progress screen, 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 video games 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.

1.2.3 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. 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.

The app makes use of a number of game design principles beyond points, leaderboards and rewards.

- 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.

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

1.2.4 Classcraft

Classcraft is a web and mobile based gamification platform aimed at younger 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). 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.

Again, this app makes use of a number of 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).
- Video game 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 team mates encourages players to bond.

Although its design and presentation parallel the video game genre of role playing games closely, it does not actually implement a video game, instead the traditional gamification tropes of points, leaderboards and extrinsic rewards are used with the visual presentation and terminology of video games overlaid. The similarity in name to Unicraft is coincidental.

1.3 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 and Fox, 2015). Competition provides an alternative motivation for participating, but it can be a double edged sword (Lepper and 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 video games 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 seen as a chance to improve.

Although there are no formulas for framing 'constructive' competition within a game, video game 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.
- 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.

None of these approaches are commonly 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 and Fox, 2015). The primary aim of UniCraft's design was therefore to incorporate some of these well-established game design approaches to encourage constructive competition for its players.

1.3.1 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). Video games 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 and nullify any expected incentives of competition. Furthermore the claim that gamification has the potential to reduce intrinsic motivation (Fuchs et al., 2014) may be amplified by the application of real world rewards. For example, gamification is traditionally used in industrial contexts to increase efficiency and quality, with financial rewards. This financial reward must be seen as fairly won and there must be confidence that no one is cheating. To avoid cheating, a game and its rules must be well defined, with outcomes

judged by a human arbiter or that lend themselves to automated fair assessment (Kiili, 2005). If those judgements are to maintain participant confidence then the assessment must be rigidly defined.

Some commercial games provide anti-cheating systems for this purpose. 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.

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. We propose the iterative design process, seen in Figure 1, in order to help guarantee fairness in the development of gamification. With each 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.

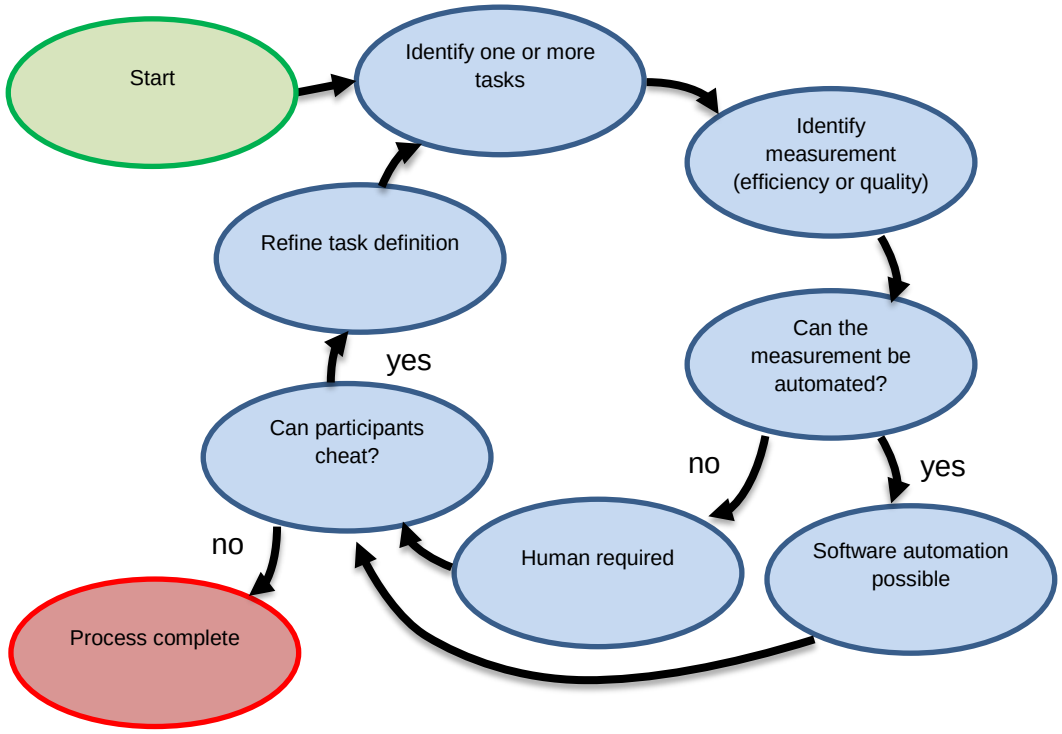

Figure 1. Gamification iterative design process

2 The design of UniCraft

2.1 Design Overview

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 video games. For example, Xbox Live (Microsoft, 2016) is hugely popular and features public

leaderboards built around their 3D avatar system. Representing players with avatars is a common game design technique in video games and is at the core of UniCraft's design.

In UniCraft, 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 2). The provision of a public anonymous avatar fits well with the idea of constructive competition as they can represent progress and status through individual visual differences. The system creates a competition to have the most impressive looking avatar (individual interpretations can vary) that can survive the longest in battle.

Figure 2. Student customised avatars

The setting for the game was a light-hearted fantasy environment (see Figure 3) where warriors battle waves of undead monsters (see Figure 4) realised using a popular 'chibi' or 'super deformed' style (Gamespot, 2017) appropriate for audiences of any age.

Figure 3. UniCraft Battle Game scene

The player's warriors are required to battle waves of undead monsters (Figure 4) within this environment, and there is no ultimate goal or finish state to the game. Each battles winner is the last avatar standing.

Figure 4. example undead enemy in T-pose

2.2 The Battle Game

In order to mitigate any potential for reduced intrinsic motivation, UniCraft was designed on the premise that participation should be optional and the game shouldn't contain real-world rewards. However, players can lose interest over time, which could lead to disengagement or cheating (Baker et al., 2009). UniCraft's Battle Game design attempts to counter this with its compulsive public competition, simple concept, short play sessions and regular progress. Inspiration was found in the 'one-button' mobile video game 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, they often rely heavily on the motivational power of avatars and have frequent, but short play sessions, making them an ideal design template.

