The effect of points and audio on concentration, engagement, enjoyment, learning, motivation, and classroom dynamics using Kahoot!

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Abstract: There are many examples on the use of game-based learning in and outside the classroom, along with evaluation of their effect in terms of engagement, learning, classroom dynamics, concentration, motivation and enjoyment. Most of the research in this area focuses on evaluations of the use of game-based learning applications and the effect they have on the students. The majority of these papers show that game-based learning has a positive effect compared to more traditional learning methods. However, there are very few papers that investigate what specific elements in game-based learning applications that produce a positive effect. In this paper, we present an experiment where we investigated how the use of points and audio affect the learning environment. Specifically, the paper presents results from an experiment where the same lecture was taught for different group of students using the game-based learning platform Kahoot!. One group used Kahoot! as it supposed to be used with audio and points, one group used Kahoot! with audio but without points, one group used Kahoot! without audio but with points, and one group used Kahoot! without points and audio. The results from the experiment reveal that there are some significant differences whether audio and points are used in game-based learning in the areas of concentration, engagement, enjoyment, and motivation. The most surprising finding was how the classroom dynamics was positively affected by the use of audio. A total of 593 students participated in this experiment with a gender distribution of 44% female and 56 male students.

Keywords: Game-based learning, student-response system, Kahoot!, evaluation, social interaction.

1. Introduction

In the sixties researchers built prototypes on student response systems (SRS) (Judson 2002), and SRSs started to be used in education in the early seventies (Bessler and Nisbet 1971, Casanova 1971). In the recent years, game-based learning has become more common in learning environment along with the introduction of game-based student response systems (GSRS). The main difference between a GSRS and a SRS is that the game-based version focuses more on engagement and motivation by stimulating the students through graphics, animation, and audio, as well the use of score to motivate to personal improvement or compete against fellow students. The gamification of SRS' is done by temporarily transforming the classroom into a game show as shown on TV, where the teacher play the role of a gameshow host and the students are the competitors. Well-designed video games are said to be learning machines (Gee 2003), and they have the potential to get the players so motivated and engaged that they are not aware that learning is actually happening. In K-12 , games have been found to be beneficial for academic achievement, motivation and classroom dynamics (Rosas, Nussbaum et al. 2003). Games have also been found to have a similar effect in higher education (Sharples 2000). Previous research indicates that games can be made an integrated part of traditional classroom lectures to improve learning, motivation and engagement (Carver Jr, Howard et al. 1999, Carnevale 2005, Wang, Øfsdal et al. 2007, Wang, Øfsdal et al. 2008, Wu, Wang et al. 2011).

This article presents an experiment where the focus was to study the effect of the use of audio and points in the GSRS Kahoot!. Section 2 presents the related work. Section 3 presents material and methods including, a description of the GSRS tool used in the experiment, the data sources used, the research context and participants of the experiment, the experiment procedures, and the data analysis. Section 4 presents the results from the experiment. Section 4 discusses the results and concludes the article.

2. Related Work

Kahoot! represents a new generation of student-response systems that has a main focus on student motivation and engagement through gamification. The tool is a result of the research project Lecture Quiz that started in 2006 (Wang, Øfsdal et al. 2007), where results from experimentation of early prototypes showed positive results in terms of increased engagement, motivation and perceived learning (Wang, Øfsdal et al. 2008, Wu, Wang et al. 2011). Educational games compared to mainstream entertainment games are known to

suffer from running on very few platforms (usually Windows PCs), too simplistic, being single player and offline, offering low production value, and are typically more targeted towards parents, teachers and formal learning curriculum than being fun for the students (Kirriemuir and McFarlane 2004). This is especially true when educational games try to copy existing game concepts and add some learning on top of it. Kahoot! was not designed to copy any existing game, but rather to find a game concept that could fit a classroom setting and that could be alignment with Tom Malone's theory of intrinsically motivating instructions (Malone 1980). Malone's theory lists three categories that make things fun to learn: *Challenge* (goals with uncertain outcomes), *Fantasy* (captivate through intrinsic or extrinsic fantasy), and *Curiosity* (sensor curiosity through graphics and audio, and cognitive curiosity). As the game should be used in the classroom, it was also important to incorporate social game play. The result was to develop a game concept where the *fantasy* is that the classroom temporarily is changed into a game show where the teacher is the game host and the students are the competitors. The *challenge* is to answer questions and compete against other players, and *curiosity* is provided through inspiring graphics and audio, as well as solving a cognitive puzzle. The lack of variety in game play is compensated by the competitive nature of playing against a whole class of students. Reports from thousands of teachers and students all over the world give an indication that the concept works as intended. Learning games are commonly used to review facts using multiple-choice questions similar to what is done in Kahoot!. However, such games can also be used to teach skills, judgment, behaviors, theories, reasoning, process, procedures, creativity, language, systems, observation, and communication using various approaches (Prensky 2005).

