Gamification in a learning resource for the study of Human Computer Interaction

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Abstract. Human Computer Interaction (HCI) is increasing in relevance as it, in part, concerns the design of digital interfaces such as downloadable apps. Despite the importance of the subject area students frequently find the topic boring, dry and overly theoretical. In order to address this apparent lack of student interest, a gamified learning resource for a HCI module in the second year of University was created. A literature review into the HCI educational requirements was conducted and used to inform the design. A further analysis of the literature on dialogic feedback, simulations and gamification features was conducted and key features were matched to the educational requirements. The resultant gamified learning resource, dubbed the 'work simulation', was evaluated first by a two cohort comparison for module lecture attendance and exam attainment. The results of the first phase of the evaluation showed a statistically significant improvement in both attendance and attainment for the cohort experiencing the 'work simulation'. A further evaluation was carried out by means of interviews with students, which suggested that dialogic feedback and the game narrative/fiction, in particular, were useful.

Keywords: Educational Technology, Gamification, Human Computer Interactions.

1 Introduction

Human Computer Interaction (HCI), sometimes Computer Human Interaction (CHI), is the study of design and evaluation methods for computer based technology. Traditionally the main concerns of HCI have been efficiency and reliability [1]. However more recently emerging concerns in HCI include; usability, accessibility and User eXperience (UX). In the last few years the availability of easy to use tools for rapidly developing web and mobile applications has led to a proliferation of apps of varying degrees of usefulness. The importance of being able to design effective interfaces and to evaluate their performance has never been more evident. The role of HCI as a subject within 'computing' courses is crucial if the next generation of software designers and developers are going to be able to meet the challenges of tomorrow.

1.1 HCI pedagogic challenges

One of the key objectives when teaching HCI is to assist students in preparing for professional practice [2]. However many of the core techniques such as scenario building and storyboarding can seem irrelevant to students and are not always taken seriously by them [3]. For instance in a study by Aberg [3] students described the study of HCI as 'fuzzy' and 'trivial'. HCI has a relatively large theory base relative, that is, to more praxis oriented subject areas such as programming. Factors such as perceived relevance and the study of theory together with the fast pace of change [4] can make HCI a pedagogic challenge.

1.2 HCI educational aspirations

It has been a long held view that a HCI learning experience should be active for students and should be engaging [1]. Aberg [3] suggests that students also need a sense of realism in HCI learning contexts for example the use of high fidelity prototypes as opposed to paper prototypes that can add to a sense of achievement. Furthermore, students should be engaged in creating meaningful projects [5] that are situated in real contexts [6]. It has also been argued that regularly submitted exercises are a good means of drawing connections to the course literature [3]. In a similar vein the use of 'case studies' in HCI education is important as it can add authenticity [1]. Case studies can be problem-based using real world or analogous scenarios which may encompass development projects and papers from the literature. Typically, students are asked to apply methods to clearly defined problem areas. Case base learning also includes decision-making cases where students are asked to arrive at a finding and be able to justify the reasoning. Decision-making cases have the advantage of encouraging reflection but are considered by some to be difficult to deliver to students [1].

Active learning and relevant case studies are the main stay of HCI education and in addition there are other aspirations for quality enhancement. For example HCI learning should facilitate both individual and collaborative learning [5]. It has also been suggested that it is useful to include feedback which can be rewarding and improve participation Aberg [3]. Some sources have argued that it is important to have strict requirements on reflection Aberg [3] as reflection is an important aspect of experiential learning [7] which underpins much of contemporary HCI education. Another useful goal for HCI education is

to support communication between students, peers and tutors [1]. It has also been suggested that unexpected experiences [7] can add interest and that puzzles and games are useful for supporting students in dealing with difficult concepts [8].

Summary of Requirements for effective HCI education from the literature:

- Active learning [1]
- Creating meaningful projects [5] real context projects [6].
- Regular hand-in exercises and feedback [3].
- Problem and decision based cases [1].
- Promote realism by working on high-fidelity prototypes [3].
- Maintain individual and collaborative learning [5]
- Promote reflection [7] [3]
- Interactions between students and tutors [1].
- Include unexpected experiences [7]
- Inclusion of quizzes and games [8].

2 Pedagogy for HCI

In the previous section we outlined the general problem which is the improvement of HCI education and arrived at a set of requirements for learning. The pedagogy provides us with a number of powerful ideas which can help to inform the design and creation of a response.

2.1 Blended Learning

Having arrived at requirements for HCI education the next step is to consider how pedagogic theory can be applied in pursuit of the goal of creating a solution. The requirements suggest that a mixture of face to face teaching and e-learning resources, commonly referred to as blended learning [9], are appropriate. Blended learning has become more significant due to the prevalence of VLE's in universities [10]. It has been suggested that blended learning represents a paradigm shift from teaching to learning [11] and that there are advantages of using both, face to face and digital resources, over technology alone [12].