Although it isn't possible to guarantee a constructive competition, design decisions can be made to reduce the chance of the competition being destructive (Hanus and Fox, 2015), by focusing on cooperation, fun, progress, flexibility and fairness. The design of UniCraft's battle system includes several conscious 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 it (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' video game characters (light-hearted).

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 5). 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 5. Undead enemies growing in strength from left to right

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 very 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 6).

Figure 6. Increasingly expensive virtual items

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.

2.3 Avoiding cheating

Most gamification projects don't embed an actual video game, even when those projects use video game tropes (Classcraft Studios Inc., 2017). UniCraft does and it must be seen as fair to all participants, 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 video game, 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.

2.4 System Features

UniCraft is an Android based gamification app for smart phones (Figure 9), 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 7) or in the common room (Figure 8).

Figure 7. UniCraft battles played out on a class projector

Figure 8. UniCraft battles played out on a large screen TV in a common room

Figure 9. UniCraft is a mobile gamification app

Staff and students access the system through their smart devices (PCs, tablets or smart phones), as shown in Figure 10. Unity3D was used to create the gamification software for PC and Android devices as it supports multi-platform development and is the leading video game development tool in the games industry (Axon, 2016).

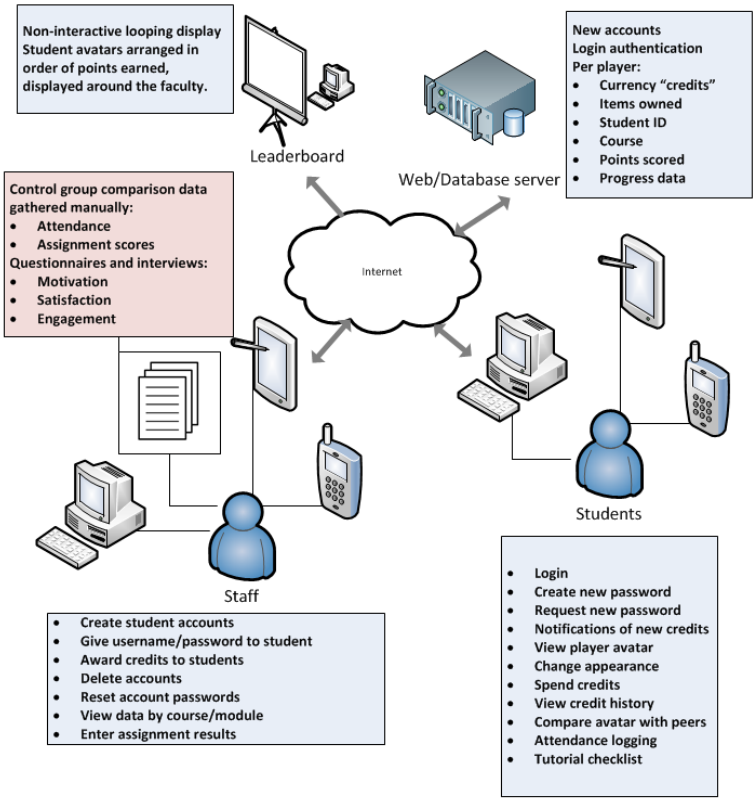

Figure 10. System architecture

2.4.1 App Overview

The diagram in Figure 11, gives an overview of the app and how the different user interface screens link together.

