Computer Game or Traditional Lecture: The Effect of Delivery Mode on Experience Ratings for High and Low Achieving Students

Dr Mick Grimley[1], Dr Richard Green[1], Trond Nilsen[2] and David Thompson[1]
University of Canterbury, Christchurch, New Zealand.[1]
University of Washington, Seattle, US.[2]
Email: Michael.Grimley@canterbury.ac.nz

A number of commentators promote the use of computer games for education (Prensky, 2001; DeHaan 2005; Lainema & Nurmi 2006) advocating their utility for being interactive, social and highly motivational. However, insufficient empirical research has been conducted to fully validate their use, especially given the practical constraints of using computer games for instructional purposes (Connolly, Hainey & Stansfield, 2007). This paper describes some of the findings of a study designed to explore the impact of using computer games to teach first year undergraduates. In particular, it addresses the issue of how using computer games in a tertiary course changes student experiences compared to the lecture approach.

Some studies reveal that lecture based instruction is less effective than more interactive approaches (Knight & Wood, 2005) and that lectures are disliked by students (Sander et al, 2000). In addition, most students presently enrolled at university are digital natives (Prensky, 2001). It is therefore reasonable to assume that students would have improved instructional experiences through computer game instruction compared to traditional lecture. This premise has been articulated by others, stating that the Net Generation is only engaged if learning by interaction, through experience and in exploratory ways (Oblinger & Oblinger 2005; Prensky 2001).

Evidence supports the opinion that it is not necessarily the instructional technique that inspires learning but how the student perceives that technique (Entwistle, 1991; Struyven et al, 2008) and instructional techniques that give the perception of assisting deep learning will also facilitate deep learning. Lectures give the perception of surface learning (Case & Marshall, 2004). Further, expectations of learning and learning environments are important when considering learning outcome and if expectations are met performance may be improved (Sander et al, 2000). However, some studies suggest that instruction that supports active learning, although demonstrating high student satisfaction may show little improvement in achievement when compared to lecture based instruction (O'Leary et al, 2005). Hardy et al (2003) emphasised that it is not necessarily instruction that predicts exam

achievement but students' antecedents. However, one cannot deny that learning is multi-faceted and not fully measurable through traditional tests of academic achievement such as examinations. Kirkpatrick (1994) includes both affective and cognitive variables and describes learner reaction as being important. For example a learner's motivation to engage with the learning material is an important aspect of these reactions and it is essential that instructors engage students and instil intrinsic motivation to learn. Without motivation, most learning environments are ineffective (Lepper & Chabay, 1985). It is therefore important to understand how student experiences within a course relate to overall achievement in that course.

This study investigates the changes in learner experience brought about by changes in instructional mode and compares the experiences of high and low achieving students.

This research asks two important questions:

1. How do student experiences change when instruction is computer game based compared to lecture based?
2. How do high and low achieving students differ in terms of their experiences for instruction delivered by computer games compared to lectures?

Method

Participants

Two separate cohorts (in two separate years) of students enrolled in a first year Bachelor of Arts Education course. In year 1 (Cohort 1), 59 (42 male, 17 female) students were enrolled and in year 2 (Cohort 2), 49 (42 male, 7 female) students were enrolled. The course was offered in Semester 2 of each year. Each cohort comprised students from an array of different majors ranging from Psychology and Education to Engineering. The course was entitled 'Computer Games and Education' thus attracting students interested in computer games as a form of instruction.

Design

Overall Course Design

The course comprised 12 weeks of instruction, split by a mid semester break into two terms of six weeks. In term 1students were instructed in basic educational psychology through weekly lectures, (two hours per week) and attended weekly workshops (also two hours per week). During workshop sessions students learned to use the *Neverwinter Nights* (Bioware, 2002) toolset to develop customized computer game modules. At the end of term 1, students were formally assessed by an examination worth 50% of their grade with content covering basic Educational Psychology. Students continued to attend labs during the second term and were

given the task of designing, building and evaluating an educational game module. Lectures continued in the second term but focused on 'game design and theory'. During its first year (Cohort 1) the course content was delivered using a traditional lecture format in a standard lecture theatre with tiered seating. In its second year (Cohort 2), the educational psychology content was delivered through custom built computer game modules (built by the research team) with the course content embedded into the game modules, delivered as together in a computer suite. In total eight educational psychology topics were covered (8hrs), the other four hours of lecture time was occupied by introductory and assessment related material. All other aspects of the course were kept constant including formal assessments.

Computer games

Neverwinter Nights and its toolset (Bioware, 2002) were used to construct the game modules, chosen because of its comprehensive graphically advanced content and capacity to construct original modules with relative ease. It 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 placing each content module in different areas of the hub (i.e. within different university departments). The overall narrative experienced by players depicted the players as first year students at a medieval University of Canterbury and encouraged them to 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 the Experience Sampling Method (Hektner, Schmidt and Csikszentmihalyi, 2007) originally 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 1 shows the experience indicators contained in the ESF which were completed by students. Students completed one ESF per hour of instruction. It was administered at a random time during each session.

Table 1. A list of experience indicators

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

Procedure

Students enrolled for the course through the normal university enrolment process. During session 1 student's 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 explained. 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 by the researchers at the end of each session.

Analysis

Data was explored quantitatively and qualitatively to establish how experiences differed between modes (traditional lecture vs game mode) and attainment levels (high attainment vs

low attainment). Attainment groups were established using the examination raw score (maximum=60) and dividing students into high and low attainment groups using a median split procedure for each cohort (see Table 2). ESF data was in the form of rating scales with several ratings generated by each student (because the course contained several lectures or game modules). Therefore all student scores on each experience item were aggregated by calculating the mean value of all ratings. Univariate Analysis of Variance was performed for each experience indicator (N=29, see Table 1) with the mean rating for each indicator used as the dependant variable and delivery mode (lecture vs game) and achievement level (high vs low) used as between subjects independent variables. Finally, rating scores were standardised by creating individual z scores in order to remove individual differences. This procedure "removes differences between individuals in how they respond to each item. These z-scores are created by subtracting the subject's overall mean for the item and then dividing by the subject's standard deviation" (Larson & Delespaul, 1992 p75). High and low achieving students within each cohort were compared qualitatively by graphing the aggregated standardised experience scores for all 29 experience indicators to produce individual experience profiles.