It is thought that adding online resources to traditional delivery can enhance student performance [13]–[17]. For instance, a study into the implementation of blended learning found a positive effect in decreasing dropout rates, and improving exam results and final grades. The positive outcomes associated with blended learning activities may improve student perception of the subject and effect career decisions [18]. A similar finding suggested that blended learning and attendance was indicative of student commitment and improved final marks [19], [20]. However not all sources are entirely positive about the use of blended learning, for instance Traphagen et al [21] points out that making learning materials available via a Virtual Learning Environments (VLE) such as blackboard can lead to poor attendance. Specifically finding that 76% of students agreed or strongly agreed that they had skipped classes because materials were available online; however it was also found that webcasting lectures largely offset the effect of non-attendance [21]. Overall there is considerable evidence that a blended learning approach is appropriate for matching our requirements.

2.2 Dialogic Feedback

Assessment and feedback is the means by which we measure academic standards and support students learning. They have a major influence on student perception and experience of learning [22]. Feedback is especially valued by students but frequently falls short of their expectations [23]. Feedback takes up a considerable proportion of staff time, effects reputation, impacts on league tables and, most importantly, shapes the way students study and learn. However survey results, across the sector, show students are often disappointed with the feedback that they receive [24]. In response academics react by attempting to produce faster feedback rather than look at the whole assessment process. It was been stated in a NUS student experience report [25] that 71% of students would prefer individual verbal feedback but only 25% of students experience this type of feedback. In a study conducted for the Higher Education Academy, Williams& Kane [24] suggested that students required dialogue in order to be able to successfully interpret feedback.

One system level approach to organising feedback is the dialogic feedback model which suggests that assessment and feedback should be organised as a dialogue between the tutor and student [26]–[28]. The dialogic feedback model is a dynamic process which provides scaffolding for the learning process [27].

The rationale for the effectiveness of dialogic feedback is based upon the central idea that the term 'feedback' implies a response. In other words, if a student submits work and receives comments that don't affect their subsequent actions then these comments are not feedback in the true sense of the word. It is not atypical for students to receive 'feedback' at the end of a module when coursework is submitted. It is possible that this feedback might affect how students submit subsequent work but it is by no means certain. The dialogic feedback approach suggests that in order to improve feedback to students, the feedback has to enable students to take actions based upon that feedback. The dialogic approach to feedback also suggests that feedback should be personalised to an individual student rather than general feedback that would be applicable to most or the entire cohort.

There are several aspects of the dialogic feedback model that have the potential to enhance the student experience such as providing a process for learning. However, for us the key question relates to how the approach may support of the HCI educational requirements. The requirements for active learning and feedback could be accommodated with the dialogic

feedback model as it requires activity from the student based upon reflection of feedback. In a similar vein the nature of the dialogic feedback model also requires interactions between students and tutors. The dialogic feedback model is generic, rather than subject based, and does not necessarily require criteria such as real world projects or problem and decision based cases. Overall the dialogic feedback model can provide a useful framework for design a learning experience which could promote learning.

2.3 Simulations

The use of work simulations in higher education can be a highly effective means of delivering employability skills [29]. It has been suggested that simulations can increase enjoyment in learning, allow safe experimentation in decision making [30] and help learners to understand theory [31]. Specifically the use of work simulations for management and executive courses is well established and often reported on favourably [32]. Ideally simulations should provide quick and detailed feedback to the learner [33] in the experiential learning tradition.

There are caveats to the approach of using a simulation including the fact that some are thought to be inefficient in general [34] and in particular for some subject areas [35], [36] have a lack of flexibility [29], over simplicity [37]. Simulations should not attempt to simplify or replace real world interactions within a group by a computer interaction [29]. It has been suggested that "topical and enduring Face To Face feedback" between students and tutor discussions can promote reflective practice and are more important than a simulation based interaction [29].

In spite of some limitations simulations can generate insights and deepen learning [38] and overall they can make a valuable addition to blended learning [29]. The key question in this study is 'how' and 'to what extent' simulations can address the requirements for HCI education which were outlined above. One of the requirements for HCI education concerns providing meaningful projects (problem and decision based cases) in real contexts and this is an affordances of simulations. Another of the key requirements for HCI education is that it should include unexpected experiences as well as quizzes and games. It would not be unreasonable to suggest that it is possible to design into the simulations narrative expected events or changes to circumstances. Although it is less clear that a simulation will provide for quizzes and games. There are other key HCI educational requirements that are not inherently supported by a simulation. For example, not all simulations enable collaborative learning and interactions between both students and tutors. Similarly, not all simulations are designed to support regular hand-in, feedback and reflection. An analysis of gamification was carried out in order to fully match the HCI educational requirements with design features.