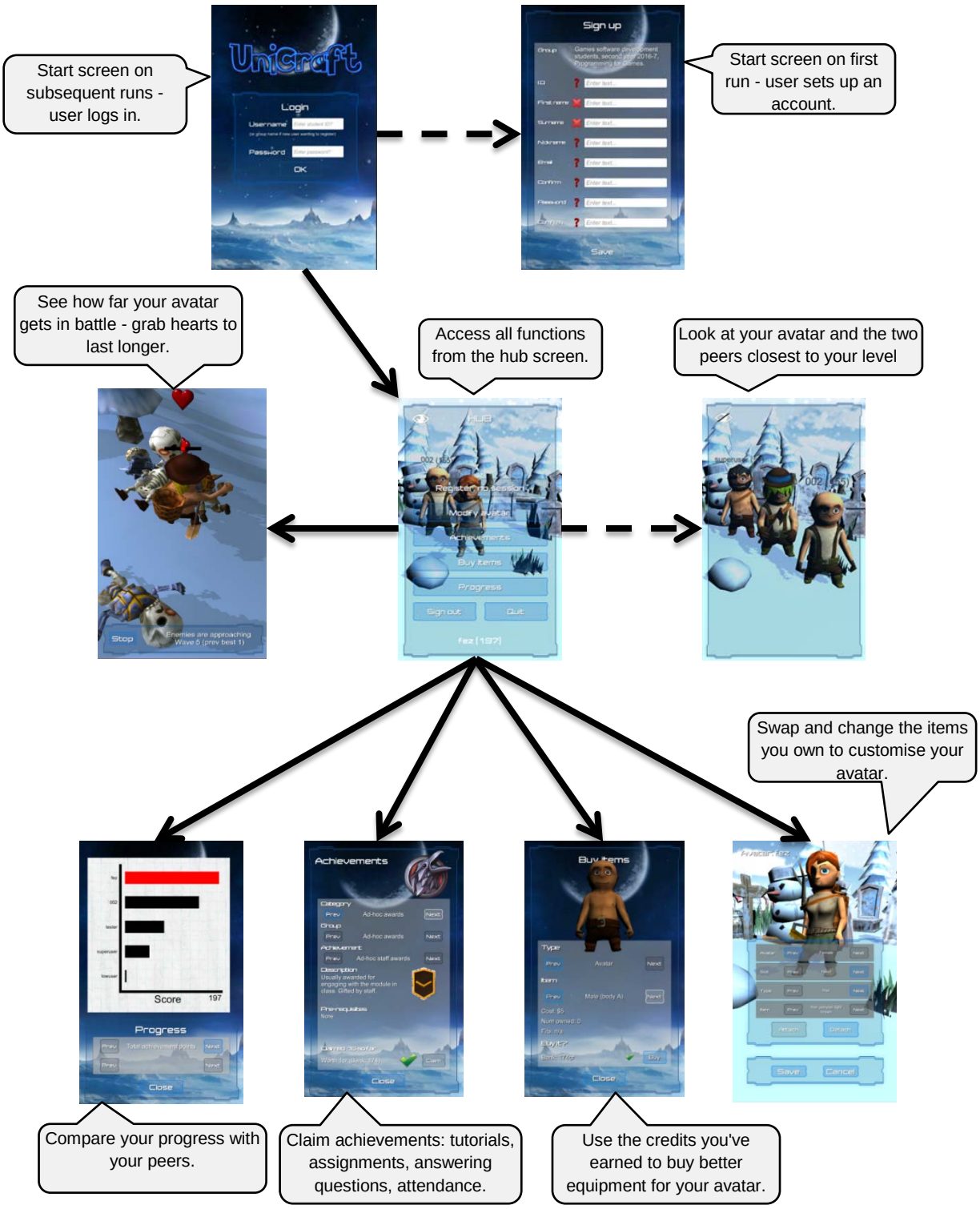

Figure 11. UniCraft user interface structure

2.4.2 Hub

All functionality can be accessed from the hub screen and the student's avatar is visible in 3D in the background (Figure 12). 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.

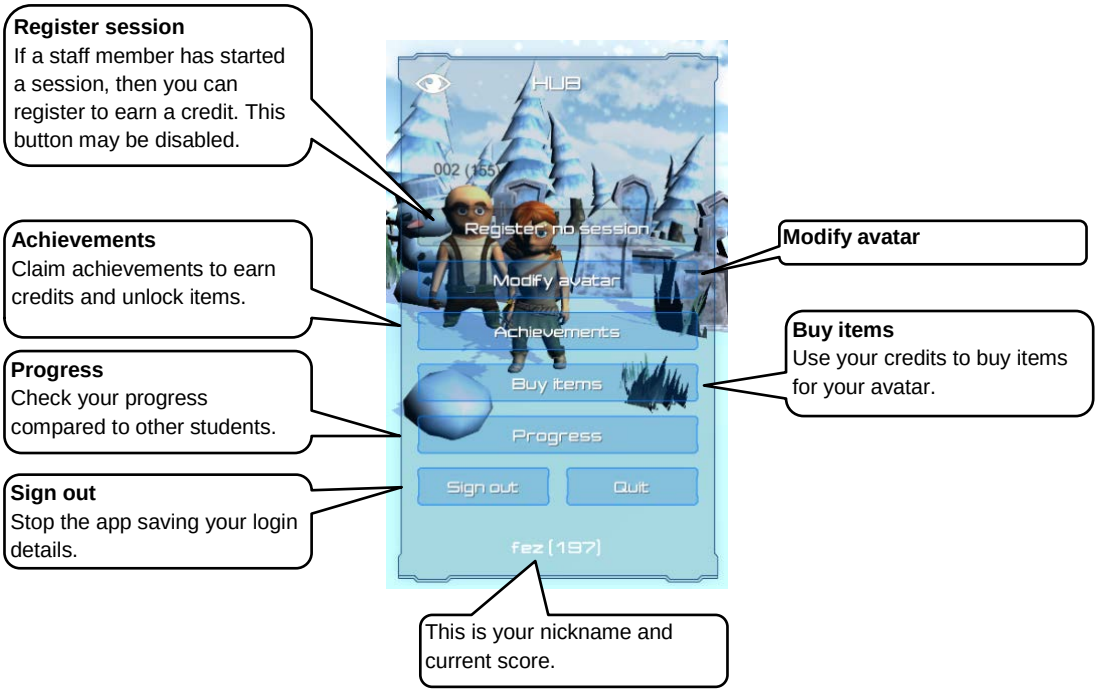

Figure 12. A breakdown of the hub screen

2.4.3 Buy Items

When the player starts using the app they have a small amount of credits and can buy a few basic items (Figure 13). As they claim achievements they earn more credits and also unlock more items.

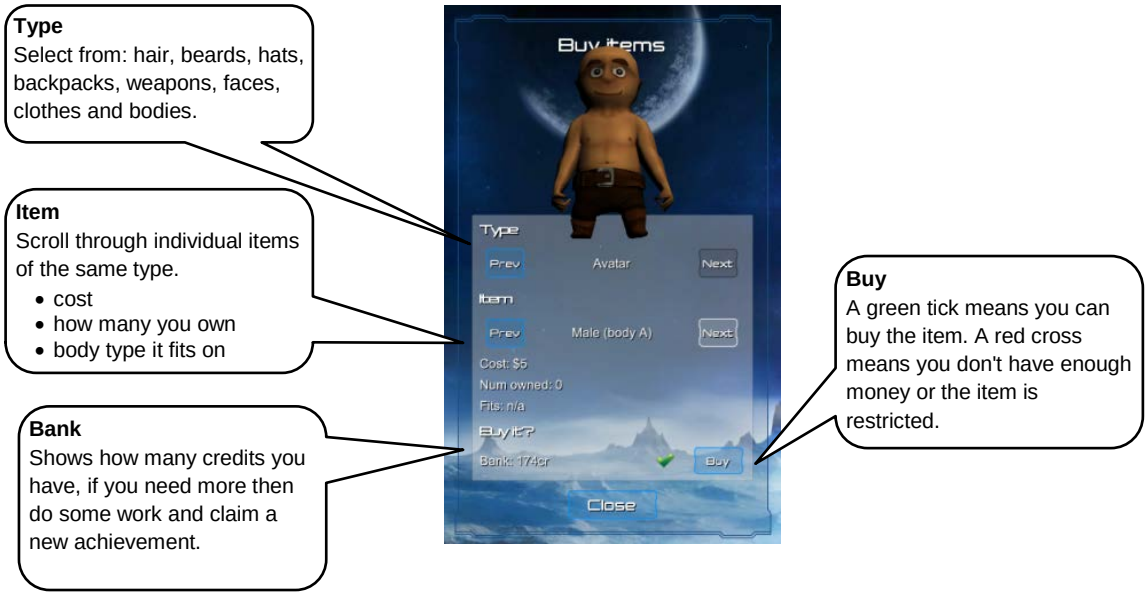

Figure 13. Buy items for your avatar

2.4.4 Modify Avatar

From the avatar interface a player can select their body type and then attach their items (Figure 14). Other students will see this avatar, current rank and nickname.