Table 2. Mean, range (N) exam scores for high and low achievement groups by cohort

	Cohort 1 (Lecture)		*Cohort 2 (Game)*	
	Mean Score	Range (N)	Mean Score	Range (N)
High Achievement Group	38.2	32-50 (24)	35.7	31-57 (19)
Low Achievement Group	22.5	8-31 (24)	18.2	7-25.5 (19)
Total	30.3	8-50 (48)	26.9	7-57 (38)

Results

Main Effects

Four main effects emerged showing significant differences between delivery modes (see Table 3). First, an effect between lecture and game mode for the challenge of the activity ($F(1, 82)=6.237$, $p=.015$) indicated that students found the game mode significantly more challenging than the lecture mode. Second, a significant difference between lecture and game mode for the importance of the activity to the individual ($F, (1,82)=10.914$, $p=.001$) showed that students found the game activity to be more important to them than the lecture activity.

Third, a difference between game and lecture was detected for the student's perception of the importance to others (F(1,82)=4.353, p=.04) with game being more important to others than lecture. Fourth, a difference between lecture and game mode was shown for the statement "Do you wish you had been doing something else?' (F(1,82)=6.058, p=.016) with students in the game mode indicating that they were more inclined to wish they were doing something else than students in the lecture condition. All effect sizes were medium (Cohen, 1988).

Table 3. Differences between lecture and game for significant main experience effects

	Lecture Mode (mean, SD)	***Game Mode (mean, SD)***	***Effect Size***
Challenges of the activity	3.77(1.75)	4.69 (1.59)	0.55
Was the activity important to you?	4.96 (1.65)	6.09 (1.48)	0.72
Was the activity important to others?	5.36 (1.41)	6.02 (1.49)	0.46
Do you wish you had been doing something else?	4.50 (2.1)	5.64 (2.09)	0.54

Interaction Effects

Six statistically significant interaction effects of delivery mode by attainment level were evident (see Table 4). First an effect for level of concentration (F(1,82)=4.380, p=.039) showed a classic cross over effect with high attainment students showing greater concentration for game delivery and low attainment students with greater concentration levels for lecture delivery (see Figure 1). Second, a significant interaction was displayed for hardness to concentrate (F(1,82)=4.711, p=.033) with high attainment students finding it harder to concentrate in the game mode and low attainment students finding it harder to concentrate in the lecture mode (see Figure 2).

Third, there was an interaction effect between mode and attainment for the level of sociability experienced by students (F(1,82)=6.214, p=.015) with high attainment students feeling more sociable in the game mode and low attainment students feeling more sociable in the lecture mode (see Figure 3). Fourth, an interaction effect between delivery mode and attainment level for boredom level (F(1,82)=3.951, p=.05) showed that high attaining students found lectures more boring and low attaining students found games more boring (see Figure 4). Fifth, an

interaction was observed between mode and attainment for perceived level of success ($F(1,82)=5.044$, $p=.027$) with high attainment individuals showing similar perceived levels of success for both modes and low attaining students showing higher perceived levels of success in the game mode compared to lecture mode (see Figure 5). Finally, a mode by attainment interaction was shown for satisfaction level ($F(1,82)=5.721$, $p=.019$) with high attaining students more satisfied with the lecture mode and low attaining students more satisfied with the game mode (see Figure 6).

Table 4. Interactions for instructional mode & achievement for student experience ($p>.05$)

	Achievement Level	***Lecture Mode (mean, SD)***	***Game Mode (mean, SD)***
How well were you concentrating?	High	5.42	6.08
	Low	5.79	5.21
Was it hard to concentrate?	High	3.16	3.63
	Low	4.00	2.92
Lonely – sociable	High	3.41	3.66
	Low	3.77	3.27
Excited – bored	High	2.91	2.59
	Low	2.62	2.91
Were you succeeding at what you were doing?	High	6.05	5.98
	Low	5.68	6.67
Were you satisfied with how you were doing?	High	5.89	5.50
	Low	5.42	6.25

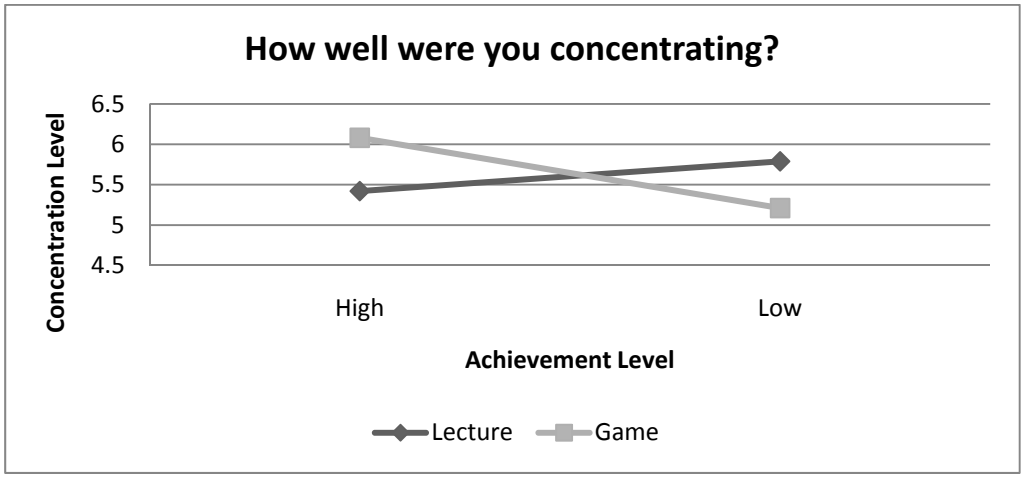

Figure 1. Interaction between delivery mode and attainment level for concentration.

