An Evaluation of a Mobile Game Concept for Lectures

Alf Inge Wang, Terje Øfsdahl and Ole Kristian Mørch-Storstein
Dept. of Computer and Information Science
Norwegian University of Science and Technology
N-7491 Trondheim, Norway
alfw / ofsdahl / olekrst@idi.ntnu.no

Abstract

This paper describes an evaluation of a new game concept, Lecture Quiz, which can be used in lectures in higher education to promote strong student participation and variation in how lectures are taught. The lecture game uses the equipment and infrastructure already available in lecture halls like the teacher's portable PC, a large screen and a video projector, network connections, and the students' mobile phones. The main game runs on the teacher's portable PC projected on a large screen, whereas the students will interact with the game using their own mobile phones. Lecture Quiz is a multiplayer quiz game, which offers a variation in game modes where unlimited number of players can play simultaneously. Games like Lecture Quiz are most useful for testing and rehearsing theory. As a bonus, the teacher will get quantitative data on how much of the theory the students actually have learned.

The evaluation of Lecture Quiz was performed in a software architecture lecture where twenty students first played the game and then were asked to fill in an evaluation form. The focus of the evaluation was on usability of the system and the perceived usefulness of using Lecture Quiz in lectures. The results of the evaluation show that Lecture Quiz was easy to use and that it contributed to increased learning. Further, Lecture Quiz was perceived as entertaining, and half of the students claimed they would attend more lectures if such systems were used regularly.

Keywords: *Software engineering education, game concept, evaluation, usability.*

1. Introduction

Video games have over the last couple of years become more and more used within schools to teach children mathematics, geography, English and other subjects. Experiences show that video games can be effective and compelling context for children's learning [16, 9, 8]. The common approach of using video games in schools is to let the children practice on certain skills in a computer lab supervised by a teacher. Previous research shows that it can be beneficial for academic achievement, motivation and classroom dynamics to use video games within a classroom [18]. It is also believed that the teaching methods based on educational games are not only attractive to schoolchildren, but also to university students [19].

There are some examples of how video games can be used in higher education, e.g. [3, 14, 13], but we believe that this area needs to be explored more extensively. The research within this domain mainly focuses on two main areas: development of new game concepts and game technologies for higher education, and evaluation of these concepts and technologies. A video game can mainly be integrated into a university course in two ways. *First*, video games can be used instead of traditional

exercises. This approach should motivate the students to put extra effort into the exercises and gives the teachers an opportunity to monitor the students when they are doing the exercises. *Second*, video games can be used within lectures to improve the participation and motivation of students.

The initial main goal of the Lecture Quiz project was to develop a game concept that could be used in any course that would (1) test, motivate and engage the students, and (2) that the game should use the existing equipment and infrastructure available in the lecture halls at our university. It was also important that as many students as possible could participate in the game simultaneously. Most lecture halls at the Norwegian University of Science and Technology (NTNU) are equipped with video projectors that can be connected to any laptop PC, and wired/wireless network. All of our students own either a mobile phone or a laptop PC than can run J2ME applications.

The game concept we developed was a variant of the existing Sony PS2 quiz-game series Buzz! [1]. The main difference is that our game allows unlimited number of players, the teacher is the game-show host, and the players will use their personal mobile phones as game controllers.

Game-based learning in mobile and ubiquitous learning environments has gained interest in recent years, e.g. [17]. Studies show that wireless technology used in an educational setting can increase mental activity [10], facilitate interactivity [20], and promote social interaction [6]. This paper describes an evaluation of the Lecture Quiz game concept used in a software architecture lecture. The emphasis of the evaluation is on how the students perceived usability and usefulness of the game when used for teaching.

The rest of the paper is organised as follows. Section 2 describes the game concept. Section 3 describes the evaluation. Section 4 describes similar approaches, and Section 5 concludes the paper.

2. The Game Concept

Malone has listed three main characteristics that makes things - in our case games - fun to learn: they should provide the appropriate level of challenge, they should use fantasy and abstractions to make it more interesting, and they should trigger the player's curiosity [12]. Lecture Quiz was developed with these three characteristics in mind and resulted in a concept illustrated in Figure 1 similar to game shows on TV. The teacher plays the role of the game show host and the students participate using their own mobile phones. Considering Malone's characteristics, quiz games are likely to trigger the player's curiosity, provide a challenge for the player, but not provide much fantasy. However, the lack of fantasy can partly be compensated by making a multiplayer game where the social interaction becomes an important motivating factor for playing. Social interaction is important for games used in lectures as it promotes more active students. The level of the challenge in a quiz game is adjusted by the changing the difficulty level of the questions. However, it cannot be tailored for the individual differences. The main benefit of choosing a quiz game concept is the independence of subject. Quiz games are most useful for testing and rehearsing theory.