2.4 Gamification

Gamification is the use of game concepts in non-gaming systems in order to improve the user experience of the system [39]. The idea is proving popular with many organisation in a range of sectors such as business, government, health and education [40]. The reasoning behind the use of gamification is that there are thought to be motivational properties of educational games which include allowing students to communicate and share accomplishments [41], [42]. There have been studies that state that student academic performance is significantly higher amongst those that participated in a gamified resources than those who did not [43].

2.4.1 Examples of Gamification

There are many examples of gamification in education such as Indiana University where course metrics and activities were gamified. Students were required to gain points, to move up the levels (grades), by completing activities presented using gaming concepts such as 'fighting monsters' which was used as a metaphor for tackling assessments [44]. In another example, narrative elements were used to target behaviours which were assessed as successes or failures [45]. In another example game elements, were used to incentivise students to complete online practice tests [46]. Although the proliferation of games concepts seems promising it has been suggested that many gamification initiatives will fail due to a lack of understanding of the cause and effect in the use of gaming concepts [40].

2.4.2 Caveats

Although there have been studies going back a number of years suggesting that educational games and gamification may lead to academic success [47], there are also studies that present significant caveats. Gamification can lead to mixed results due to design of the resources and their motivational affordances [48], [49]. It has been suggested that gamification helps students improve practical work but not written work [50]. It has also been found that students with prior experience of games had a greater positive valence for gamification [51] than mature students would did not have prior experience of games [43]. In some instances gamification did not have a positive affect thought to be due to cognitive dissonance for students who did not like the mixing of work and play [52]. Whilst it has been suggested that gamification can generate positive, intrinsically motivating learning experiences [53] it has also been asserted that gamified materials led to less intrinsic motivation [54]. The contradiction here is important because it is thought that deep learning is associated with intrinsic motivation whilst surface learning is associated with extrinsic motivation [55]. The concern regarding extrinsic motivation is focused on the potential for the goals of the game to become more important than learning the material. Out of concern for this possibility it has been suggested that gamification should avoid excessive use of the achievement aspects of gamification as it is based upon extrinsic motivation which isn't sustainable in the long run [56]. In a more recent study it was found that there was a decline in usage of a gamified resource over time [43] there was a similar decline in participation in this study a finding that is discussed below.

2.4.3 Design Features

Educational gamification includes the use of game mechanics with a Virtual Learning Environment (VLE) providing a flexible learning environment [41]. The game mechanics can include avatars, badges, leader boards, content unlocking and other

virtual goods [57] these game features can act as external rewards [58]. Goal setting in the gamified learning resource can be used to direct the attention of learners and to motivate students [41]. Kofinas[59], proposed a narrative approach to gamification to encompass both formative and summative assessments which can be set as challenges to overcome. A narrative approach was utilised in this study.

It has been suggested that in the design stage of a gamified learning resource that the process of feedback to students has to be incorporated. The feedback process should be implemented using a loop of motivation to action to feedback to motivation, in order to encourage engagement with the resource [60]. Another key feature of a gamified system is the 'novelty effect' which seeks to intrigue users and to encourage them to progress through the content of the learning resource, however as the novelty wears off the motivation of students may decrease [48], [49], [54], [61]. The ideas of using a 'feedback loop' and the 'novelty effect' were instantiated in the 'work simulation' in this study.

The use of games concepts has been used quite informally with individual researchers choosing familiar ideas and applying them to learning [40]. However, Bedwell [62] has created a taxonomy of gamification attributes which are explained in table 1 [62].

Table 1. Gamification Attributes

Attributes	Explanation
Action Language	Communication between player and game e.g. UI controls
Assessment	Progress tracked e.g. points and/or leader board
Conflict/challenge	Problems and difficulty e.g. inter-team competition
Control	Player alter the game e.g. discussion forum
Environment	Surroundings of the player e.g. move from physical to virtual
Game fiction	Game story e.g. lectures and tests are renamed adventures
Human Interaction	Degree of player interaction e.g. participation noticeable to others
Immersion	Affective & perceptual experience e.g. use of real world imagery
Rules/goals	Information for progress e.g. correct answers

2.5 Summary

This section contains a review of a number of approaches to the design of a blended learning resource such as; simulation, dialogic feedback and gamification. In summary table 2 provides a mapping of requirements to attributes suggested by the approaches.