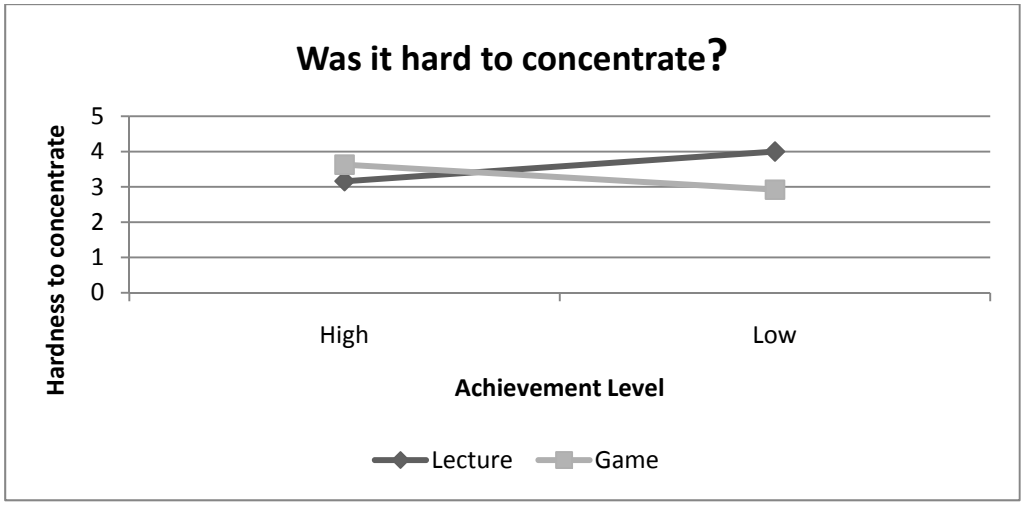

Figure 2. Interaction between delivery mode and attainment level for hardness to concentrate.

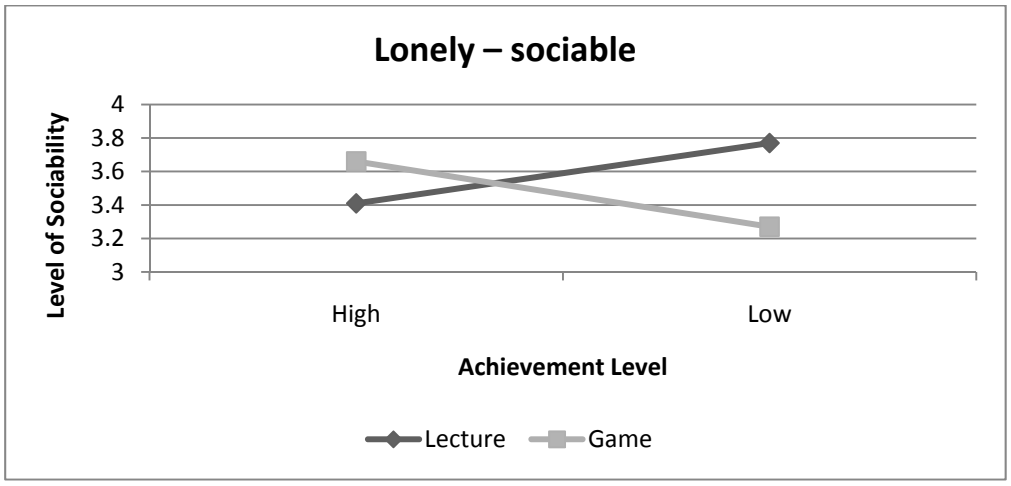

Figure 3. Interaction between delivery mode and attainment level for sociability.

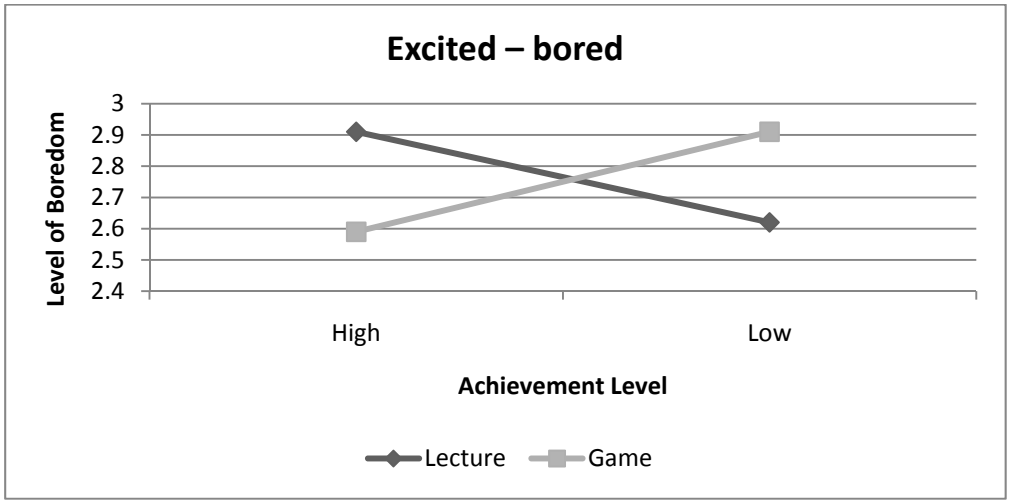

Figure 4. Interaction between delivery mode and attainment level for boredom.

