Dissertation Progress Review

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Introduction

The project aims to explore how gamification and analytics can be used in the design of educational software. Gamification is a fairly young field of study, the term having only really gained popularity in late 2010, as shown in figure 1 (Google 2014). Its recent discovery has meant that far less has been done to incorporate developments on gamification into the current education system. While outside the scope of the project, one question that remains to be answered is how the engagement increases from gamification hold up when its use becomes widespread: is it only an increase relative to content that is not gamified, or can it offer an absolute increase in engagement?

In addition to the study of gamification, the project also seeks to provide an example of how analytics can be used to support lecturers and allow them to better use their time when teaching in a higher education context. This will be achieved by suggesting topics and delivery methods for guided one to one or seminar style tuition in an attempt to reinforce the progress made by students online. It will also be possible to match students who share learning styles and strength/weakness pairings in specific subject areas.

Construction of a web platform capable of the aforementioned functionality is a daunting undertaking, and the research required for it to be effective in it's aims will be substantial. Taking on a project in an exciting and relatively new field is proving to be both stimulating and rewarding.

Background Research

Before the start of term I enrolled on a MOOC entitled gamification design (Iversity, 2014), which ran over several months and included a vast array of references and resources. In addition to this, a number of other sources of information have been identified. Of particular note are those concerned with gamification in the context of higher education, (Nicholson, 2013) (Niman, 2014) given that it would appear that comparatively less work has been done in this sector of the education system. Most of the work I have done so far focusses on gamification in a broader sense in order to gain a sound understanding of the topic as whole, to facilitate a more in depth study of the facets specific to the project over the coming months.

It is worth studying the use of gamification in other fields, such as marketing, in order to gain additional insight into why it can be so effective, and to identify techniques which could be brought across into gamification in education. Game based marketing typically employs gamification techniques such as social networking elements and leaderboards, similar to those proposed for the project. It is often found that instead of incremental gains, customer attraction and retention increases exponentially (Zichermann and Linder, 2010).

It is also important not to forget research carried out on the *flipped classroom* model which the project follows. This is where students consume lecture material in their own time outside of school or university, instead using time spent in the classroom to ask questions and complete assessments usually done at home. Such systems often incorporate online testing and analytics like those in the project. The techniques being used to generate 'significant increases in student learning and achievement' (Fulton, 2012) are being adapted for use on
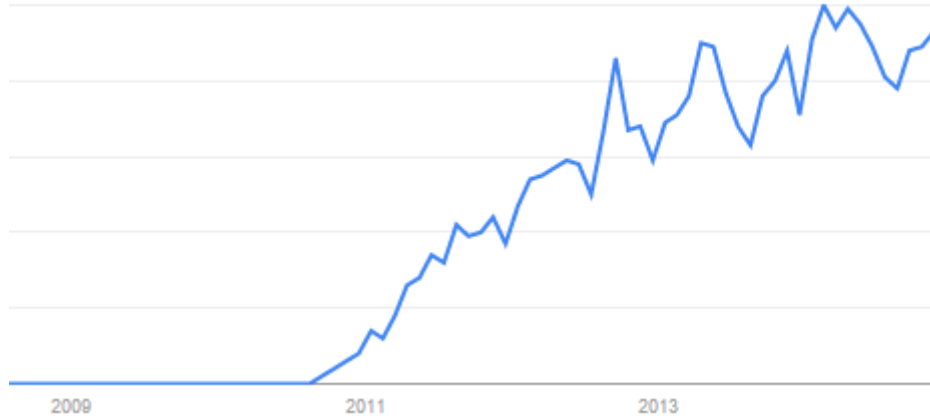
Figure 1: Usage of the term 'gamification' by month as a proportion of the total number of google searches for gamification, from 2009 to the present day (Google 2014)

the aforementioned web platform, with the aim of allowing lecturers to use their time with students more effectively.