Table 2. Mapping of requirements to pedagogy

HCI Educational Requirement	Simulation	Dialogic feedback	Gamification Attribute
Active learning [1]			Action Language
Creating meaningful projects [5] real context projects [6].	Case study	Submit work	Immersion
Regular hand-in exercises and feedback [3].		Feedback	Environment
Problem and decision based cases [1].			Challenge
Promote realism by working on high-fidelity prototypes [3].	Employability Tasks		Assessment
Maintaining individual and collaborative learning [5]			Human Interaction
Interactions between students and tutors [1].			
Promote reflection [7] [3]		Response to Feedback	Control
Include unexpected experiences [7]			Game Fiction
Inclusion of quizzes and games [8].			Rules/Goals

3 Designing a gamified learning experience

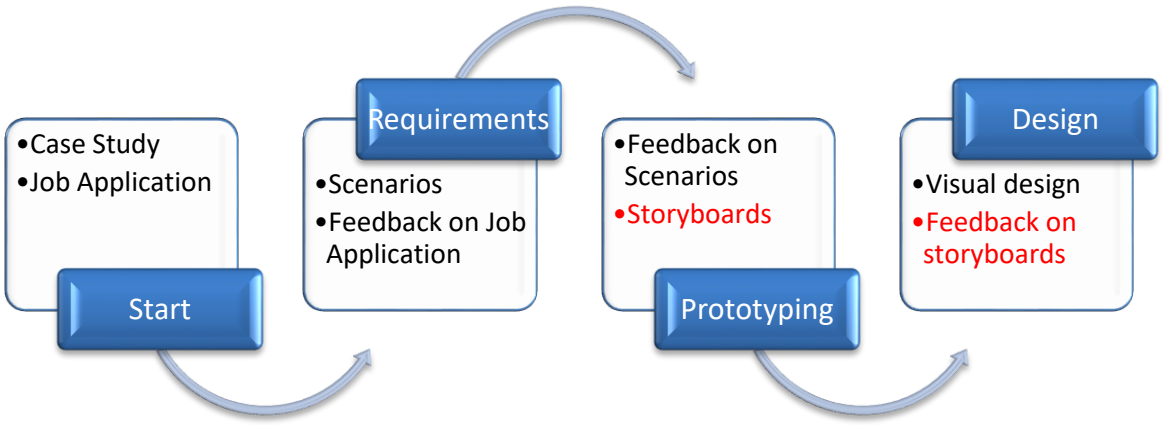
The design for the learning resource began with an examination of the modules learning requirements together with the HCI educational requirements. The design process was iterative taking account of good practice from the literature review including the gamified attributes which were articulated into specific features. The work simulation narrative was based on the premise of the student working as an intern at an app design and development business. The narrative was presented via first a job

advert, then emails and sms from the 'boss'. In addition, there were decisions trees which presented students with real world decisions scenarios which they examine using interactive trees. Screen shots in figure 1 illustrate some of the interface elements.

Fig. 1. Work simulation

The Dialogic Feedback model was implemented via weekly feedback to students as illustrated in figure 2.

Fig. 2. Work Simulation Dialogic Feedback



The feedback was made up of verbal comments and a gamified marking rubric, which used language common to games such as 'expert' and 'newbie'.

The final stages of the design process involved ensuring that the HCI educational requirements were mapped to a game attribute [62] and implemented in at least one specifically gamified feature. A summary of the attributes to features is give in table 3.

Table 3. HCI Requirements mapped to gamification features

HCI Educational Requirement	Game Attribute	Gamified Feature
Active learning [1]	Action Language	UI Controls
Creating meaningful projects [5] real context projects [6].	Immersion	Incremental tasks as SMS and emails
Regular hand-in exercises and feedback [3].	Environment	Real or virtual world tasks
Problem and decision based cases [1].	Conflict or Challenge	Decision Trees
Promote realism by working on high-fidelity prototypes [3].	Assessment	Progress tracking using rubric descriptions
Maintaining individual and collaborative learning [5] Interactions between students and tutors [1].	Human Interaction	Individual and group tasks
Promote reflection [7] [3]	Control	Player impact on game
Include unexpected experiences [7]	Game Fiction	Narrative of work simulation
Inclusion of quizzes and games [8].	Rules/Goals	Accessibility game & ethics quiz

4 Methodology

The problem addressed in this research is the creation of an effective gamified learning resource which addresses key requirements for HCI education. In devising an evaluation methodology there are two distinct processes which need to be examined; the first is a holistic measure, of effectiveness for the gamified work simulation approach in general, the second is to examine the constituent parts of the resources. The holistic measurement of the work simulation can be inferred by general data such as student module lecture attendance and attainment in the exam. However, a constituent analysis should look at the HCI educational requirements matched to the attributes of the resource, otherwise it is impossible to determine which if any individual element is having a positive effect on learning. The aim of the research is stated in the following research question and hypotheses.

RQ – Is there evidence of educational effectiveness for the work simulation?

H1 – Module lecture attendance is improved for students experiencing the work simulation
H2 – Attainment in the end of module written exam is improved for students experiencing the work simulation
H3 – Students report favourably on one or all aspects of the work simulation

The module lecture attendance and examination attainment was examined for two cohorts, one of 97 students the other 104 students, both studying an HCI module. The lecture content, assessed by means of an exam, was the same for both cohorts. The control cohort experienced a 'traditional' delivery for the practical classes. The traditional practical class delivery provided students with a list of assessment tasks in digital form, responses to which were submitted at the end of the module's twelve-week delivery period. The experimental cohort experienced the gamified work simulation during the practical classes. The gamified delivery required students to attend in order to receive feedback on the previous week's task. This in practice meant that attendance at the practicals was mandatory for the experimental group. In summary, both cohorts were assessed by means of an exam, the control cohort submitted a coursework based on the practical tasks (at the end of the module) whilst the experimental cohort submitted the work simulation tasks (each week).