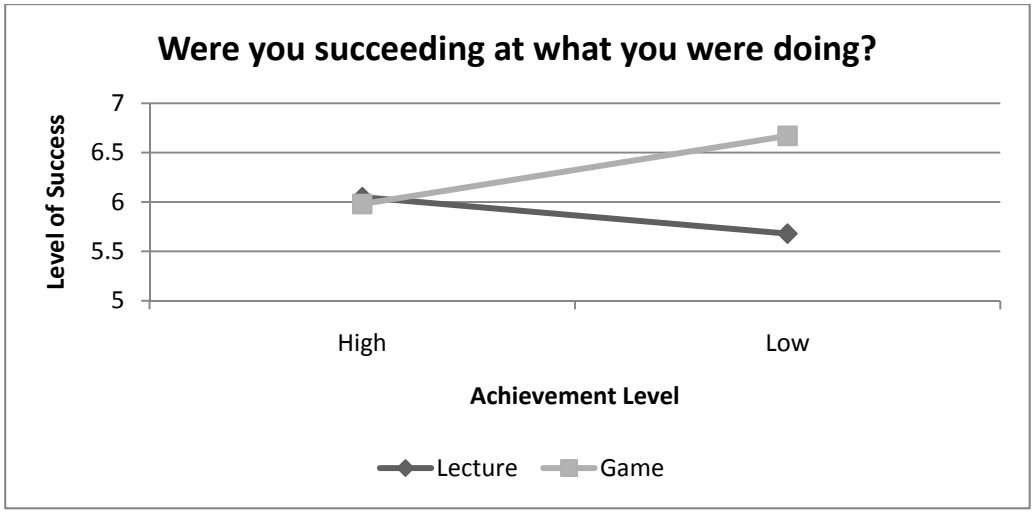

Figure 5. Interaction between delivery mode and attainment for level of success.

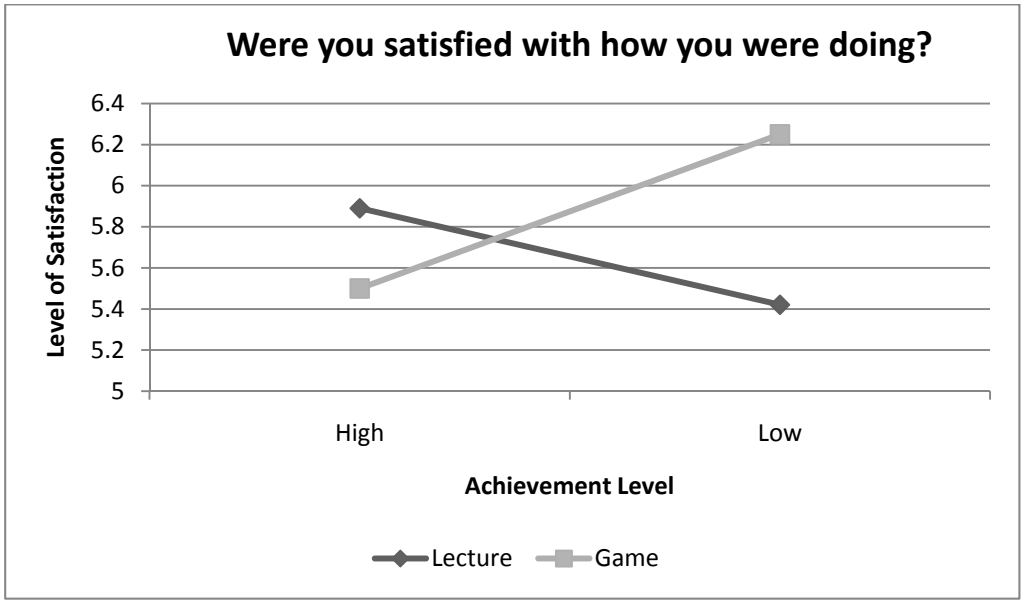

Figure 6. Interaction between delivery mode and attainment level for satisfaction.

Qualitative Comparisons

Line graphs (individual profiles) were compiled in order to compare different overall experience profiles for high and low achieving students in each of the instructional modes. Three high achieving students and 3 low achieving students were included from each cohort.

Lecture Mode Profiles

Figures 7, 8 and 9 show three different pairs of individual lecture experiences for students differentiated by their examination result. It is evident from these comparisons that high achieving students generally have more positive experiences (standardization of scores

provide a mean of zero and standard deviation of 1, thus a positive index indicates a positive experience with the reverse true for negative scores) than low achieving students.