While not all of the research for the project has bee completed, taking a look at the development timeline revealed that it was more appropriate to include research for the four personality types within the timeframe allotted for their development. In this way the research can better inform the programming. However, it would be foolish to just delay this research completely. Much of the broader work I have done so far has included analysis of these types, and as such, there are only a few avenues of enquiry left to persue. In structuring the research work in this way it is hoped that the later analysis can be completed swiftly.

Technical Content

Over the past eight weeks, work has been progressing largely according to the timeline set forth in the specification. The core of the platform has been completed, including the following high level features. Figure 2 contains an overview of the database which serves the project. It uses MySQL, and is currently hosted by the University's Computing Society. Database development uses phpmyadmin as installed on the Computing Society's server, which was chosen over the mysql command line interface (CLI) because it was easier to use without any prior experience, and the extra features that the CLI offers are either not required or can be exposed via running SQL commands through phpmyadmin. An overview of the classes used in the software is given in figure 3. PHP development is done using JetBrains PHP Storm, a powerful development environment used extensively in industry. Having already had some experience using PHP Storm, it was the logical choice given how its features allow for quicker and less

error prone development. To date, the following features have been completed:

User Accounts

In addition to an ID number and a username, those using the system also have persistent statistics stored and associated with their profile. This currently comprises information on their Bartle personality type, as derived from answers given to questions from course content, and a score aggregate. These values are used to generate a mask containing the users dominant personality types. Profile data is updated at the end of each module based on the answers given. A time weighted average is taken of the new scores and existing data according to a time decay constant defined in the user class. This value determines how quickly data decays in importance, or inversely, how much more relevant new data is than old data.

Content Creation

There is currently basic functionality allowing the creation and deletion of content and structural database elements. The logic for the creation page is mainly concerned with selecting and inserting database elements correctly. If there is enough time towards the end of the project, these tools could be improved, but they are currently sufficient to demonstrate the other features of the software.

Content Delivery

The content delivery pages present users with questions from the module they selected. Once a question has been answered, the response chosen is logged in the database, and the user is presented with the next question in the module for which they have not given an answer. If that was the only remaining unanswered question, they are instead directed to the module review page. This page shows the users persistent statistics, as well as their performance on the last module they took.

Progress and Next Steps

I realised fairly early into the term that the timetable I had submitted as part of the specification was a bit more demanding than was practical. While it achieved its objective in that it encouraged me to work hard from the start of the project, I am currently a week behind schedule after not having enough time available to complete all the work I had timetabled. In terms of the core of the application - the components required to facilitate the gamification features - development has finished, and these features are ready to use. This will allow me to begin researching and developing the areas that are linked to each Bartle personality type. A brief explanation of these personality types is given in appendix I. In addition to development, I have also been researching the wider usage and implementation of gamification. A selection of these resources are referenced in the background research section.