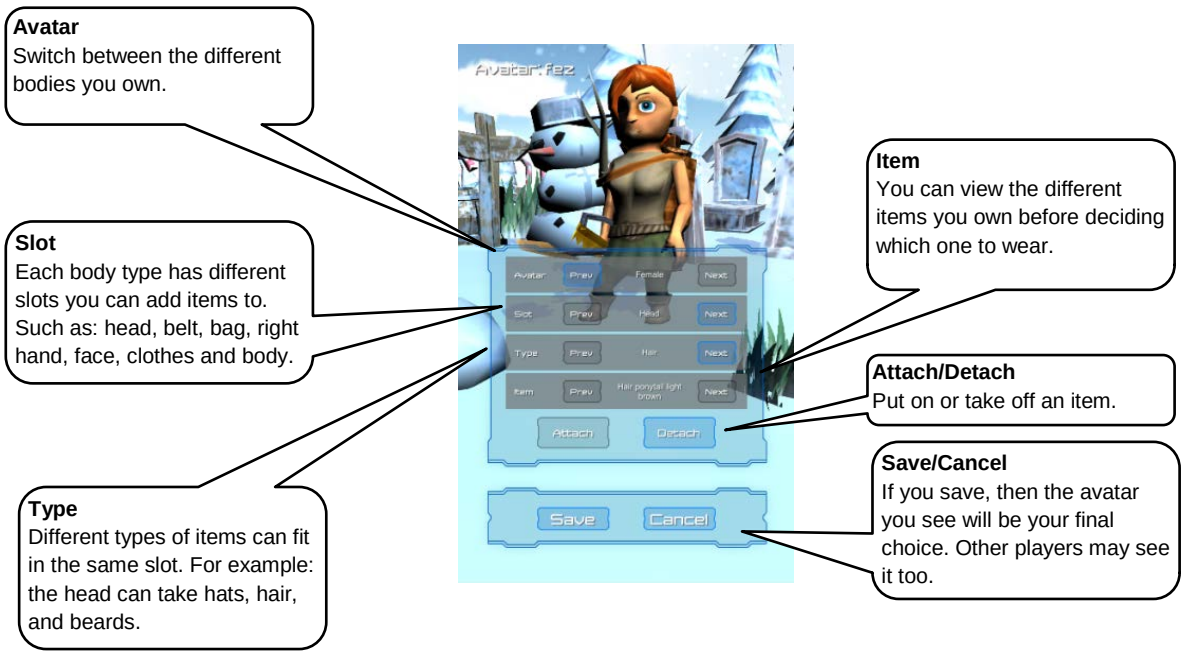

Figure 14. Modify your avatar

2.4.5 Progress

Here the player can see their avatar's rank and compare it to all the other student avatars in their peer group (Figure 15). As well as an overall total score, a player can compare their progress to other students in each achievement category.

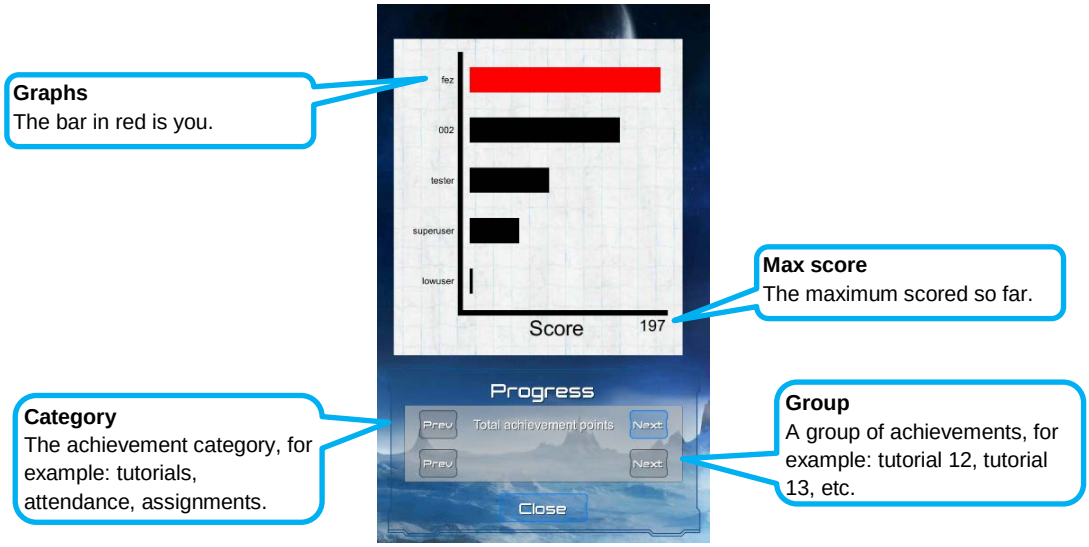

Figure 15. Progress comparison

2.4.6 Achievements

Positive engagement with the subject is measured by logging achievements, for example, completing a tutorial or answering a question (Figure 16). This is how credits are earned, which can then be used to buy virtual items.