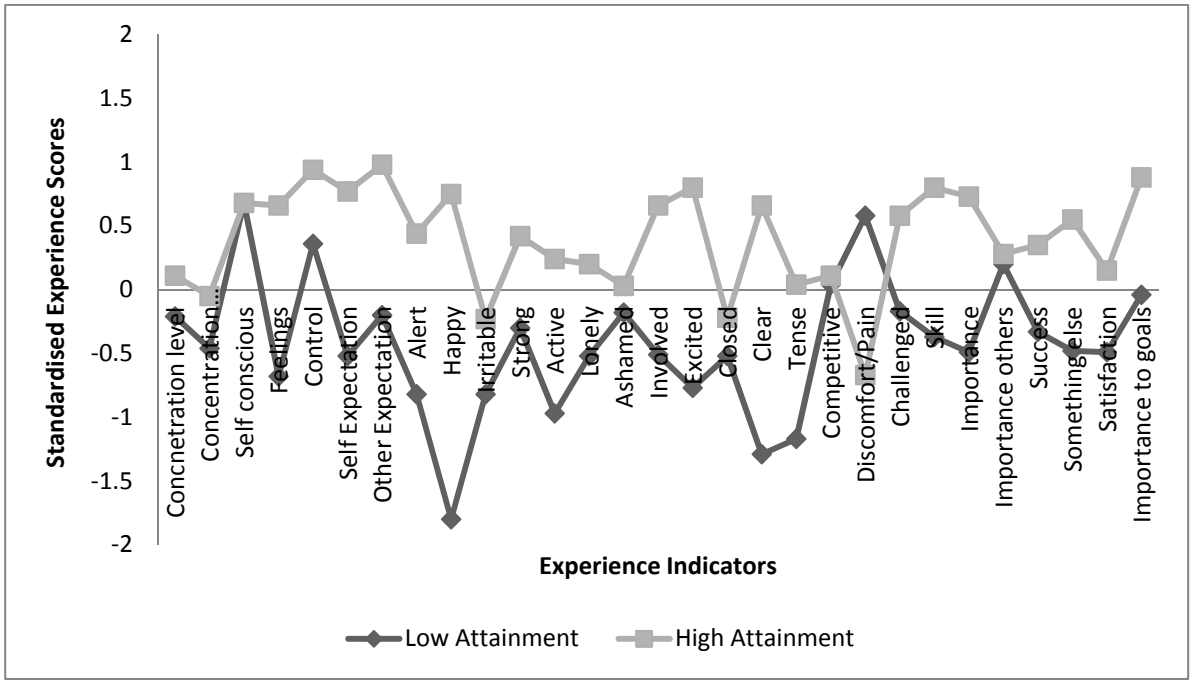

Figure 7. Individual Experience Profile of a low attainment student and a high attainment student for aggregated standardized LECTURE experiences

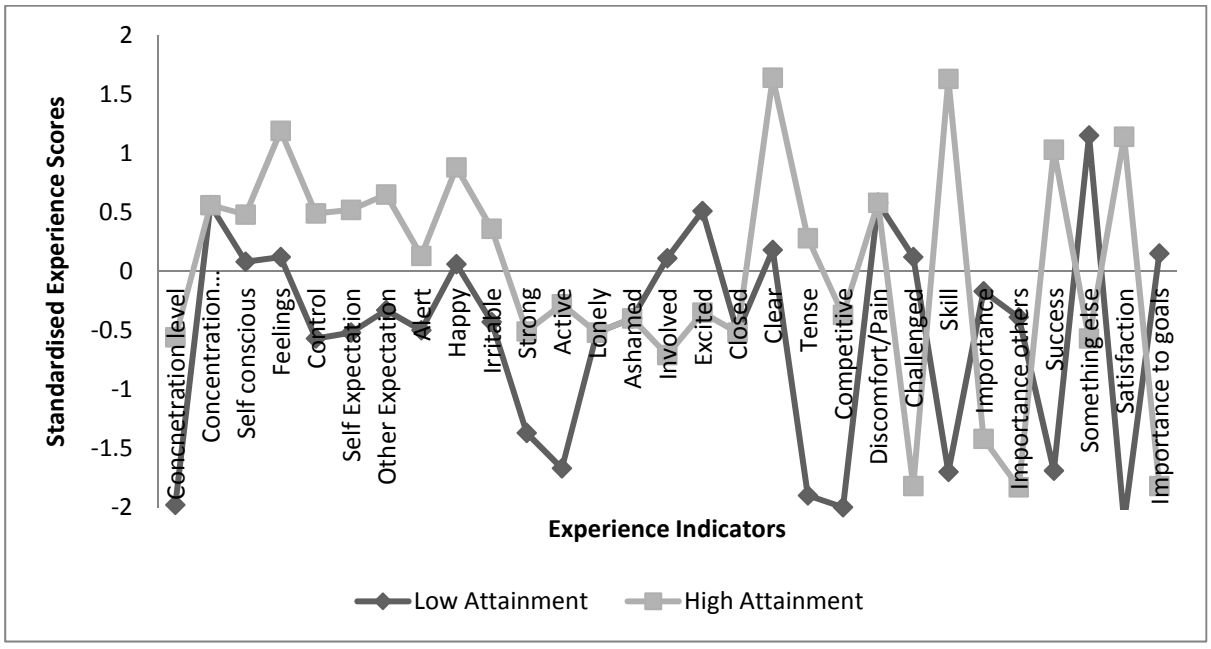

Figure 8. Individual Experience Profile for a low attainment student and a high attainment student for aggregated standardized LECTURE experiences