A game session in Lecture Quiz starts by students registering a nickname on the mobile client. When the game starts, the teacher's PC will display a question with a number of alternatives on a large screen, and the students have to choose among the alternatives on their mobile client. The questions are timed-out after a specified number of seconds, and the performance results are displayed on the large screen. Feedback is also given directly to the students on the mobile client. Version 1.0 of Lecture Quiz evaluated in this paper offered two game modes played in succession:

Score distribution: In this game mode, the presentation of the students' answers distributed on the various alternatives is shown in an animated 3D bar diagram and the correct answer is
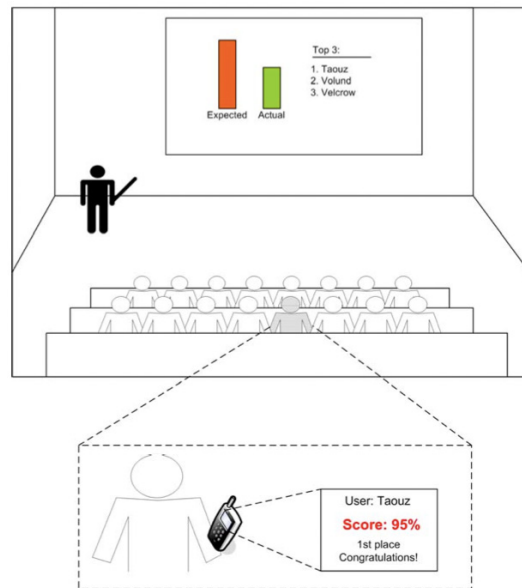
Figure 1. Illustration of the Game Concept

highlighted as shown in Figure 2a). The graphics are scaled in size (both the bars and the text), enabling a variation in number of alternatives.

Last man standing: In this game mode, the players have to answer correctly to play in the next round. After each question, all the players that have participated in the round are displayed on the screen as avatars with a nickname beneath, see Figure 2b). The players that have answered incorrectly get shot and will not make it to the next round. The goal of this game mode is to be the last man standing as shown in Figure 2c). Also for this mode, the graphics automatically scale the avatars and the text to adjust for the number of players.

In version 1.0 of Lecture Quiz, the same questions are used for both modes. This means that the students can learn the correct answers in the first round (*score distribution*), but only the students that remember all the correct answers get through the second round (*last man standing*).

The Lecture Quiz game was implemented by two master students (the second and third authors) in four months. The client runs on any mobile phone supporting J2ME MIDP 2.0 or a PC through a web-based J2ME-emulation. Any available wireless network that supports http-access can be used to transfer data between the mobile client and the game server (GPRS, Edge, 3G, WiFi etc.). Note that if the mobile phone does not support WiFi, the user will be charged for a small amount for the data transmissions. The teacher's game client runs on any PC than can run Java SE and an open GL API. A technical description and evaluation of Lecture Quiz can be found in [23].

3. Evaluation of the Lecture Quiz

The test of Lecture Quiz was conducted May 8th 2007 in the summary lecture in a software architecture course at NTNU. Twenty software engineering master students participated in the experiment. The student population was 85% male with an average age of 23. None of the subjects
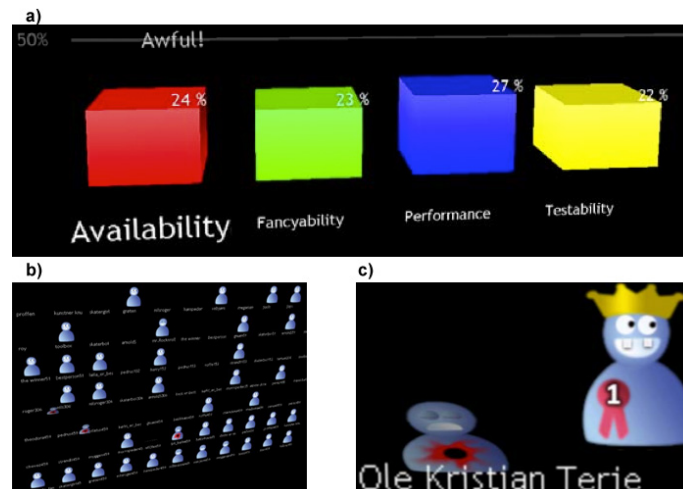
Figure 2. Lecture Quiz game modes

had played Lecture Quiz before.