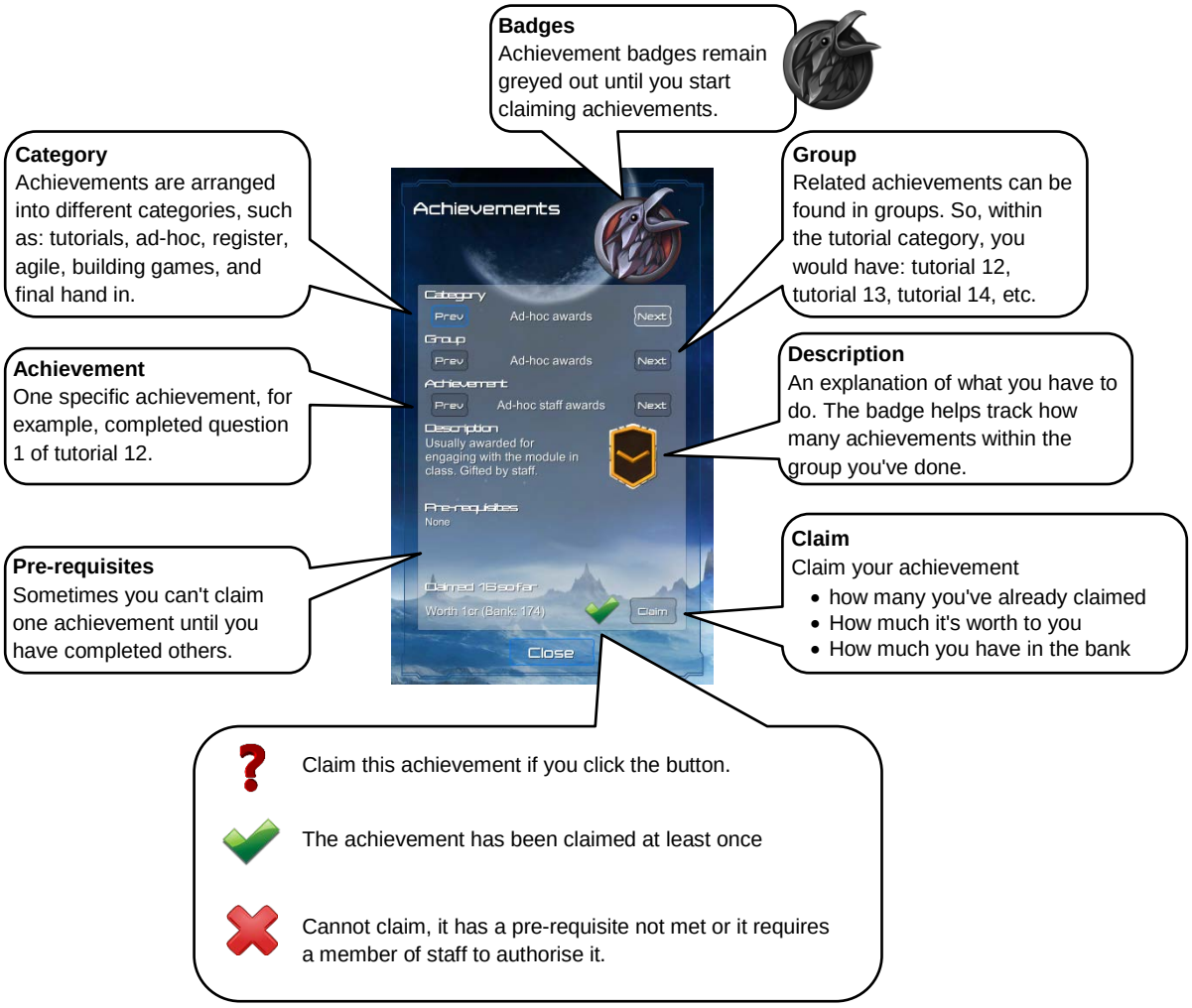

Figure 16. Claim and review achievements

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.

2.4.7 Battle Games

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 or more expensive equipment (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 17).

Figure 17. Battle game

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 7 and Figure 8). 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 et al., 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.

2.4.8 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 19, 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 18, a teacher is authorising an achievement for a specific student, this is time consuming if extended to the entire student cohort, but it eliminates the possibility of cheating.

Figure 19. An achievement that can only be awarded by staff

Figure 18. Administration list of students

3 Evaluation

3.1 Research questions

In this study, we were interested in finding out whether UniCraft's Battle Game improves the wider gamified application, and explore any potential side effects of its inclusion. The Battle Game is designed to encourage constructive competition, which should increase student's motivation to use the app. Internal game metrics are capable of providing a rich and accurate picture of engagement with the application over time, allowing us to compare the difference in student engagement with the Battle Mode enabled and disabled.

Therefore, our hypothesis was 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).

Conversely, destructive competition would potentially become stressful for participants, and decrease students' motivation to use UniCraft, resulting in a decrease in engagement.

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

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

3.2 Design

This was a longitudinal 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. 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. The organisation of the study is shown in Table 2.

	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 2. Organisation and schedule of study, A and B refer to two tutorial groups of student participants

App interaction data was automatically recorded directly from the app throughout the 12 weeks. 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.

3.3 Participants

A second-year undergraduate programming module was used for the study, which ran for one, 12-week long semester. In line with the 'unoppressive' design aims of UniCraft, 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. So 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 UniCraft'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.

3.4 Measures

A mix of quantitative and qualitative measures were recorded as part of the study. This included in-app metrics and semi-structured interviews. The aim of these measurements is

to quantitatively capture the impact of the Battle Game, while providing qualitative insights into any potential side effects common to competitive gamification systems.

3.4.1 Metrics

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.

3.4.2 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, usage outside class time, levels of engagement of different users, etc. This informed a question script for the interviews (Table 3). Participants were all encouraged to attend, the interviews were held in large groups, audio recordings made and then transcribed.

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 3. Interview questions

3.5 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.

3.5.1 Group Results

When the Battle Game became active, app usage overall showed a statistically significant increase of 217% (one way ANOVA $F(1,44)=12.40$, $P=0.001$, $\eta 2=0.28$) 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 at some level.

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
					η2=0.93
B	weeks 7-9	383	1176	207%	F(1,20)=3.3
					P=0.08
					η2=0.17

Table 4. App usage pre and post battle game

The increase in app usage is lower in group B (Table 4), one possible explanation is that this group were using the app in the latter half of the semester when students are generally more fatigued. It may also be related to the order in which the battle game was introduced, group A used the app without battle game for three weeks before it was activated, group B could use the battle game straight away for three weeks before it was deactivated.

In Figure 20, 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).