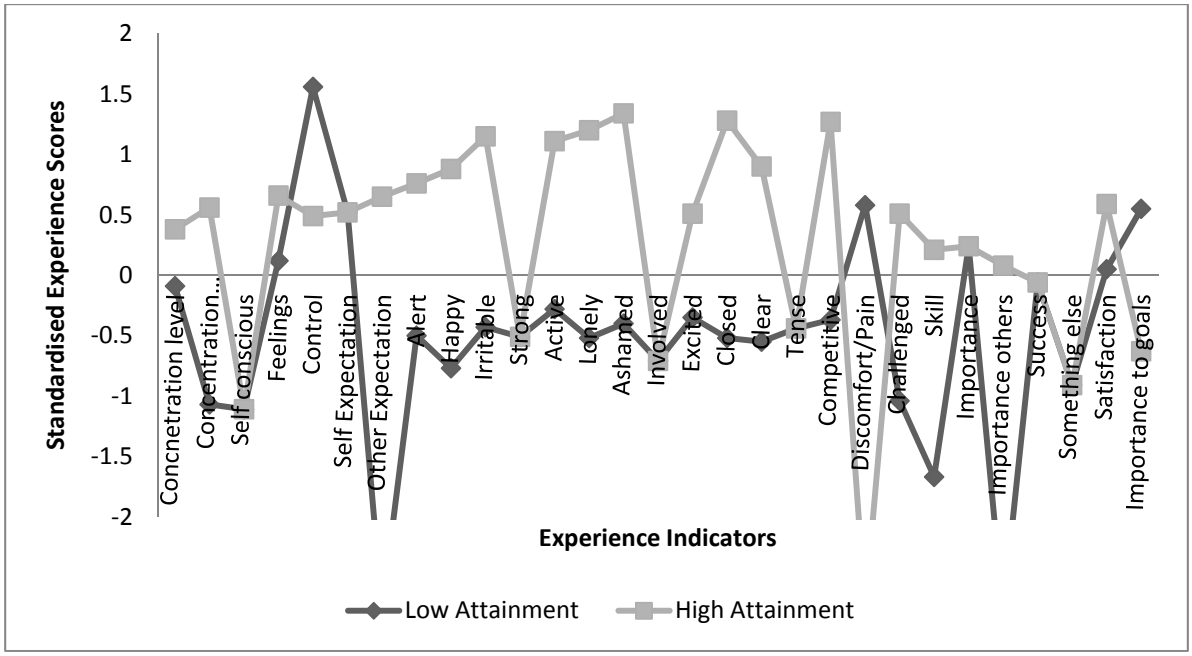

Figure 9. Individual Experience Profile for a low attainment student and a high attainment student for aggregated standardized LECTURE experiences

Game Mode Profiles

Figures 10, 11 and 12 show three different pairs of individual game experiences for students differentiated by their examination result. Game experience profiles differentiated by attainment level show no clear patterns. Compared to lecture profiles, these high and low achieving students show very similar experiences. It is clear that compared to the lecture experience profiles, game experience profiles show that high achieving students have reduced positive experiences and low achieving students have increased positive (reduced negative) experiences.

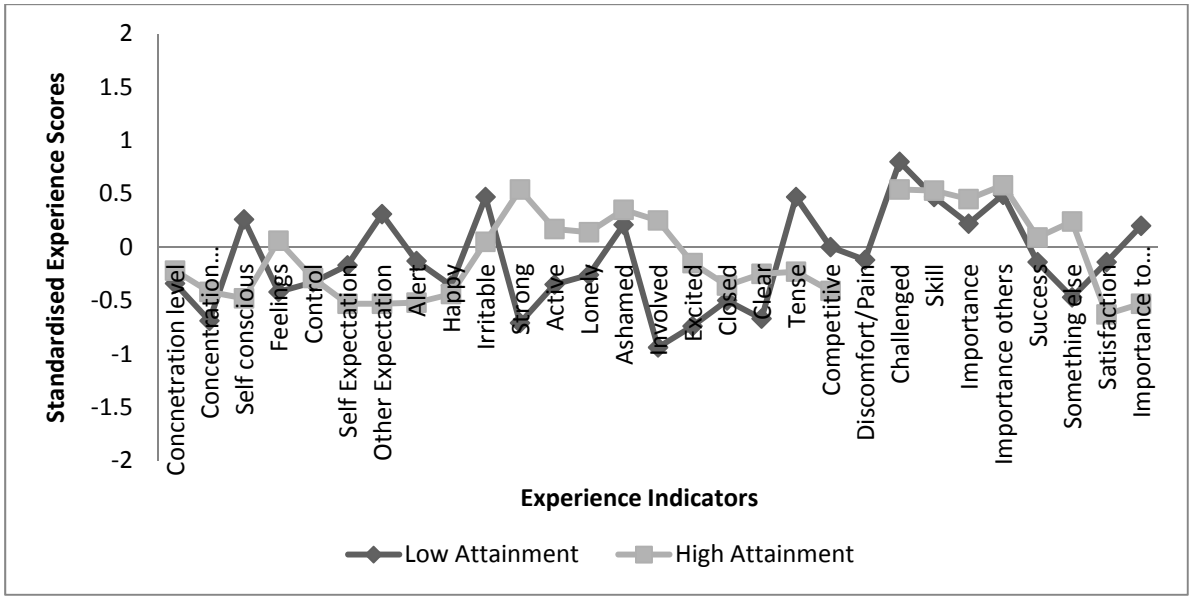

Figure 10. Individual Experience Profile for a low attainment student and a high attainment student for aggregated standardized GAME experiences