After the four Bartle areas have been covered, the product will be thoroughly tested for bugs, and user feedback sought from a small focus group. In the focus
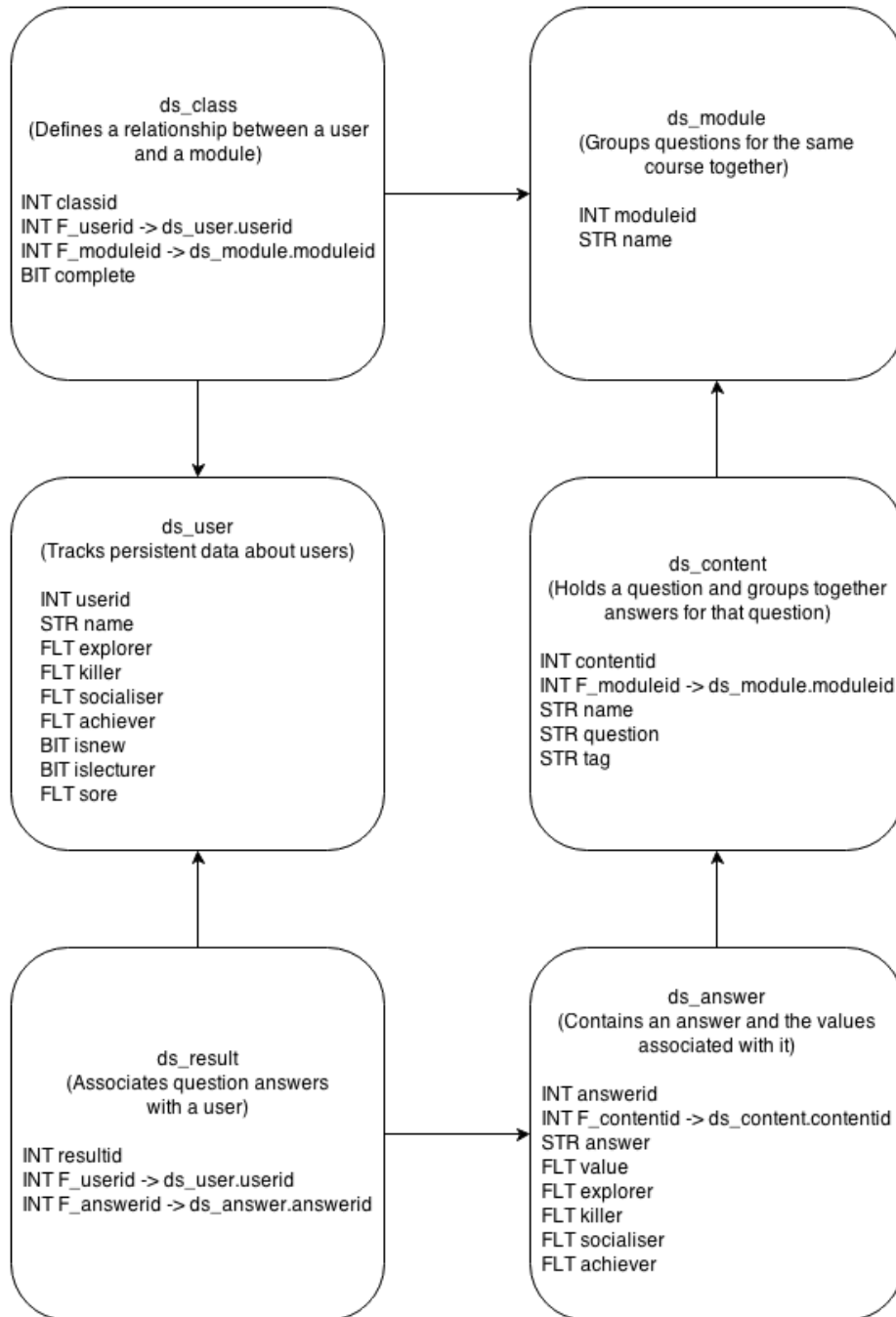
Figure 2: Diagram of the current project database. Arrows denote foreign key relationships. Foreign key fields are prefixed with 'F_' and have the field they reference appended after the '-⟩'.

index.php
Acts as a portal to the other parts of the software, and is responsible for setting session variables such as the module currently being worked on. Different options are offered for students and lecturers

content.php
Presents unanswered questions from the current module to the user and records the results

review.php
Offers an overview of the users current profile as well as feedback on the last module they took

create.php
Offers a suite of tools to lectureers including content creation, deletion and monitoring of students and classes

CORE MODULES

database.php
Exposes the database to other modules through a *query* command. Also facilitates the escaping of strings before insertion

login.php
Identifies users based on their username and lets the rest of the software know which user to associate records with

