Using computer games for instruction: The Student experience

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Computer games are fun, exciting and motivational when used as leisure pursuits. But do they have similar attributes when utilized for educational purposes? This paper investigates whether learning by computer game can improve student experiences compared with a more formal lecture approach and whether they have potential for improving performance. Instruction was split between lectures and computer games and student experiences were recorded using an Experience Sampling Method to capture real time experience and feelings of flow. Results indicated that student experiences in the game mode showed increased alertness, increased feelings of being active, increased feelings of involvement and an increased perception of challenge. Flow characteristics revealed boredom during standard lectures but anxiety and flow during game modes. Finally, some evidence of improved attainment was evident. By using contemporary interactive approaches such as computer games student learning experiences and attainment may be improved. Some practical issues of implementing games are also discussed.

Keywords: Computer Games, lecture, instruction, student experience, flow, learning, active learning

Introduction

One artefact of the digital era that holds some promise for educational instruction is the computer game often called the serious game when used for learning scenarios (DeHaan 2005; Lainema and Nurmi 2006; O'Neil, Wainess and Baker 2005; Vogel et al 2006). Anyone with teenage sons or daughters knows the power of the digital game to instil immense amounts of intrinsic motivation. Massively multi player online role-playing games are attracting millions of players across the world. Players invest massive amounts of time, money and energy into playing these games (Gee 2003; Prensky 2002). Computer games are particularly advanced and conducive to adaptation for educational purposes, being social, interactive and highly motivational. Businesses are now beginning to adapt and build these types of games for training purposes (Prensky 2001; 2002a; 2003). A multitude of advantages can be gained from the use of interactive technology for instruction at a tertiary level such as flexible access to course materials, alignment of distance and campus delivery modes, improved motivation (and consequently improved learning), improved marketing and above all greater satisfaction from a digitally aware and experienced tertiary population.

Research indicates that lecture based instruction is less effective than more interactive approaches (Caldwell 2007; Knight and Wood 2005) with lectures being the most disliked form of instruction encountered by students (Sander, et al 2000). Bligh (2000) contends that lectures are good for knowledge transmission but do not promote thought, attitude adjustment, enable behavioural skills to be learned or inspire interest in the subject. It is essential that new and different ways of instruction are developed to accommodate changing learner expectations such as lifelong learning, differing student and employer expectations and contemporary learning strategies (Holley and Dobson 2008). Further, the majority of students currently enrolled in university degrees have been raised in a technological era. It is therefore reasonable to assume that these students would expect and thrive in a similar learning environment. A number of writers have articulated that the Net Generation is different from previous generations and that they are only engaged if they are learning by interaction, through experience and in exploratory ways (Oblinger and Oblinger 2005; Prensky 2001; Tapscott 1998).

Evidence supports the opinion that it is the perception of the student that determines learning and not the instruction per se. It is not the instructional technique that inspires learning but how the student perceives that technique (Entwistle 1991; Konings, Brand-Gruwel, and Merrie¨nboer 2005; Struyven et al 2008). Instructional techniques that convey the perception of assisting deep learning will also facilitate deep learning. Passive environments such as lectures give the perception of surface learning (Case and Marshall 2004). Student expectations of learning and learning environments are also of importance and if expectations are met there is the potential to improve performance (Sander et al 2000). However, caution should be exercised when comparing passive and active instructional techniques as some evidence indicates that instruction that supports active learning, although demonstrating high student satisfaction, shows no improvement in achievement when compared to lecture based instruction (Ballard, Stapleton and Carroll 2004; O'Leary et al 2005;Woo and Kimmick 2000). Hardy et al (2003) emphasise that course involvement does not necessarily predict exam achievement and that it is student antecedents that predict achievement and nothing else. O'Leary et al (2005) compared instruction by traditional lecture to instruction through an educational game and found that the latter instructional technique was more enjoyable but achievement was not improved. However, it is important to consider learning as multi faceted and complex, not fully measurable through traditional tests of academic achievement such as examinations. Kirkpatrick (1994) offers a four stage model of learning in order to evaluate the effects of a learning episode. Kirkpatrick's levels include both affective and cognitive variables. The four levels are: Reaction (level one); describing the level of learner satisfaction, Learning (level two); using the usual metrics of learning that measure increased skills and knowledge, Behaviour (level three); a measure of how much the course has changed real life behaviour, more commonly known as learning transfer and, Results (level four); measurement of how the course has changed the system it was intended for, such as improving the efficiency of a particular job.