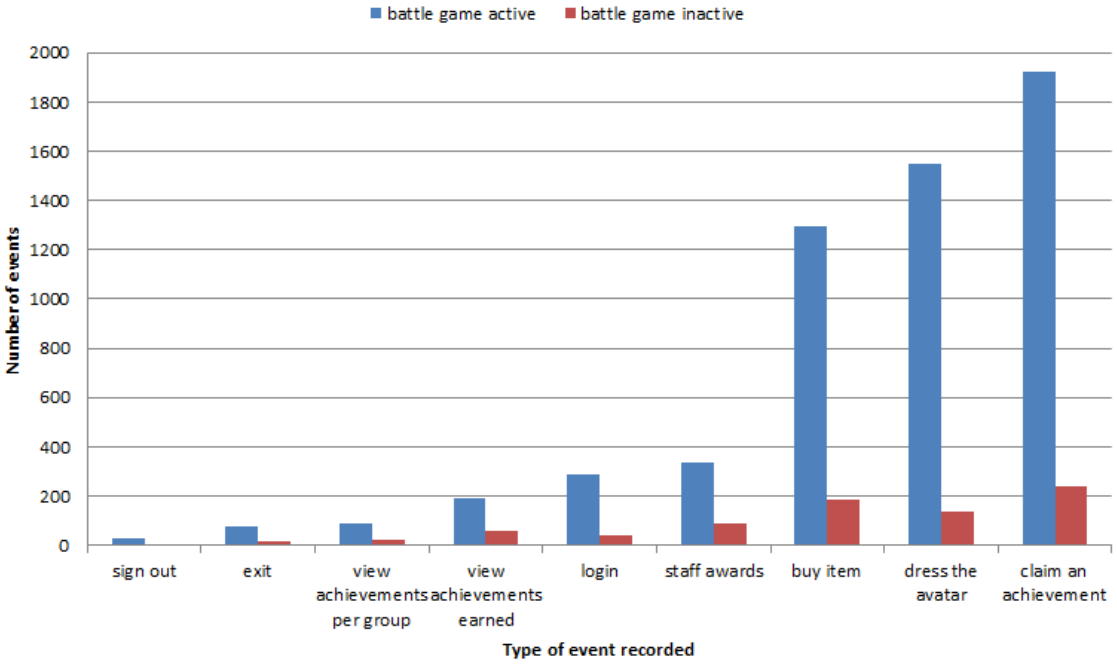

Figure 20. Rate of common events recorded before and after Battle Game activation

Figure 21 shows the total number of achievements claimed by all players over the life of the study.

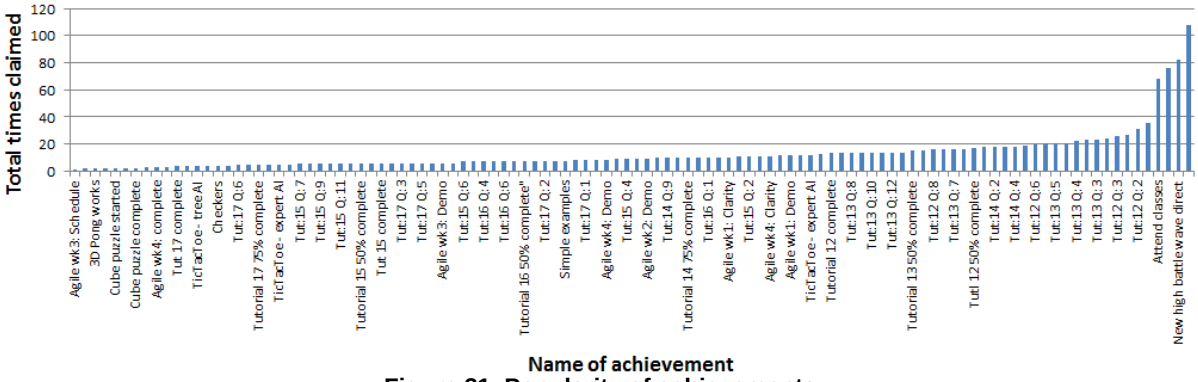

Figure 21. Popularity of achievements

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.
- 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's useful to be able to produce a distribution graph like Figure 21, 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.
- 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 shows this is not happening (the achievements with high claim rates were expected).

3.5.2 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 revealed there were different patterns of behaviour evident. 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 behaviour 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 progres. The behaviour is not a good match for Bartle's explorer or killer player types.

Bartle's taxonomy of player types aren't an exact match for the behaviour observed in this gamification study and it may be the case that a different taxonomy is more appropriate for gamification.

Figure 22 shows each user's level of total app activity, indicative of a low, medium and high level user.

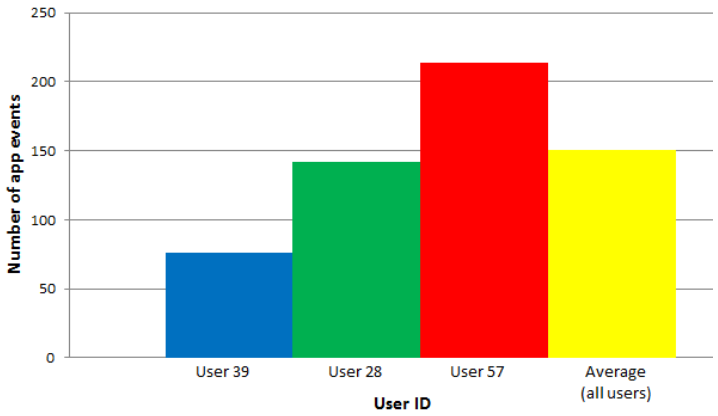

Figure 22. Total app events per user

User 39 is categorised more towards the Achiever part of the spectrum, user 28 comes under Socialiser and user 57 matches the Exploiter category. These categorisations are based on the metrics data and interviews which follow.

There was a wide variation in usage during the day, as can be seen in Figure 23. The app was created for a lesson that ran 9am until 1pm, but some students used it well outside those times.