All students were required to 'swipe' their student ID cards using a card reader in order to register their attendance. The attendance data was examined for the two cohorts over a 10-week period, in respect of student attendance at the lectures only. One cohort had to attend the practicals the other did not, therefore the analysis of attendance data for the practicals would be heavily slanted. However, both cohorts experienced the same block of 10 weekly lectures. The data was examined as a comparison of the percentage of the cohorts that attended.

The attainment data in respect of the exam was examined for the two cohorts of students as explained above. Students in both cohorts were given a mark out 100 (operationally a percentage) for the tasks either presented in the traditional manner or the gamified work simulation. The data for each cohort was analysed to compare the distribution of ordinal grades; A, B, C, D, F. Such an approach yields data such as how many 'A's in one cohort as compared to another.

In the second phase of the evaluation process two sets of structured interviews were conducted in order to determine which aspects of the work simulation, if any, were considered to be useful to students. There were a total of ten student volunteers. In the first set of interviews five students from the control group and five from the experimental group gave responses to question associated with the HCI requirements list. The requirements were operationalised as questions (given in appendix 1).

In the second phase five students from the experimental group were asked questions specific to the work simulation, which the control group did not experience. The questions were based upon the features of the work simulation. The participants were asked to 'describe your experience of X' and 'was your experience of X positive, neutral or negative'. Where X was a specific feature for example the decision trees.

The comments from the interviews were summarised by a three person panel.

5 Results

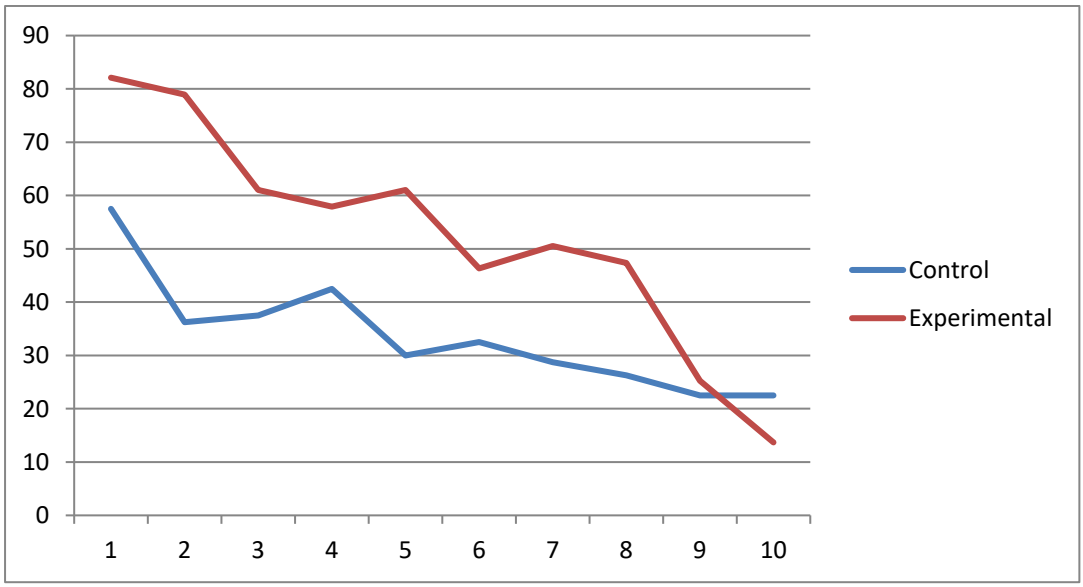
There are two result sections; module attendance and attainment in the exam as well as student interviews.

5.1 Attendance & Attainment

Data for two cohorts were examined; the first acted as a control and didn't have access to the resource, the second was the experimental group which did have access.

The attendance data was taken over 10 weeks and was in regard to the module's lectures. The gamified resource, known as the 'work simulation' was used in the practical session, this meant that relative rates of attendance between the two cohorts at the practicals would not be not be meaningful. However, the lecture arrangements were the same for both cohorts. The results for the experimental group showed a mean attendance score of 52% whilst the control group mean was 33%. The data showing a higher rates of attendance for the experimental group is shown in data-set 1 and illustrated in figure 3.