Learner reactions are an important aspect of learning episodes as suggested by Kirkpatrick's model. A learner's motivation to engage with the learning material is also an important aspect of these reactions. It is essential that instructors engage students and instil intrinsic motivation to learn. Without such motivation, most learning environments are ineffective. If the learner is not motivated to learn and engage in learning, then the learner is no longer a learner but merely a spectator (Lepper and Chabay 1985; Malone and Lepper 1987). Csikszentmihalyi (1997) suggests that learners who attain 'flow,' where 'flow' is the highly motivational and pleasant state experienced when you are engrossed in an activity, will be more satisfied and more motivated to engage in a similar task in the future. He also states that learners should neither be bored nor anxious in learning situations if motivation is to be attained (Csikszentmihalyi, Rathunde and Whalen 1993). Flow has been related to the feeling that is experienced by users of computer games and has also been related to effective learning environments (Kiili 2005).

The hype of the computer game has certainly arrived within the educational arena with authors such as Marc Prensky advocating their use for instructional purposes. However, to date, little empirical research has been conducted to validate their use within schools and tertiary environments (Connolly, Stansfield and Hainey 2007). This paper describes some of the findings of a study designed to explore the impact and practicality of using computer games to teach a first year undergraduate tertiary course. In particular, it addresses the issue of how the use of computer games in a tertiary course changes student experiences compared to a lecture approach. It asks important empirical questions such as; how do student perceptions change when instruction is computer game based compared to lecture based? Do game experiences within a course actually improve learner reactions and increase incidences of flow states? What aspects of experience are changed by the use of computer games? What impact do these changes in experience have on traditional attainment measures?

Method

Participants

Participants comprised students enrolled in a first year Bachelor of Arts Education course entitled 'Computer Games and Education'. Thirty one students (21 male, 10 females) enrolled in the course and the course was offered in semester two of the University teaching year. Further information about the student cohort is given in Table 1.

TABLE 1 ABOUT HERE

Design

General course design

The course was offered in Semester two and comprised 12 weeks of instruction, separated by a mid semester break into two terms of six weeks. During the first term students were instructed for 2 hours per week in basic educational psychology through either lectures or computer games sessions (instructional sessions), and attended weekly labs (also two hours per week). During lab sessions students learned to use the *Neverwinter Nights* (Bioware 2002) toolset that can be used to develop customized computer game modules. At the end of term 1 students were formally assessed for their understanding of the educational psychology content (worth 50% of their final grade). In the second term students continued to attend labs but were given the task of completing an assignment to design, build and evaluate a game module comprising educational content taken from the first terms educational psychology content. Lectures continued in the second term but had a different content focus of 'game design and theory'. Half of the educational psychology content (four topics) was delivered by the course lecturer in a standard lecture theatre with tiered seating whilst the remaining educational psychology content (four topics) was delivered through custom built computer game modules with course content embedded into game modules. In total eight educational psychology topics were covered, the other four hours of lecture time was absorbed by introductory and assessment related material. Each session was on a different aspect of

Educational Psychology (see table 2 for brief descriptions). The order of delivery for lecture style content and game style content is shown in Table 2.

Formal assessment

In the final week of term one students completed an examination (1hour 45minutes in duration) to assess their knowledge and understanding of the educational psychology content delivered during the first terms lectures (or games). The examination consisted of seven main questions, each containing sub questions, covering the seven main educational psychology topics (note that the two lecture areas covering motivation were merged). Questions contained a mix of recall and understanding questions covering content within the lectures (or games) and the assigned readings for the course. Both cohorts received identical examinations carried out under similar conditions. Exams were blind marked by two independent but experienced tutors according to a marking guide prepared by the course lecturer. Each exam paper was given a unique number and the order randomised so that it was not possible for the markers to distinguish between cohort one students and cohort two students.

TABLE 2 ABOUT HERE

Instruments

Computer games

The commercial computer game *Neverwinter Nights* and its toolset were used to construct the game modules and students were instructed in its use. *Neverwinter Nights* was chosen as the preferred game engine because of its comprehensive graphically advanced content and the potential to construct original modules with relative ease. *Neverwinter Nights* is a medieval fantasy role playing game (RPG) based on the Dungeons and Dragons system. Individual modules constructed for the purposes of delivering the educational content were embedded into an overall hub module (depicted by Ye Olde University of Canterbury) by distributing each module in different areas of the hub (i.e. within different university departments). The overall narrative encountered by players placed them in a medieval University of Canterbury as first year students who could progress into subsequent years and follow the career development of an academic as they completed modules successfully and gained experience tokens.