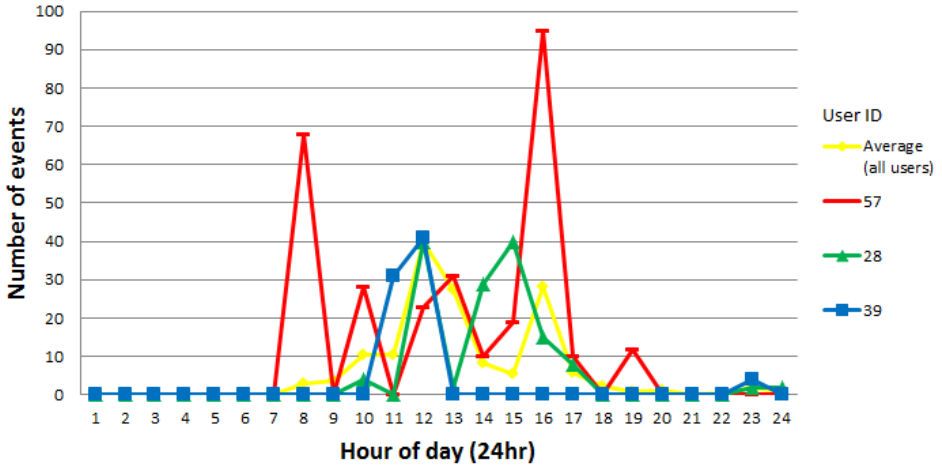

Figure 23. App usage patterns by hour of day per user

The lesson ran on Thursdays with most usage recorded on that day, but some students used the app on other days, see Figure 24.

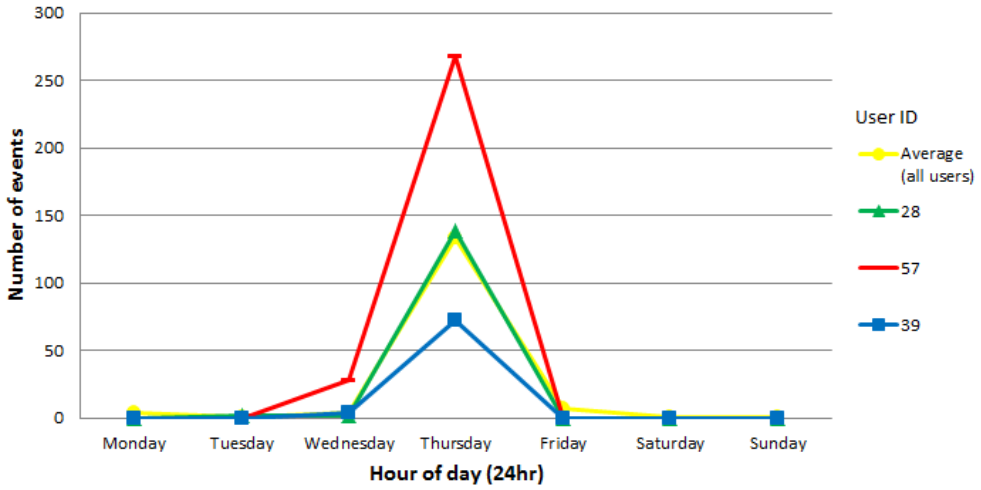

Figure 24. Usage patterns by day of week per user

Playing the app's embedded Battle Game motivated some students more than others, see Figure 25.

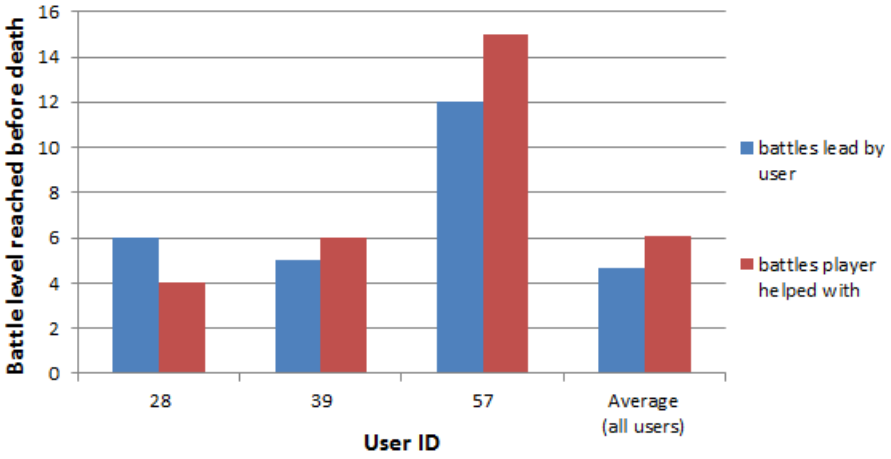

Figure 25. Highest level achieved in battle per user

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 26.

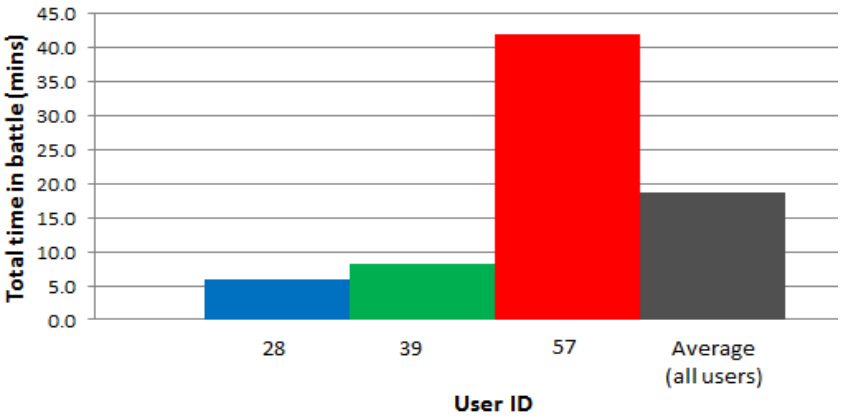

Figure 26. Total time spent in battle per user

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 7) or communal area large screen TV (see Figure 8).

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 16] and looked at what I should be doing."

4 Discussion and Conclusion

4.1 Summary of Results

The introduction of the Battle Game into the gamification app increased engagement with the app by 217% as predicted by our hypothesis. Interviews and metrics confirmed one competition related side-effect: cheating.