user.php
Defines a *user* object and exposes its properties via get methods and allows changes using to internal algorithms through set methods
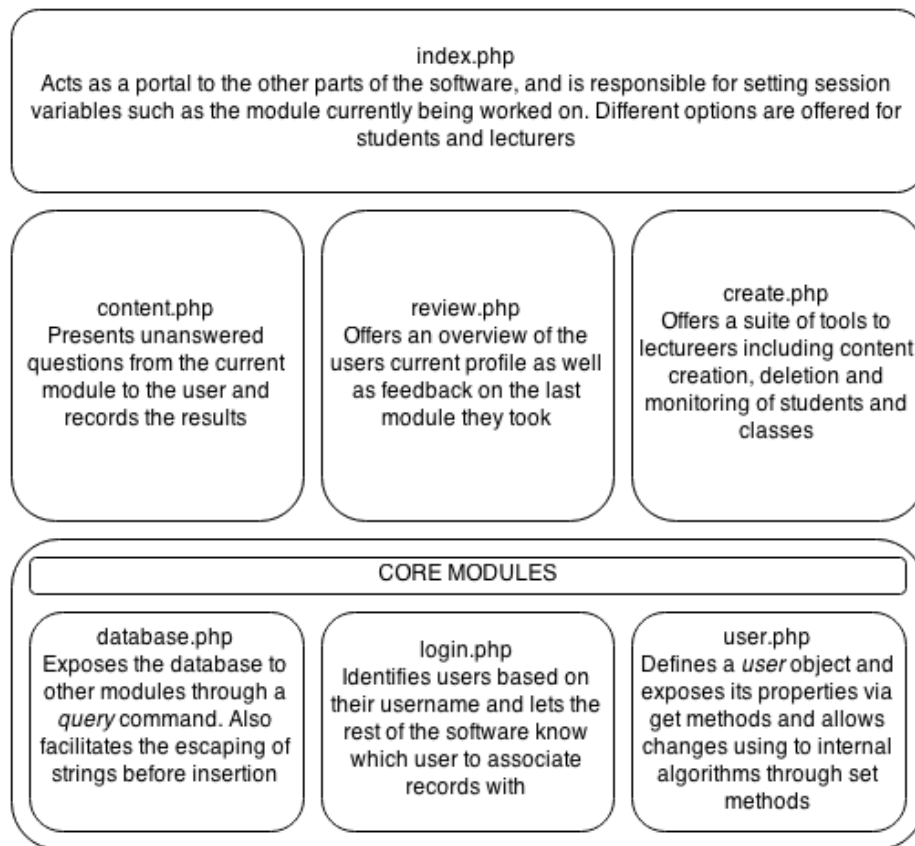
Figure 3: An overview of the classes used in the software.

group, a small number of people from the target demographic (undergraduate students) will be given a number of sample modules generated from computer science courses and asked to complete them. This data will be analysed in terms of assessing how accurately the software tracks a students user type, and how effective the tools targeted at each user were. These can be partially verified against a widely used online Bartle test available at *gamerdna.com*. Any major bugs will be fixed during this time, and any minor ones logged to be worked on should there be spare time towards the end of the project. Finally, the presentation will be delivered and the report compiled between the end of term two and the start of term three.

Appraisal

There was an error in the original timetable submitted in that the time set aside for writing this report was scheduled for after the due date. This, in addition to the scheduling issue mentioned above, has been rectified in a revised timetable contained in appendix II. The timeline is the only portion of the original specification that has been altered. On reflection, I am glad that I took the time to fully assess the data that would need to be stored in the database, as once the database structure is determined it is very costly to change. As such, being able to leave it alone during the rest of development has saved me valuable time. The scope of the project is large, and in order to ensure its completion I have had to distil the core elements down to their simplest form in order to develop and integrate them in the allotted time. To this end, the project as it stands appears quite bare bones, but I feel that this is acceptable given that the project is more of a gamification/split classroom prototype than an exercise in rigorous software development. As mentioned before, any spare time towards the end of the project can be used to add styling and other visual elements.

Ethics

As described in appendix I, ethical consent will have to be obtained for the user feedback testing planned for week five of term two. This approval still needs to be sought. However, as the activities proposed are eligible for devolved consent this will not take long, and will be completed at the beginning of term two.

Project Management

In terms of project management, I have been following a variant of the incremental build model, as identified in appendix I. This has been working well, and has allowed me to timetable software development more accurately than if a more popular agile methodology had been used. As mentioned in appendix I, the typical agile project has a basic version of the functionality developed before incremental improvements are added in each subsequent sprint.