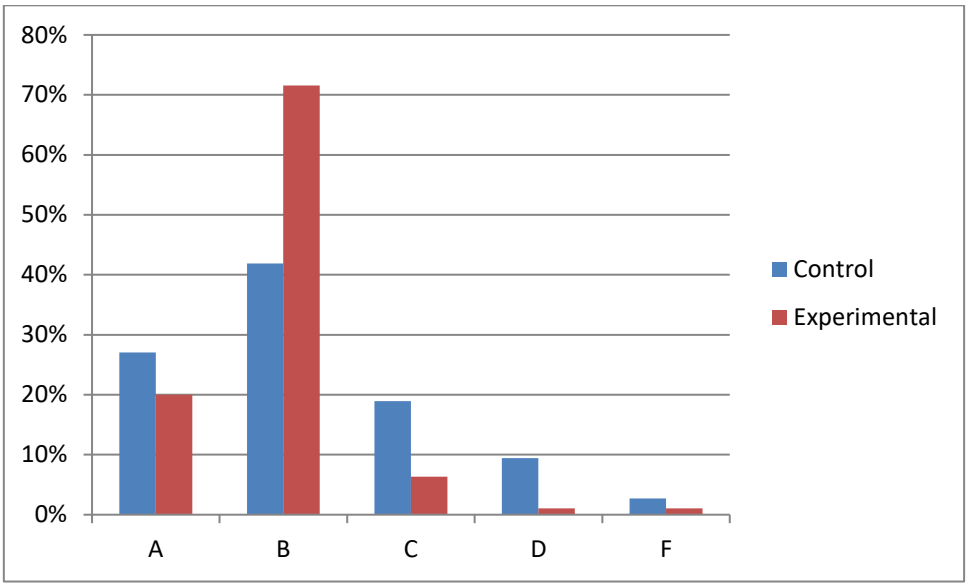
Fig. 3. Attendance percentage s for two cohorts over 10 weeks



A two tailed t-test was carried out to test for statistical significance and was found to be P=.05%, which can be expressed as a one in twenty chance that the difference between the two sets of scores occurred by random factors. The result shows that the experimental group, which experienced the work simulation, had statistically significant higher rate of attendance at the lecture than the control group.

The attainment data was taken from the results of a written closed book examination. Both the control and experimental groups had access to lectures and tutorials made up of the same materials. The control group spent the practical sessions working on the practical assessment in a self-organising way, whilst the experimental group experienced the work simulation. The examination questions differed between the two groups but in both papers the primary aim was to assess the understanding of the same knowledge content related to the lectures. The results were; a difference in the means between the control group of 62.5% and the experimental group of 66% which was statistically significant at P=.05% for a two tailed t-test. The results in data-set 1, which are illustrated in figure 4, show the results categorised in an A-F ordinal scale.

Fig. 4. Examination Attainment grades for two cohorts



In the experimental group 72% or students attained a B grade (60-70%) as opposed to the control group which attained 42% B grades. However, the control group had a greater number of students attaining an 'A' grade at 27% as opposed to the experimental group which had 20%.

5.2 Student Interviews

In order to obtain a more in depth perspective on the student perceptions of the work simulation interviews with a group of student volunteers were conducted. The interview participants were asked about the HCI educational requirements (given above) using the questions set out in appendix 1.

In summary the findings in regard to the HCI requirements from both the experimental and control groups were;

- Improvement for the experiment group
  - Regular hand-in and feedback
  - Problem and decision based
  - Peer and Tutor interactions
  - Unexpected experiences
- Little or no improvement for the experimental group
  - Active learning
  - Meaningful projects
  - Promote realism
  - Promote reflection
  - Include quizzes and games

In addition, interview participants were asked to describe their experience of the various features of the work simulation stating whether they were positive, neutral or negative.

In summary the key findings in regard to the gamified features from the experimental group were;

- Simulation
  - Case study was broadly useful but the employability tasks were not
- Dialogic feedback
  - Weekly submission was considered by some to be a burden but feedback and response to feedback were very positive
- Gamified features
  - Largely positive concerning; 'Immersion' in terms of the weekly tasks, 'game fiction' in terms of the narrative, action language in terms of the user interface and 'conflict or challenge' in terms of the decision trees.
  - 'Control' and 'assessments' in the gamified resource was negatively reported upon.

The results are discussed in the next section.

6 Discussion

This study involved determining the requirements for HCI education and subsequently the creation of a resource based on a number of ideas from the pedagogy intended to match those requirements. The results of evaluation of the 'work simulation' resource are now interpreted in the light of the examined literature.

6.1 Blended Learning

The use of blended learning is thought to be useful for improving student attainment [13]–[16]. For example Lopez-Perez et al [18] stated that blended learning could improve results as well as attitudes to learning.
In this study, which examined two cohorts, an improvement in the mean percentage for the experimental group was found. A breakdown of the percentages, converted to grades A-F, (see figure 4) shows that there was a substantial increase in the number of B grades. However, this was not the case for A grades. The effect found in the results is not a uniform improvement in exam attainment with C grades becoming B grades and B grades becoming A grades. Rather figure 4 shows that effect is limited to C grades becoming B grades this suggests that the resource might be supporting 'average' students rather better than 'excellent' students. Although it should be noted that these are two separate cohorts, we can speculate that the increased number of B grades is due to improvements in base level understanding and that the effect is more pronounced with C grade students.