Experience sampling method

Student experiences were rated using an Experience Sampling Method (Hektner, Schmidt and Csikszentmihalyi 2007) designed to capture real time experience and measure feelings of flow. The Experience Sampling Form (ESF) selected for this study was adapted from that used in the ‘Talented Teenagers’ study (Csikszentmihalyi, Rathunde and Whalen 1997, p52-53) and contained subjective questions designed to sample participant’s mood, thoughts, general feelings and feelings about the activity. Table 3 shows the experience indicators contained in the ESF that were completed by students. Students completed one ESF for every one hour of instruction. Experience sampling methods are established methods of gaining reliable and valid information on subjective experiences and gaining information about motivational experiences through the calculation of ‘Flow’ (Hektner, Schmidt and Csikszentmihalyi 2007).

TABLE 3 ABOUT HERE

Procedure

Students enrolled for the course through the normal university enrolment process. During session one students’ were told about the format of the course and that the course was part of a study to explore the efficacy of computer games for the delivery of educational content. Students were asked to agree to take part in the study and consent forms were completed. In addition, students were introduced to the ESF and its purpose. In subsequent sessions students collected an ESF on entering the room and completed it when instructed to do so by an objective observer at a random time during the session (one form per one hour session). Forms were collected at the end of each session.

Analysis
ESF data was in the form of individual rating scales each using a 10 point likert scale. Therefore in order to control for individual differences the data was transformed into z-scores (M=0, SD=1), based on all completed forms, which is a standard way of controlling for subjective ratings (Hektner, Schmidt and Csikszentmihalyi 2007).

Game Experience versus Lecture Experience
Student t-test scores were used to calculate whether there were any overall differences in experience between lecture delivery mode and game delivery mode for each of the 29 dependant variable (experience indicators).

In addition, individual student flow states were calculated and frequencies compared between traditional and digital delivery modes. The method used to calculate the flow experience was to first categorize the students' perception of challenge and skill as high or low based on whether the z-score for the variable was above or below the mean for that individual (standardized mean calculated as a zero z-score). These two ratings were then combined to give a flow rating; high challenge & high skill = flow; low challenge & low skill = boredom; low challenge & high skill = relaxation; high challenge & low skill = anxiety (see Hektner, Schmidt and Csikszentmihalyi 2007, pp93-94). The percentages of students in each of these flow conditions for each delivery mode were then calculated.

Finally, comparisons were made between exam attainment for questions based on traditional lecture delivery compared to attainment for questions based on game delivery.

Results

Game versus lecture experience indicator comparisons
Comparison of game delivery experience against lecture experience (for the educational content only) indicated that when delivery was via the game students were more alert, more active, felt more involved and perceived the activity as more challenging. All effect sizes were small apart from the challenge of the activity that showed a medium effect size (Table 4).

TABLE 4 ABOUT HERE

Flow state comparison
Calculation of the percentage of students in the different flow states indicated that boredom was the most prevalent state during traditional lectures. However, anxiety was the most prevalent state closely followed by a state of flow during game mode experiences.

FIGURE 1 ABOUT HERE

Assessment comparison
Table 5 shows how the average percentage scores for exam questions differs across exam questions and that these differences do not appear to be related to the mode of delivery but more related to perhaps the content area and difficulty of the questions themselves. However, an examination of the overall average percentage performance for students in the game delivery compared to the traditional delivery indicates that average exam performance is better for game mode compared to traditional mode (traditional=41.0%; game=46.4%).

TABLE 5 ABOUT HERE

Discussion and conclusions

This study is unique as it reports on the use of computer games as an instructional technique in a tertiary education course with a particular focus of investigating the impact upon student experience compared with the more formal lecture approach. The research literature suggests that computer games are suited to this purpose, especially given their motivational qualities for leisure pursuits. However, there is currently scant evidence to support instructional benefits, apart from studies using non computer based games that indicate potential experiential benefits (O'Leary et al 2005).