The use of GitHub as a source and document control tool has been extremely useful, and it's use as a backup location has already proved invaluable once after an equipment failure. Being able to easily access and synchronise project files across multiple locations and physical devices has also been a great boon for

productivity. As a less formal form of project management, I have also been meeting with my project supervisor as required. These meetings have been used to ensure that the project is proceeding in a timely manner and that any documents that need to be submitted are of a sufficient standard. A log of all meetings to date can be found in appendix III.

Appendices

Appendix I - Original Project Specification

Project Title

Exploring the use of Gamification and Analytics in the Design of Educational Software.

Justification

While the uses of gamification and teaching analytics are often explored at the levels of primary and secondary education, far less has been done to study its effects in the context of undergraduate study. Researching and determining the most effective ways to use gamification in this project will be challenging task, as gamification is still in it's infancy, the concept having only really gained popularity around 2010. In addition to this, the web application that will developed for the project will be complex. It has to manage large amounts of analytics data as well as course content, serving the needs of both students and lecturers.

Objectives

Broadly, the goal of the project is to explore the use of gamification and advanced analytics in the development of educational software. This will be achieved through the development of an online platform allowing undergraduate students to test and enhance their understanding of course content through hybrid lectures/slides. Questions will be woven in to content delivery to provide students with rich, instant feedback on their understanding of a concept as well as additional material for extra practise. In addition, the software will categorise users into the four Bartle Test personality types (Achiever, Socialiser, Explorer and Killer) or which a brief description is given below. Users will be shown gamification elements appropriate to the users type.

The other way in which the software will aim to aid learning is in the tools presented to lecturers. Lecturers will be offered a broad overview of their modules, showing how different sections of content are being received by students. They will also be presented with detailed information on individual students, showing areas they are strong/struggling with. One example of the way in which this information can be used is to suggest content to be used as seminar content. Identifying problem areas in this way also allows for more effective use of teaching time and a better learning experience for students. Lecturers can put students who share a Bartle type together for seminars so that they can target their teaching style for maximum effectiveness.

This data can also be used to help students directly. One possible way to do this is to encourage students who are particularly strong in an area to help

others who are struggling. Likewise, students who are finding a particular piece of content challenging could be prompted to seek help from colleagues who have done well at that task. By designing content assessment to be more specific than the traditional right/wrong it might be possible to give more targeted feedback and suggestions for improvement that traditional tests or assignments allow.

What follows is a brief description of the high level functionality each software component will provide. These are the components used in the development timeline below.

Core App

The core of the application provides services such as database connectivity, objects to encapsulate users and content as well as login and authentication. It must be completed first because every subsequent task builds upon the functionality it provides.

Content Delivery

This part of the software is responsible for reading content from the database and displaying it to the user. It also takes input from the user if the content is interactive.

Analytics

A large part of the project revolves around capturing data about users and how they interact with the software. The analytics module is tasked with collecting and storing this data, and making inferences which can be used to offer a more engaging experience to the user (i.e. to decide which gamification elements are used).

Explorer Features

The explorer user type is most engaged by discovering new content. This user type can be targeted with extension material to consume at the users own pace, and should not require much additional functionality, just content.

Socialiser Features

Users who associate more with the socialiser personality type tend to seek out social experiences over anything else. To this end, the features targeted at socialisers include the ability to interact with other users who are consuming the same content, be it to give or seek help or even just discuss the task at hand.

Achiever Features

Achievers tend to prioritise completion and progress awards when they interact with systems. The features offered to them will help them track how much of the content they have completed and offer achievements based on challenging goals.

Killer Features

While many of the tendencies displayed by killers are not productive in an education environment, the competitiveness and desire for control they show can still be leveraged to provide an engaging experience. Features like scoreboards appeal to killers, and it may be possible to encourage them to assist other users as it puts them in a position of control.