Not all studies lend support to the use of blended learning for example Woltering et all [20] suggested that such an approach was deleterious to attendance. Furthermore Traphagen et al [21] found that 76% of students agreed or strongly agreed that they skipped classes when materials were available via a VLE. In this study attendance for some classes was mandatory and was designed that way in part to address such concerns. However, the results of an analysis between two cohorts for lecture attendance, which was not mandatory, showed better results for the experimental group than for the control group.

It should be noted that the results showing improvements in exam attainment and attendance could be the effect of inherent differences between the two cohorts. Notwithstanding this caveat H1 (Attendance is improved for students experiencing the work simulation)and H2 (Attainment is improved for students experiencing the work simulation) are supported by these findings. Assuming that there is a positive effect as the results indicate, it is worth considering what elements of the work simulation might be contributing to that success.

6.2 HCI Requirements

The central ethos for the design of the work simulation was to match the HCI educational requirements as suggested by the literature review. The HCI requirements, which were mapped to design features, were posed as questions to two groups of students one from the control and one from the experimental group. It was found that the work simulation resulted in more positive responses from the experimental group for; regular hand-in and feedback, problem/decision based learning, peer/tutor interactions and unexpected experiences.

Results from students in the experimental group indicated that the weekly hand-in regime was found to be onerous but at the same time the weekly feedback was valued. This finding was echoed in responses to the peer and tutor interactions. The problem and decision based experiences were also positive and there was a clear distinction between the two groups concerning the increased opportunities provided for this by the work simulation. Because the work simulation was controlling the access to the tasks and resources as the narrative progressed, students had 'unexpected experiences' and, it is argued, felt more engaged as indicated in de-Marcos [61].

6.3 Simulation & Dialogic Feedback

The experimental group also responded to question concerning the designed features of the 'work simulation' grouped into; simulation, dialogic feedback and gamified aspects as set out in the literature review.

The dialogic feedback, given on the work simulation coursework tasks was, overall, appreciated by students; they found benefit in the process of obtaining weekly feedback and being able to respond to the feedback in order to improve their exam attainment. The design for the feedback schedule, modelled on Beaumont et al [27] and the feedback loop suggested by Werbach [60], was valued by students. It is possible that the process of work simulation coursework feedback helped to reinforce learning and led to improved performance in the exam although that can't be stated definitively.

In terms of the simulation aspect it was found that students appreciated the case study but not the employability aspect, which was, for example, the writing of a CV style letter in response to the case study. There is only tacit support for the simulation aspect, however there is an overlap with the simulation case study and the narrative of the game which we will turn to next.

6.4 Gamified Features

The gamification aspects of the work simulation were laid out in table 3 (above). The gamified elements [62] discussed next are highlighted in bold for clarity.

Student responses to the interview questions indicated that the **immersion** and **game fiction** features, which delivered the narrative, were positively received. This finding supports the literature concerning the use of games style narratives [44], [45], [59].

It was also stated by some student respondents that the **game fiction** provided context for the weekly tasks. In addition, some students stated that the decision trees were "interesting and engaging" and the '**action language**', these were calls to actions in the work simulation, were also thought to be a positive aspect.

However, it was also found that students did not find the '**control'** aspects of the work simulation to be positive. The idea of 'control' in the work simulation was the way that navigation and content viewing was controlled by the software. Specifically, each week the software revealed the next set of role play tasks. In the future, it would be possible to allow students greater levels of user control with a 'peek forward' feature aimed allowing students to explore the future content.

According to Kofinas [59] **assessments** in a narrative can be 'challenges'. In this case study the 'assessments' findings were somewhat negative. The student feedback was that the assessments which involved submitting the weekly practical tasks were somewhat onerous. In this study, however, the **conflicts and challenges** element was intended to be the decision trees which provided the students with an unfolding scenario which presented choice points which affected the next step. Some of these choice points were counter intuitive, so for instance, it would not always be optimal to select 'ask the user' it might be a better choice to 'ask the client'. The results from the interviews suggested that students enjoyed exploring the decision trees.

The game **environment** attribute referred to the mixture of real world and virtual world elements in the gamified resource. For instance, some elements were conducted in the real world such as presenting a storyboard whilst others where interactive tasks such as the decision trees. The findings from the interviews were a mixture of positive to neutral comments, with one student reporting that the resource had a good balance between the real and virtual world.

The **Human Interaction** attribute referred to the interactions both between students and with students and tutors. The results of the interviews for this attribute were fairly positive. Students, to the extent they expressed a view, were positive about the interactions with teaching staff but in one instance concerned about workload balance amongst group members.