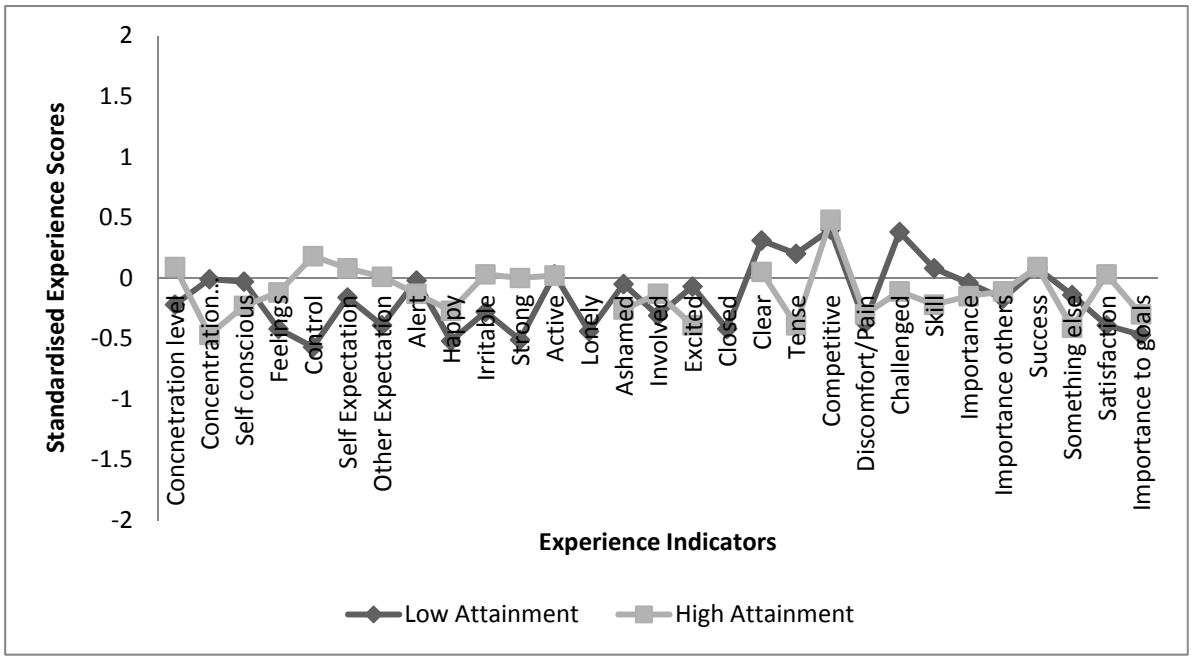

Figure 11. Individual Experience Profile for a low attainment student and a high attainment student for aggregated standardized GAME experiences

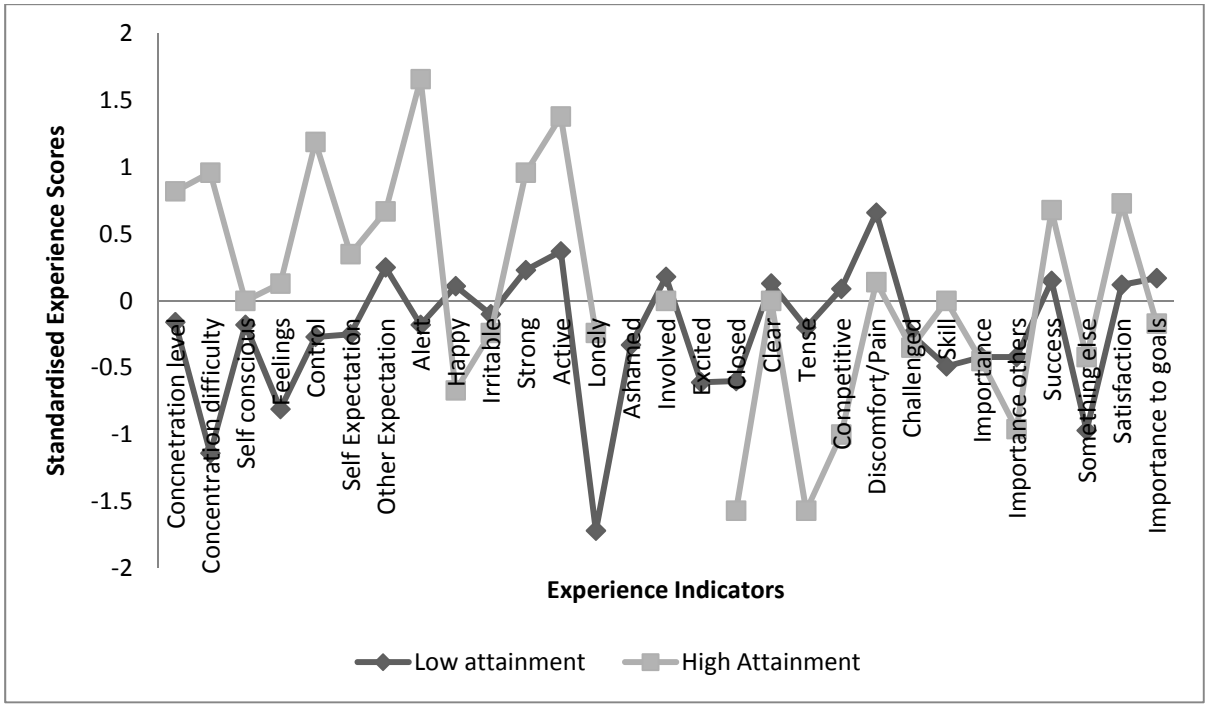

Figure 12. Individual Experience Profile for a low attainment student and a high attainment student for aggregated standardized GAME experiences

Discussion

A number of main effects were evident indicating that experiences differed between students who were engaged with more traditional instruction versus students engaged with computer game instruction. Student responses indicated that they found the game mode more challenging than the lecture mode. This likely reflects the interactive nature of learning through computer games compared to lectures as lectures tend to be mostly passive. From a contemporary learning theory perspective instructors thrive to make instruction both active and challenging, therefore such experiences should be viewed as positive.

Results also indicated that students felt that the activity of learning using a computer game was important to them compared to the lecture experience. This may reflect the fact that this was a self selecting sample that was likely to have an interest in computer games and in their use as an instructional tool. In addition, lectures would be more familiar thus making the game experience different and potentially perceived as being more important. Interestingly, students in the game mode also indicated that compared to lectures they thought that learning through games was important to others. However, this question is somewhat ambiguous as it is difficult to ascertain who ‘others’ might refer to. For instance others could refer to the researchers in this instance who the students may perceive as thinking that the activity was important to them.

One premise that many researchers or instructors have about game based learning is that their student/participants find it fun and motivating and this is often an underlying reason for using this approach as an instructional tool. However, students in the game mode were more likely to wish that they were doing something else compared to students in the lecture mode. Maybe the incorporation of computer games for instructional purposes in a formal course renders the game as just another instructional tool rather than a fun leisure activity. If this is the case it is important for instructors who are contemplating using a computer game as an instructional tool to consider its educational potential in terms of what it can add as a learning tool rather something that makes learning fun or intrinsically motivational. The challenging and active nature of the game experience likely adds quality to the learning experience thus maximising instructional time more effectively.