The subjects had to fill in a form after they had played the game. The goal of the experiment was to provide empirical data regarding if lectures can benefit from using games like Lecture Quiz. The form measured 1) the usability of the system and 2) the suitability and usefulness. ISO 9241-11 defines three measurements for usability: satisfaction, effectiveness, and efficiency [15]. To measure usability we used the System Usability Scale (SUS), which is a generic questionnaire with 10 questions for a simple indication of the system usability as a number on a scale from 0 to 100 points. Each question has a scale position from 1 to 5. For items 1,3,5,7 and 9, the score contribution is given by subtracting 1 from the scale position. For item 2,4,6,8 and 10, the contribution is 5 minus the scale position. This implies that each question has a SUS contribution of 0-4 points. Finally, the sum of the scores are multiplied by 2,5 and divided by the number of replies to obtain the SUS score. The questionnaire is commonly used in a variety of research projects [5].

In addition to the 10 generic questions from SUS, we added 11 specific questions regarding suitability, the perceived usefulness and about the equipment being used.

3.1. Results from System Usability Scale (SUS) Questions

The results of the System Usability Scale score is shown in Table 1. Our system scored 74,25 of 100 points, which indicates that the system is easy to use. This was not a big surprise as the user interface of the client is very simple. The main challenge for some users was to enable their mobile phone to send/receive data and to download the game client. This process can be improved by allowing the students to send an SMS to receive a direct download link.

3.2. Results from Questions about Suitability Usefulness and Equipment

The results from the questions about how useful Lecture Quiz was are shown in Table 2. The results indicates that the students found the use of Lecture Quiz engaging, that they perceived they learn more using such games and that they would be likely to attend more lectures if such games are used regularly. How much the students actually learn from the game is hard to assess, but there was

Table 1. Lecture Quiz SUS Scores

#	Question	Avr	Score
1	I think that I would like to use this system frequently	3,6	2,6
2	I found the system unnecessarily complex	1,85	3,15
3	I thought the system was easy to use	4,02	3,05
4	I think that I would need the support of a technical person to be able to use this system	1,35	3,65
5	I found the various functions in this system were well integrated	3,2	2,2
6	I thought there was too much inconsistency in this system	1,95	3,05
7	I would imagine that most people would learn to use this system very quickly	4,35	3,35
8	I found the system very cumbersome to use	1,95	3,05
9	I felt very confident using the system	3,55	2,55
10	I needed to learn a lot of things before I could get going with this system	1,95	3,05

SUS score	74,25

a significant improvement in number of correct answers from the first to the second game mode. Further, they did not feel that the introduction of a game in the lecture was distracting. In question 17, we asked if the students felt reluctant to pay 0,50 NOK ($0,07) for the data transfer necessary to play the game in the lecture. Most students did not find this a problem.

Table 2. Usefulness of using Lecture Quiz

#	Question	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
11	I think I paid closer attention during the lecture because of the system	10%	10%	30%	40%	10%
12	I found the system had a distracting effect on the lecture	35%	35%	15%	10%	5%
13	I think I learn more during a tradition lecture	5%	55%	25%	10%	5%
14	I found the system made me learn more	5%	5%	40%	50%	0%
15	I found the system made the lecture more fun	0%	0%	5%	35%	60%
16	I think regular use of the system will make me attend more lectures	15%	0%	15%	45%	25%
17	I feel reluctant to pay 0,50 NOK in data transmission fee per lecture to participate in using the system	35%	15%	30%	10%	10%

In addition to question 11 - 17, we also asked questions regarding the mobile client. 90% of the students did not have any problem with the running the client software. 100% of the students said that they owned a laptop PC with WiFi support. 75% of the students said that their mobile phone supports Bluetooth. Thus it could be possible to use Bluetooth for communication between the client and the server. The main problem with this approach is the long delay for establishing connections, low bandwidth, limited number of connections, and addition hardware (Bluetooth server). Finally, 35% of the students said they used a laptop to play the game.