A wide variety of software now exists that employ some variation on game elements to motivate, supply feedback, and structure participation trajectories. Research in educational settings has shown that games and game elements can influence subjective experience as well as behavior and learning outcomes, but these factors are often intermingled within studies. Further, individual game elements are rarely tested in isolation, making it difficult to determine the impact of individual design features, or their factorial interplay, relatively to e.g. the basic functionalities of a student-response system or extrinsic motivators leveraged within organizations when they adapt gamified learning platforms. However, a few studies have begun to emerge, that test the psychological and behavioral impacts of individual game design elements in non-game settings (Deterding, Dixon et al. 2011) by adopting controlled experimental rigor in the lab or the field (Attali and Arieli-Attali 2015, Lieberoth 2015, Mekler, Brühlmann et al. 2015). For instance, Lieberoth used a three-group experimental setup to dissociate the psychological effects of competitive game mechanics from the psychological expectations created by the gamelike look of the activity. In this study using a combination of behavior and survey, intrinsic motivation was found to be significantly higher in conditions using the "game looking" elements than the control condition, regardless of whether any actual game mechanics used. A weakness of such studies, however, is that individual design elements are rarely completely isolated in favor of comparing a "full game" with many moving parts to a (often passive) control condition. In Lieberoth's game framing study, for instance, the effect of the competitive mechanics were not isolated. In order to create a full 2x2 factorial design, a fourth condition with game mechanics but with no game looks would have been needed, so all four resulting groups could be compared using a slightly different statistical technique. In order to dissociate the effects of different design elements in Kahoot!, we therefore opted for a true 2x2 factorial design, switching sound and points off and on in a field experiment. The colorful look, social space and immediate feedback remained staple, which arguably creates a certain baseline game feel (Swink 2009) somewhere between the "juiciness" of casual games (Juul 2010) and "shallow" gamification (Lieberoth 2015). But the setup allows us to uniquely investigate the subjective impact of two of Kahoot!'s moving parts: Points and audio/music.

Points and other kinds of score tallying has been a staple of game design for what looks like millennia (Bell 1980, Elias, Garfield et al. 2012), but the phenomenon is also well known in education, where it has been debated in terms of immediate impact on classroom behavior versus long term achievement (McLaughlin and Malaby 1972, Greene, Sternberg et al. 1976, Deci, Koestner et al. 1999). This discussion has resurfaced in the use and criticism of points and badges in gamification (Fuchs, Fizek et al. 2014, Lieberoth, Møller et al. 2015, Prestopnik and Tang 2015). The most comprehensive review of gamification results to data shows generally mixed results (Hamari, Koivisto et al. 2014). When discussing "full games" for purposes like citizen science, empirical studies indicate that points can have a supportive role in engagement, but that factors like science interest and different kinds of narrative surrounding the task hold more motivational power (Iacovides, Jennett et al. 2013, Lieberoth, Pedersen et al. 2015, Prestopnik and Tang 2015). Likewise, studies from online tasks to learning contexts without "full game" structure have shown some behavioral impact of points in terms

of response speed (Attali and Arieli-Attali 2015) and number of tasks completed (Mekler, Brühlmann et al. 2015), even though this did not necessarily mirror task performance, nor measures of intrinsic motivation or participants' subjective participation motifs. This latter category of traditional gamification fits Kahoot! somewhat better than "full" learning games, but Kahoot! also differs notably in its real-time merging of quiz/polling with in-person lectures shared in the social setting of a lecture hall.