This study had a number of limitations resulting from the ethical and practical constraints of working with students during lectures and tutorials, while complying with their university regulations. The purpose of the application was to increase student satisfaction with their studies, with the expected side-effect that attainment would increase. Although the students interviewed confirmed they had enjoyed using the application, no measurements were made of attainment. Gamification and competition specifically, have been associated with reductions in intrinsic motivation (Deci and Ryan, 2000). This study did not attempt to measure intrinsic motivation. Gamification is prone to positive results due to novelty (Hanus

and Fox, 2015) and the study lasted only 12 weeks (one semester) with the Battle Game only active for 3 weeks at a time. This first prototype application was used with students from a games related course and in small numbers. It's important that any outcomes should be verified with a larger group of participants from non-gaming related courses.

4.2 Qualitative discussion

In this study the compulsive nature of the gamification app was evident even without any real-world reward and students did engage with the software and value the progress of their virtual avatar. However, care must be taken in selecting credit earning achievements and deciding their value. The embedded video game and general competitive design elements create a compulsive desire in students to earn more credits to improve the status and battle performance of their virtual avatar. It is desirable for achievements to be evenly spread across a range of positive student activities that promote engagement with their studies. As noted in the interviews there is a tendency for some students in this group (Exploiters) to optimise their use of the app and earn the maximum quantity of credits for the minimum time/effort - gaming the system (Baker et al., 2009).

It was assumed that without real-world significance there would be little reason for users to cheat. Therefore some achievements could be left to user self-certification, e.g. students can tick off tutorial work as they complete it, whenever they complete it, without needing authorisation. Some students (Exploiters) identified this part of the app as a way to earn more credits - they cheated.

Time spent by staff administering a system like UniCraft will never be zero; just looking up a student to award some points takes time. Technology can help, in this app students were arranged into an alphabetically sorted scrolling list of surnames, in a future version it would be faster to complement that list with photos. In terms of pedagogical flexibility, the only part of the app tied to the subject were the self-certified tutorials, but that only required a staff member to enter text descriptions of tasks, which were easily and quickly modifiable. However, it isn't practical to get a staff member to authorise every tutorial task each student completes within a large class. This was a factor in allowing self-certification of parts of the gamification app, which then became problematic due to cheating. There are a number of issues related to self-certification and cheating:

- Societal pressure not to cheat - generally people know that cheating is wrong and will need sufficient motivation to push past that taboo, even when there is no technical impediment to cheating.
- Task value - using the app takes effort e.g. turning it on, logging in and finding the part of user interface to claim a reward. The virtual reward must be compelling enough to warrant the effort or students will not bother.
- Perceived fairness - any voluntary game based endeavour loses its compulsive allure if it is widely accepted that players are cheating.

If self-certified rewards cannot be completely eliminated we must accept some amount of time overhead for staff authorisation. It’s important that strategies are developed to minimise this overhead (e.g. grouping tutorial tasks together so there are fewer of them to authorise).

It’s common to present progress in gamification systems through a leaderboard, but being able to demonstrate progress through a short Battle Game, either on a smart device or shared on a class projector, added interest and drama. However, the game design required careful consideration:

- The game should allow play (and avatar progress) without interaction so it can be displayed in class, on smart device or displayed in communal areas so players share the experience of progression together, adding to its compulsive nature.
- By using a game that can be played without interaction it was possible for students to play while working. Clearly students should be spending time studying, not playing a non-educational game.
- By additionally supporting a 'light-weight' form of interaction some players engage more strongly with the game. Although we want players to spend time studying, it's easier for them to engage with the app as a 'real video game' if there is some form of interaction. In UniCraft, this involved a 'one button' interface and students grabbing 'hearts' to help their avatar survive longer.
- The more compulsive the game part of the app is, the higher the risk that students will actively play it (one button clicking) during classes, this was mentioned during the interviews, where some students found direct interaction more compulsive than others and continued playing in other classes.

Through interviews, three broad player types were identified: Exploiter, Achiever and Socialiser. Each player type engaged with the app in different ways and by designing the app to maximise flexibility, these different engagement patterns could be supported to maximise participation.

Nobody can deny that video game inspired experiments, both inside and outside the classroom, have had an impact on education (McClarty et al., 2012). If elements of the student experience can be more compulsive, fun and competitive then that could help increase the retention of information and improve grades (Behm-Morawitz, 2013). If there are ways to bring forward the educational potential of video games without the time and expense of building subject specific games then that would reduce the cost to institution budgets and limit interference in rapidly changing curriculums (Deterding et al., 2011b). Gamification systems offer this potential, but only if they are inherently fun, non-compulsory and the competition that they rely on is constructive. Even with a thoughtful approach to game design that encompasses all these factors, the outcomes can be unpredictable and an agile iterative test-driven approach is needed.

4.3 Future work and impact

The next iteration of this software must do more to address cheating. Participants cheat when they lack motivation (they are seeking an easy way to make progress), this is less of a problem with UniCraft as participation is not compulsory. However, participants may also cheat when they are highly motivated (they are seeking to optimise their progress). Self-certification of progress was the only part of the software where cheating was detected and the next version should remove this element. It would be a mistake to simply switch to staff certification as that would increase the administration workload unacceptably. One potential replacement would be to introduce a group activity, such as a multi-choice quiz, administered by staff, with credits feeding the game's economy.

This study has shown it is possible to significantly increase participant engagement with a gamification project using constructive competition and video games. This increase in engagement occurred without using potentially negative extrinsic motivators: compulsory participation, financial rewards, prizes, prescriptive measurement or linking outcomes to students' final grades. Designing a video game for gamification is challenging, because the aim is to create something attractive that is perceived as a modern, fun, interactive 3D video game, yet participants must spend the majority of their time engaged with the task being gamified and not playing the video game. UniCraft shows one successful example of this approach to games design. A future experiment could attempt to measure levels of intrinsic motivation when using constructive competition and video games to confirm the efficacy of this approach.

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