3.3. Experiences from the Teacher's perspective

Lecture Quiz was tested in a summary lecture[1] in the course Software Architecture. In addition, Lecture Quiz has been tested on several students not being part of a particular lecture. Lecture Quiz has received good reviews from the students on concept, engagement and playability. For the teacher, the game concept is easy to integrate into a lecture. PowerPoint is used in many lectures making it easy to start Lecture Quiz without any additional delays or interruptions. The questions were added to the game through a web-based mySQL database-interface. An improvement would be to make a simpler web-interface to enter questions. The first time the game is introduced to the class, the students have to download the game client. In the summary lecture described, Lecture Quiz was played in the second half of a two-hour lecture. At the end of the first half (before the break), the teacher displayed a slide describing how to download, install and run the game client. Thus, there were no unnecessary delays during the lecture.

As Lecture Quiz was used in a summary lecture, the questions focused on the main topics from the syllabus in the software architecture course. Here are three examples from the questions used:

```
What design pattern allows a uniform treatment of groups and primitives?
What is view fusion in reconstruction of architecture?
What is the most important output of the CBAM?
```

It was useful and a bit disappointing to see the performance of the students during the first game mode (Score Distribution). However, during the second game mode (Last Man Standing), most students performed much better.

In addition to summary lectures at the end of a semester, Lecture Quiz can be used regularly during a semester to test how much the students learn during lectures, and engage students to pay more attention to what being taught in lectures. As a bonus, students might find it easier to interact in the traditional lectures. A game session can typically last from 5 to 20 minutes depending on how many questions being asked and the number of game-modes played. The first author has previous experiences from using a variant of *Who Wants to Be a Millionaire* in classes several times in a semester with success. Such games are most appropriate for reviewing theory in one topic before staring on a new. The main benefit with Lecture Quiz approach is that all students can participate.

4. Related Work

As far as we know, there are no papers describing exactly the same game concept using the technical infrastructure in lecture halls. However, there are some related approaches presented in this section.

The TVREMOTE Framework was designed to allow hundreds of students to participate and give feedback during lectures using mobile phones over the GPRS network [4]. The system features polling of students' opinions and electronic question submission. The teacher can also broadcast links, notes, and multiple-choice questions. The teacher collects the feedback and reads it from a private display.

Classroom Presenter is a Microsoft PowerPoint plug-in to allows students to write comments directly onto the digital slides with a stylus or a keyboard input using a tablet PC [11]. Exercises are broadcasted to the tablet PCs, and the students write their answers onto a blank space of the slide. The teacher can then browse through the replies.

---

[1]last lecture before the final examination

WIL/MA is a tool for digital hand raising, spontaneous student comments and multiple-choice questionnaires [21]. The clients run on PDAs and a WiFi connection is used to transfer data. The teacher obtains the students' responses on his PC.

ClassInHand features a presentation controller, real-time quiz and student/teacher interaction [22]. The students' clients run on Windows Mobile PDAs and the teacher is also running his/her client on a PDA. The teacher's client is used for information retrieval and this information can later be presented to the students independently of the ClassInHand system.

ClickPro is a commercial classroom polling application for teaching in elementary school [2]. The system is based on infrared technology, giving the students special remote controls to submit the answers of multiple-choice questions. The teacher controls the application on a PC and the answers are displayed on a large screen. Each student is assigned a number that is displayed on the screen so the student can see if his answer is correct or not.

Buzz was originally conceived as commercial trivial game for Sony PS2. With government funding, a new version of the game named *Buzz! The School quiz* was designed especially as a tutoring tool [7]. The game will be marketed towards education institutions and comes with content covering Stage 2 National Curriculum for private schools in the UK.

Apart from Buzz! The School quiz, none of the systems above was intentionally designed as a game. Many of the systems provide functionality for running quiz, but the main focus is for the teacher to get the knowledge level of the students, as the result is not presented for the students. The ClickPro system has many similarities to Lecture Quiz, but was not designed as a game e.g., including different game modes. Only TVREMOTE was design to support large classes.

5. Conclusion

In this paper we have presented an evaluation of the Lecture Quiz game integrated into a software architecture lecture. The results of the evaluation showed that the game was easy to use and run using the available equipment in lecture halls. Further, the students claimed that the game contributed to increased learning and motivation. The students also claimed that they would more likely to attend to more lectures if such games were used.

More work needs to be done to evaluate how regular usage of such games in courses will affect the students' motivation and how much they learn. The main benefit from using such games in lectures is to provide a fun way for students to review topics and to provide useful feedback to the teacher of how much the students have learned.

References

[1] Sony Playstation 2. Buzz! Web: http://www.buzzthegame.com, 2007.

[2] Aclass Technology. EduClick - Overview. Web: http://www.aclasstechnology.co.uk/eduClick/index.html, 2007.