Results from this study indicate that the computer game mode invoked perceptions of a more active and challenging learning experience compared to more traditional lectures. If we have a constructivist view of learning then ensuring that learners are active and challenged in learning situations is of paramount importance. These positive effects for the game mode compared to the lecture mode ought to lead to higher engagement for students. Further, if student perception of the instructional technique is enhanced then attitudes toward the learning content should be improved (Struyven, et al 2008; Entwistle 1991; Konings, Brand-Gruwel, and Merrie¨nboer 2005). These positive effects should also promote higher intrinsic motivation for the learned content as demonstrated by a greater proportion of students in a 'flow' state during game delivery compared to traditional delivery. This increased level of flow amongst students playing the computer game should, according to Csikszentmihalyi (1997), lead to more satisfaction amongst students and inspire motivation to engage in similar tasks in the future.

The flow state comparison also revealed that participants showed higher anxiety states in the game mode than in lecture mode. This was likely to be as a consequence of the challenging nature of the learning, especially given that the flow measure was based upon the ratio between reported challenge and skill. Low-mid levels of anxiety have been shown to be beneficial for learning (Ormrod 2008) therefore this may be a positive effect. In fact, the level of anxiety reported in these studies may be associated more accurately with an arousal state that is akin to flow (Csikszentmihalyi 1997). Arousal theory suggests that arousal activation is an important aspect of positive cognitive performance and has been linked with improved long term memory (Nielson, Yee, and Erickson 2005; Revelle, and Loftus 1992). In addition, it may be an important aspect of using computer games as a learning tool because certain aspects of computer games such as narrative and suspense have been shown to increase arousal (Vorderer 1996).

Inspection of student performance in the examination suggests that students instructed using game modes possibly perform better than students instructed through traditional lectures, and certainly no worse. However, interpretation of such results in the current study should be made with caution as it is difficult to compare attainment over different topic areas and for questions with varying levels of difficulty without the inclusion of controls.

There are also a number of qualitative and practical issues related to the use of computer games as a form of educational instruction. Table 6 lists some of these issues and attempts to suggest some mediating factors that may be taken into account when considering these.

TABLE 6 ABOUT HERE

Further, when it comes to making educational game modules versus standard lectures, preparing lecture material is a well-known domain, whereas in designing game modules there is a much smaller pool of experience and domain information to draw upon, both in technical and pedagogical principles. Thus, the quality level of the modules might be considered a confounding factor when it comes to levels of student achievement in this comparison. Both efficiency and quality improve with experience.

Situating the research in a fully functioning tertiary course does not come without its issues for instance it was important that some control was maintained over the data gathering procedure therefore it was important to ensure that ESM reports could be linked to actual game experience and that students completed game modules. This was achieved by situating each game session in a computer lab with all students in attendance at the same time. Thus, a large computer lab with a capacity of fifty plus computers was used. However, apart from the practical issue of class size in labs this also meant that the flexibility of instruction was lost. When the course lecturers initially attended game sessions they reported a feeling of loss of control over the learning and detachment from the learning scenario. However, they soon realised that this could be transformed into a positive aspect of the sessions as it allowed instructors to circulate during sessions and to have more one to one time with students. The issue of scalability is important in the tertiary setting as very often course sizes are in the hundreds or even thousands. Although this course was situated in a computer lab it could easily be rolled out across the web and students could engage from a distance or flexibly, thus, allowing for large course numbers.

Further research in this area is needed to establish whether improved satisfaction and motivation have an impact on longer term outcomes such as self directed learning, learning transfer and individual interest in the subject matter. Also, due to the fact that computer games and 3D virtual worlds are becoming more accessible and increasingly more advanced it is also increasingly important to explore the advantages such tools could bring to educational settings. One such advance is the increased ability to situate computer games and virtual worlds in a social environment that facilitates communication between learners. It is therefore important to establish the effects of collaboration.

It is clear from this study that the use of computer games as an instructional technique enhances student experiences through active participation. Therefore there is much to be gained from the use of computer games as an instructional tool but perhaps not as a substitute for existing techniques. Computer games could best function as a supplementary tool blended with other interactive and didactic techniques. However, it should be noted that this study uses a small sample from one course within one university and as such has its limitations. In addition, the samples were self selecting and participants were likely to have an inherent interest in computer games given the title of the course ('Computer Games in Education'). Further research in this area is warranted which should include a more substantial sample and explores how course content and other student populations differ.

On a more practical note it is not necessary to be a genius with the computer to use computer games for educational purposes. Just as institutions such as libraries and some innovative schools around the world are using computer games as a motivational technique, educators can also use them to inspire their learners. Younger learners will already be familiar with the digital environment and will seize the opportunity to apply these skills within the learning domain.