In addition to the main effects showing that students overall found the game experience different form the lecture experience, which is to be expected, six interaction effects indicated that high and low achieving students react differently in terms of their experience in different instructional modes. The first of these interaction effects asked students ‘How well were you concentrating?’ High attainment students indicated that they were not concentrating as well for the lecture condition as they were for the game condition. However, the reverse was true for the low attainment group who indicated that they were concentrating well for the lecture condition but not so well for the game condition. The second interaction effect may shed some light on the meaning of this first interaction because high achieving students indicated that they found it harder to concentrate in the game condition than the lecture condition whereas low achieving students found the reverse true and found it harder to concentrate in the lecture condition. This may indicate that low attainment students find the lecture content more difficult to understand than the high attainment students. In the game condition low attainment students may believe that they are concentrating well by focussing on the game play (rather than the passive nature of the lecture material) but high attainment students may find it easy to concentrate on lecture content but find the added distracter of the game interaction frustrating. Clearly from the outcome of the assessment the low attainment group failed to judge the adequacy of their concentration effectively, whereas the high group were more able to cope with both types of instruction.

Another aspect of the student experience that was evident was that high achieving students found the game mode more sociable than the lecture with the reverse true for low achieving students. This may be due to low achieving students being more off task in the lecture scenario, thus also adding to their lack of ability to concentrate in a lecture context. In reality,

game mode should be much more sociable than lecture mode because students worked together in a computer lab, at their own pace, without the need to listen to the lecturer.

Low attaining students indicated that they were more bored in the game situation compared to high attaining students who were more bored in the lecture situation. This result is difficult to explain because one would expect the reverse. One explanation for this result may be that students who are struggling with the content of the lectures are having to concentrate hard to comprehend the material, but are less likely to be bored. The same students in the game mode may fail to engage fully with the course content but concentrate on game playing which fails to live up to their normal leisure time game play. This is supported by the result showing that low attaining students were inclined to perceive that they were not succeeding during lectures but were succeeding during game mode. Contrary to this, high attaining students felt that they were succeeding during both forms of instruction. The final interaction also supports these ideas because low attainment students seemed much more satisfied with their performance in the game mode than in the lecture mode, whereas high attaining students were more satisfied with their performance in the lecture scenario than in the game scenario.

Through qualitative analysis of individual experiences between modes for high and low achievers some clear patterns were observed. It was apparent that low achievers in lecture mode were encountering some extreme negative experiences compared to high achievers. These negative extremes were not evident for game mode experiences. In addition, lecture experiences seemed to differentiate between high and low achievers in that high achievers indicated a more positive profile compared to the low achievers who had more negative profiles. However, profiles between high and low achievement students in game mode were much less differentiated. Although it could be argued that high achievers showed a slightly more positive experience profile than low achievers they were in fact very similar. It seems that the introduction of a computer game instructional mode tended to decrease the experiences of high achievers. But the introduction of a computer game for low attainment students improved their experiences.

References

Bioware Corp. (2002). *Neverwinter Nights* [Computer Game]. Distributor: Atari. URL: http://nwn.bioware.com/

Cohen, J. (1988).*Statistical power for the behavioral sciences* (2nd ed.) Hillsdale, NJ: Erlbaum.

Connolly, T. M., Hainey, T., & Stansfield, M. (2007). An application of games-based learning within software engineering, *British Journal of Educational Technology* 38 (3): 416–428.

Csikszentmihalyi, M., Rathunde, K. & Whalen, S. (1993). *Talented teenagers: The roots of success and failure*. Cambridge: Cambridge University Press.

DeHaan, J. W. (2005). Acquisition of Japanese as a foreign language through a baseball videogame, *Foreign Language Annals* 38, (2): 278-282.

Entwistle, N. J. (1991). Approaches to learning and perceptions of the learning environment: Introduction to the special issue, *Higher Education* 22: 201–204.

Hardy, S. A., Reay, D., Thompson, R. A., & Zamboanga, B. (2003). Student background and course involvement among first-year college students in introduction to psychology: Implications for course design and student achievement, *Psychology Learning and Teaching* 3 (1): 6-10.

Hektner, J. M., Schmidt, J. A., & Csikszentmihalyi, M. (2007) *Experience sampling method: Measuring the quality of everyday life*. London: Sage.

Kirkpatrick, D. L. (1994) *Evaluating training programs: the four levels.* San Francisco, CA: Berrett- Koehler.

Knight, J. K. & Wood, W. B. (2005). Teaching more by lecturing less, *Cell Biology Education* 4: 298–310.

Lainema, T. & Nurmi, S. (2006). Applying an authentic, dynamic learning environment in real world business, *Computers & Education* 47: 94–115.

Larson, R. & Delespaul,P.A.E.G. (1992). Analyzing experience sampling data: A guidebook for the perplexed. In DeVries, M. (Ed.), *The experience of psychopathology: Investigating mental disorders in their natural setting* (pp.58-78). Cambridge, UK: Cambridge University Press.

Lepper, M. R., & Chabay, R. W. (1985). Intrinsic motivation and instruction: Conflicting views on the role of motivational processes in computer-based education, *Educational Psychologist* 20, (4): 217-230.

Oblinger, D. G. & Oblinger, J. L. (2005). Educating the Net-Generation, *Educause*. www.educause.edu/educatingthenetgen/

O'Leary, S., Churley-Strom, R., Diepenhorst, L., & Magrane, D. (2005). Educational games in an obstetrics and gynaecology core curriculum, *American Journal of Obstetrics and Gynaecology* 193, (5): 1848–1851.

Prensky, M. (2001). Digital Natives, Digital Immigrants, *On the Horizon* 9, (5).

Sander, P., Coates, D., King, M., & Stevenson, K. (2000). University students' expectations of teaching, *Studies in Higher Education,* 25, (3): 309-323.

Struyven, K., Dochy, F., Gielen, S., & Janssens, S. (2008). Students' experiences with contrasting learning environments: The added value of students' perceptions, *Learning Environment Research,* 11: 83–109.