[3] Alex Baker, Emily Oh Navarro, and André van der Hoek. Problems and Programmers: an Educational Software Engineering Card Game. In *ICSE '03: Proceedings of the 25th International Conference on Software Engineering*, pages 614–619, Washington, DC, USA, 2003. IEEE Computer Society.

[4] Henning Bär, Erik Tews, and Guido Rößling. Improving Feedback and Classroom Interaction Using Mobile Phones. In *Proceedings of* Mobile Learning 2005, pages 55–62, 2005.

[5] J. .Brooke. SUS - a quick and dirty usability scale. In *Usability Evaluation in Industry*, pages 189–194. Taylor and Francis London, 1996.

[6] Camila Cortez, Miguel Nussbaum, Raul Santelices, Patricio Rodriguez, Gustavo Zurita, Monica Correa, and Rafael Cautivo. Teaching Science with Mobile Computer Supported Collaborative Learning (MCSCL). In *WMTE '04: Proceedings of the 2nd IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE'04)*, pages 67–74, Washington, DC, USA, 2004. IEEE Computer Society.

[7] Emma Boyes. Buzz! spawns School Quiz. Web: http://www.gamespot.com/news/6164009.html, 2007.

[8] James Paul Gee. *What video games have to teach us about learning and literacy*. Palgrave-MacMillan, New York, NY, 2003.

[9] Henry Jenkins. How should we teach kids Newtonian physics? Simple. Play computer games. *Technology Review*, March 2002.

[10] Susana Juniu. Implementing Handheld Computing Technology in Physical Education. *Physical Education, Recreation & Dance*, 73, 2002.

[11] Natalie Linnell, Richard Anderson, Jim Fridley, Tom Hinckley, and Valentin Razmov. Supporting Classroom Discussion with Technology: A Case Study in Environmental Science. To Appear ASEE/IEEE Frontiers in Education, 2007.

[12] Thomas W. Malone. What makes things fun to learn? Heuristics for designing instructional computer games. In *SIGSMALL '80: Proceedings of the 3rd ACM SIGSMALL symposium and the first SIGPC symposium on Small systems*, pages 162–169, New York, NY, USA, 1980. ACM Press.

[13] Lasse Natvig, Steinar Line, and Asbjørn Djupdal. Age of Computers: An Innovative Combination of History and Computer Game Elements for Teaching Computer Fundamentals. In *FIE 2004: Proceedings of the 2004 Frontiers in Education Conference*, 2004.

[14] Emily Oh Navarro and André van der Hoek. SimSE: an Educational Simulation Game for Teaching the Software Engineering Process. In *ITiCSE '04: Proceedings of the 9th annual SIGCSE conference on Innovation and technology in computer science education*, pages 233–233, New York, NY, USA, 2004. ACM Press.

[15] NIST. Common Industry Specifications for Usability - Requirements. Web: http://www.nist.gov/isur, 2007.

[16] Seymour Papert. Does Easy Do It? Children, Games, and Learning. *Game Developer Magazine*, page 88, June 1998.

[17] Marc Prensky. *Digital GameBased Learning*. McGraw-Hill, 2001.

[18] Ricardo Rosas, Miguel Nussbaum, Patricio Cumsille, Vladimir Marianov, Monica Correa, Patricia Flores, Valeska Grau, Francisca Lagos, Ximena Lopez, Veronica Lopez, Patricio Rodriguez, and Marcela Salinas. Beyond Nintendo: design and assessment of educational video games for first and second grade students. *Computers & Education*, 40(1):71–94, 2003.

[19] Mike Sharples. The design of personal mobile technologies for lifelong learning. *Computer & Education*, 34(3-4):177–193, 2000.

[20] Elliot Soloway, Cathleen Norris, Phyllis Blumenfeld, Barry Fishman, Joseph Krajcik, and Ron Marx. Log on education: Handheld devices are ready-at-hand. *Communcation of the ACM*, 44(6):15–20, 2001.

[21] UCE Servers & Clients, Lecture Lab. WIL/MA, Wireless Interactive Lecture in Manheim. Web: http://www.lecturelab.de/, 2007.

[22] Wake Forest University. ClassInHand. Web: http://classinhand.wfu.edu, 2007.

[23] Alf Inge Wang, Terje Øfsdahl, and Ole Kristian Mørch-Storstein. LECTURE QUIZ - A Mobile Game Concept for Lectures. In *11th IASTED International Conference on Software Engineering and Application (SEA 2007)*, pages 128–142. Acta Press, 2007.