There are many commercial computer games and virtual worlds that can be used for educational purposes. Commercial games or virtual worlds can be used to stimulate discussion or debate, stimulate writing through blogs, diaries, stories, character and place descriptions, technical instructions and many more. Simulation type games offer content that can be directly used within a particular domain. For example *Civilisation 4,* a history game, has remarkably realistic content. Some commercial games have modding tools that allow you to create customized modules (such as NWN, the game used in our study).

Finally, many virtual worlds (e.g. *Second Life*) are beginning to develop educational content related to a variety of subjects and enabling users to easily build their own in-world content for educational purposes. For those interested in using *Neverwinter Nights* for development, as we did, the tutorials that we created explaining how to build modules can be downloaded at our website: www.applied-games.com.

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Table 1. Age, ethnicity and indication of computer game experience for the study participants

	Percentage
Age in years	
< 25	93.1
26 – 35	6.9
36 - 45	-
46 - 55	-
>55	-
Ethnicity	
New Zealand European	41.9
East Asian	29.0
Pacific Islander	9.7
South Asian	3.2
European	3.2
Other	12.9
Previously played Computer Games?	
Yes	96.8
No	3.2

Table 2. Lecture number, associated mode of delivery and content area

Lecture Number	Mode of Delivery	Lecture Content
2	Traditional	Cognitive processes and learning
4	Game	Information Processing
5	Game	Feedback and learning
6	Game	Learning transfer
7	Traditional	Instructional approaches
8	Game	General motivation
9	Traditional	Intrinsic motivation
10	Traditional	Flow theory

Note: In total for the first term there were 12 one hour sessions; lectures 1 - 12

Table 3. A list of experience indicators

Feelings About the Situation	***Mood Scales***	***Feelings about the Activity***	***Physical Indicator***
How well were you concentrating? Was it hard to concentrate? How self conscious were you? Did you feel good about yourself? Were you in control of the situation? Were you living up to your own expectations? Were you living up to others expectations?	Alert – drowsy Happy – sad Irritable – cheerful Strong – weak Active – passive Lonely – sociable Ashamed – proud Involved – detached Excited – bored Closed – open Clear – confused Tense – relaxed Competitive – cooperative	Challenges of the activity Your skills in the activity Was the activity important to you? Was the activity important to others? Were you succeeding at what you were doing? Do you wish you had been doing something else? Were you satisfied with how you were doing? How important was this activity in relation to your overall goals?	Did you feel any pain or discomfort as you were beeped?

Table 4. Showing all results reaching statistical significance and their means, standard deviations and effect sizes

Rating Scale Descriptor	t score	df	Sig	Traditional M (sd)	Game M (sd)	Effect Size (Cohen's d)
Mood is alert* - drowsy	3.83	1, 288	.051	.22 (1.02)	-.02 (.96)	.24
Mood is active* – passive	10.85	1, 278	.001	.33 (1.04)	-.07 (.93)	.41
Mood is involved* – detached	7.13	1, 285	.008	.24 (1.03)	-.07 (.87)	.33
Challenges of the activity	39.38	1, 296	.000	-.44 (.94)	.26 (.95)	.74

*Note: The first named experience is quantified as low scoring on the scale and the second named as high scoring on the scale