Methodology

The software will be web based, written in PHP, HTML, CSS and javascript, using appropriate frameworks and libraries. Github will be used for version control for both software and documents, and the repository will be synchronised with my personal webspace on the computing society's web server to allow for easy testing. User information and module content will be stored in a mySQL database, also hosted on the computing society's server.

The software development methodology used will be an adapted version of the incremental build model. Each section of the software will be developed, tested and integrated in sequence. As the analytics part of the software (tasked with storing and updating user data, as well as making inferences based on this data) is a dependency bottleneck, the agile practise of developing a basic version first before adding features would not work. The lack of external stakeholders removes the need for frequent releases and feedback and makes the proposed methodology effective for the task at hand.

The effectiveness of the product will be determined primarily by feedback from students and staff. The exact nature of the interactions with these parties will be determined early in term two, but will definitely feature one on one sessions and interviews. The feedback provided by these sessions will form the basis for discussion on the success of the project.

Timeline

Term/Week	Tasks
1/1	Specification
1/2	Specification
1/3	Core App, Environment
1/4	Core App, Content Delivery
1/5	Analytics
1/6	Analytics
1/7	Socialiser features
1/8	Achiever features
1/9	Killer features
1/10	Progress Report
Christmas Holiday	Buffer zone (catchup)
2/1	Explorer Features
2/2	Full product testing
2/3	User feedback sessions
2/4	User feedback sessions and feedback analysis
2/5	Report
2/6	Report
2/7	Report
2/8	Pesentation
2/9	Presentation
2/10	Presentation
Easter Holiday	Report

Dependencies for software related tasks

Task	Dependencies
Core App	Specification
Content Delivery	Core App
Analytics	Content Delivery, Core App
Explorer features	Core App, Analytics
Socialiser features	Core App, Analytics
Achiever features	Core App, Analytics
Killer features	Core App, Analytics
Full product testing	All of the above

Resources

As mentioned above, the master copy of project documents and source code will be on Github. In addition, a clone of the repository will be copied after every commit to my Computing Society webspace for testing, and working copies will exist on my desktop and laptop. In terms of reliability, two of the above services could fail with no loss of data for the project. If an alternative web server is required for testing, it is possible to host the project on Joshua in the department if required. The schema and data used to create and populate the database will be added to the repository to aid recovery in the event of the database server failing. This can be uploaded to Joshua in the event of the Computing Society server failing.

When it comes to academic resources, copies of any potential papers or studies will be stored on my personal computer to provide a backup source should access to an online version be lost.

Legal, social, ethical and professional considerations

As student and staff feedback will be required, approval will have to be sought from BSREC. As this project fulfils the conditions for delegated approval, any such activities will only have to be signed off by the project supervisor instead of being formally submitted to the committee.

Appendix II - Revised Timetable

Term/Week	Tasks	Changed from v1
1/1	Specification	No
1/2	Specification	No
1/3	Core App, Environment	No
1/4	Core App, Content Delivery	No
1/5	Content Delivery	Yes
1/6	Analytics	No
1/7	Analytics	Yes
1/8	Progress Report	Yes
1/9	Socialiser features	Yes
1/10	Socialiser/Achiever features	Yes
Christmas Holiday	Buffer zone (catchup)	No
2/1	Achiever Features	Yes
2/2	Killer Features	Yes
2/3	Killer/Explorer features	Yes
2/4	Explorer Features	Yes
2/5	Product testing and feedback sessions	Yes
2/6	Feedback analysis	Yes
2/7	Report and presentation writing	Yes
2/8	Report and presentation writing	Yes
2/9	Report and presentation	Yes
2/10	Report and presentation	Yes
Easter Holiday	Report	No

Appendix III - Meeting Log

Date	Format
Thu 2nd Oct 2014	Face to face
Mon 6th Oct	Face to face
Tue 7th Oct 2014	Email
Fri 31st Oct 2014	Face to face
Wed 12th Nov 2014	Face to face
Tuesday 13:30	Face to face
Tue 18th Nov 2014	Face to face

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