The **Rules & Goals** gamification feature prompted both neutral and positive comments from students. In the work simulation there were several features that could be described as having 'rules and goals' however as the work simulation narrative which had rules and goals was analysed in other attributes, the focus here was on an accessibility empathy game and an ethics quiz. The empathy game was based upon the idea of helping interface designers to consider software from the point of view of a user with a cognitive disability. The game involved the students having to use a navigable web interface to find information whilst preventing the loss of life in an arcade style game in a window to the side. The intention was to emphasise the possible distractions that a user might be experiencing. The ethics quiz took students through a number of ethical scenarios in which they had to make a choice. The inclusion of these features is suggested by Bedwell [62] and also by the 'novelty effect' laid out in de-Marcos [61]. The interviews with students suggested that the game and quiz did have a 'novelty effect' but the educational purpose was not clear to all students.

Overall the gamified features were fairly well received by students, at least as indicated by the interviews, and there is therefore partial evidence to support H3 (Students report favourably on one or all aspects of the work simulation). In reflecting on this study in the light of key ideas from the literature, for instance, the conflicting assertions about whether gamification would lead to increasing intrinsic motivation [53] or decreasing intrinsic motivation [54] over time, there weren't any comments from interviewed students to support either position. However, the attendance at the lectures did decline over time, as was the case in Tsay et al [43], which may suggest waning motivation.

7 Conclusions

HCI is an important subject because it is concerned with improving usability and accessibility of interfaces to technology. As technology, particularly mobile apps, proliferates the mastery of the subject becomes ever more essential. However, the subject matter can prove problematic for 'computing' students as it has a relatively large, and often contentious, theory base.

An analysis of the literature was carried out in order to garner the prerequisites for effective HCI education and resulted in a set of requirements. A consideration of the pedagogy produced a set of attributes to aid the design and creation of a HCI learning resource. In particular, blended learning, dialogic feedback, simulation and gamification ideas were used. A mapping of requirements to attributes was carried out. A design for the HCI learning experience was developed in relation to the mapping and taking into account the module learning outcomes. The design was used to create a gamified 'work simulation' based on the narrative of working as an intern at a design and development business and completing a set of weekly tasks. Dialogic feedback was implements via weekly feedback to students which comprised verbal comments and incorporating a gamified marking rubric.

The evaluation of the HCI learning experience involved two processes; the holistic measures of the effectiveness of the gamified work simulation and examination of the constituent parts. In terms of the holistic measure; data was collected regarding attendance and exam attainment. Interviews were conducted to ascertain from students the usefulness of the work simulation's constituent parts. The results indicated that the work simulation can be considered to have a statistically significant positive effect in terms of attendance and exam attainment particularly at the C to B grade boundaries. In relation to the individual components as revealed in interviews with students; the employability feature of simulation was not considered helpful whereas the dialogic feedback and gamification elements were deemed beneficial. These positive results for the gamified features are in line with Tsay at al [43]. In the light of these findings there is tentative support for the research

question concerning ‘evidence of educational effectiveness for the work simulation’ and the related hypotheses. In particular, the gamification elements that were useful to students were ‘game fiction’ and ‘action language’.

Despite the merits of this study, which has utilised a methodology made up of quantitative and qualitative data, there are a number of limitations. The two cohort study results may be affected by inherent differences in these two cohorts rather than by the learning resource. The interviews were intended to gain insight into the constituent parts of the learning resource but didn’t take account of the inter play between features. In future work it would be useful to examine elements of the gamified features such as ‘game fiction’ in isolation rather than in concert with other features.

It has been stated by Landers [40] that there is a lack of understanding of gamification in the literature. This study has demonstrated an innovative way to match HCI educational requirements to a gamified resource in a way that may have contributed to improvements in exam attainment and module attendance.

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Appendix 1

Interview questions were derived by an academic using the HCI educational requirements. The questions were then revised by three academics.

HCI Educational Requirement	Interview Question – In respect of the practicals and assessment
Active learning [1]	Was your learning experience active (with things to do) or passive (listening)?
Creating meaningful projects [5] real context projects [6].	Did you create projects that were meaningful to you and that seemed realistic?
Regular hand-in exercises and feedback [3].	Did you feel that there was regular hand-in and feedback? Was it useful?
Problem and decision based cases [1].	Did you feel that there were times that you had to problem solve and make decisions? Was it useful?
Promote realism by working on high-fidelity prototypes [3].	Did you find working on the prototype useful?
Maintaining individual and collaborative learning [5]	Did you feel there were opportunities to interact with peers? Was this useful?
Interactions between students and tutors [1].	Did you feel there were opportunities to interact with tutors? Was it useful?
Promote reflection [7] [3]	Did you feel there were opportunities to reflect on your work, for example to thing about ways of improving your work? Was it useful?
Include unexpected experiences [7]	Did you feel there were unexpected aspects to the experience which were either useful or not?
Inclusion of quizzes and games [8].	Did you make use of the quiz and the game? Were they useful?