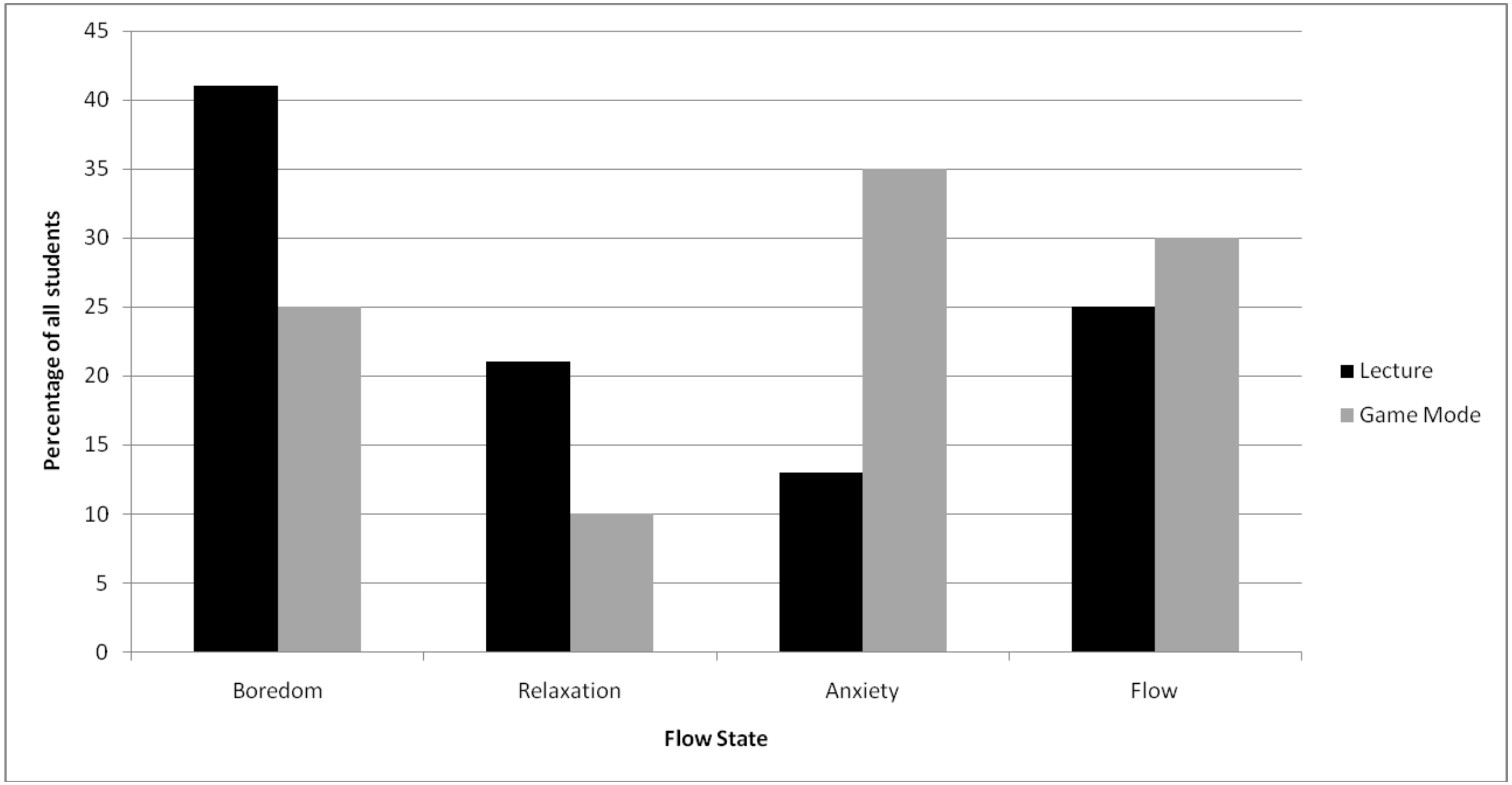

Figure 1. Graph showing percentage of students in the different flow states for lecture mode and game mode

Table 6. Issues and practicalities related to the use of educational games and some mediating factors.

Issues/practicalities	Mediating factors
Time to build the games	Gets quicker with experience, more and more commercial games are incorporating the ability to build customised modules or have built in toolsets
Cost to build/buy games and licenses	If built by the lecturer costs can be minimal, licenses etc can be offset by the students
Lack of evidence to support increased achievement in the traditional sense	Improved motivation, improved satisfaction more time with students one to one, good for distance/flexible learning
Lack of control over when students complete the content/games e.g. rather than the day before an assessment	We should be encouraging self regulated learning, use of large computer labs with compulsory attendance to complete the games
Games need to be well designed to facilitate learning	Encourages constructivist techniques and good teaching/learning strategies
Off the shelf games rarely have everything that an educationalist wants in order to facilitate learning e.g. NWN lacks the ability to communicate via audio and only supports textual communication	New games, toolsets and 3D Virtual worlds are being constantly developed
Content is restricted to what's built into the game and new games/modules have to be built when new content is added to the course	Students can build their own games based on the content of the course

Table 5. Average percentage scores for individual exam questions differentiated by mode of delivery.

Exam Question	Delivery Mode	N	Mean as a percentage of possible max marks for question
Question 2	Game mode	36	50.5%
Question 3	Game mode	36	53.2%
Question 4	Game mode	36	35.5%
Total			46.4%
Question 1	Lecture mode	36	52.8%
Question 7	Lecture mode	36	36.2%
Question 5	Lecture mode	36	34.0%
Total			41.0%
*Question 6	Mixed mode	36	43.7%
Overall Total			44.5%

*Note: The topic assessed by question six was split over two lectures and was delivered by traditional and game mode