One feature that might contribute to the shift from psychological "lecture mode" to a more game/play oriented frame is Kahoot!'s use of audio and music. The psychological impact of music has been studied at multiple levels from its social psychological role in everyday life (Rentfrow 2012) to its biological underpinnings (Juslin and Västfjäll 2008, Janata, Tomic et al. 2012) and how at least three universal emotions can be recognized in and elicited by music across cultures (Fritz, Jentschke et al. 2009). Audio effects, and more or less ambient and dynamic music, has been a central part of digital game design for almost as long as technology has allowed (Collins 2009, Kamp 2014). Indeed, in Malone's early work on games for learning, it was found that music was among several motivating game factors, but most notably for female subjects (Malone 1981). More recently, music in video games has been linked to stress responses (Hébert, Béland et al. 2005) and aggressive behavior (Zhang and Gao 2014). In he broader behavior design framework, situational music has been found to have a bearing on gambling behavior (Dixon, Trigg et al. 2007), and both pleasant (North, Tarrant et al. 2004) and chilling (Fukui and Toyoshima 2014) music has been found to induce altruistic behavior in field- and behavioral economy experiments respectively.

Points and music are thus to well-studied phenomena that may each have their own role to play in the experience of, and behavior in, Kahoot! use in lecture rooms.

3. Material and Method

This section presents the Kahoot! game-based learning platform, the data sources, the research context and participants, research procedures, and the method for data analysis.

3.1 Research Questions and Research Approach

The research goal of the experiment presented in this article was to investigate how the use of audio and points in the game-based learning platform Kahoot! affects the students. The research method used is based on the Goal, Question Metrics (GQM) approach (Basili 1992) where we first define a research goal (conceptual level), then define a set of research questions (operational level), and finally describe a set of metrics to answer the defined research questions (quantitative level).

3.1.1 Research Goal and Research Questions

The research goal of this study was defined as the following using the GQL template (Basili 1992):

The purpose of this study was to *evaluate the effect of use of audio and points in a game-based learning platform* for *teaching new material* from the point of view of a *student* in the *context of a lecture*.

Our null-hypothesis was that there is not difference in students' attitude related to variations in use of audio and points in a game-based learning platform. In the context of the use of game-based learning platform in classroom teaching, the following research questions (RQs) were defined by decomposing the research goal:

- RQ1: How does the use of audio and points affect the students' concentration?
- RQ2: How does the use of audio and points affect the students' engagement?
- RQ3: How does the use of audio and points affect the students' enjoyment?
- RQ4: How does the use of audio and points affect the students' motivation and effort?
- RQ5: How does the use of audio and points affect the students' learning outcome?
- RQ6: How use of audio and points affect the classroom dynamics?

3.2 The Kahoot! Game-based Student Response System

Kahoot! is a game-based student response system (GSRS) launched by the teacher in a web-browser on a laptop connected to a large screen. Kahoot! provides a tool for creating quizzes including adding pictures and YouTube videos to the questions. It also makes it possible to publish and share your own quizzes, and edit

quizzes made by others. When playing Kahoot!, the students will log into the system using a gamepin (a number) and a nickname. The goal for the students is to answer the correct answer as fast as possible to get as many points as possible. Figure 1 shows how Kahoot! is played. A question is shown on the large screen along with four or less alternative answers shown in different colors with associated graphical symbols. The students give their answers by choosing the color and symbol she or he believes corresponds to the correct answer.

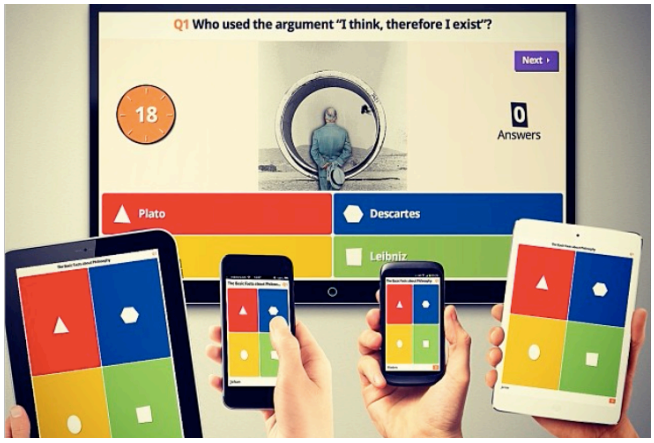

Figure 1 Playing Kahoot!

Between every question, a distribution of how the students answered is shown before a scoreboard of the five best players. The students get individual feedback on their questions in terms of correctness, the number of points, the ranking, how far the student is behind the student ranked above, and the correct answer if wrong answer is given. At the end of a Kahoot! session, the winner's nickname and points will be shown on the large screen. During the quiz, Kahoot! uses a playful graphical user interface as well as music and sounds to give it a playful and competitive atmosphere similar to a game show on TV. The students are also asked to give feedback on the quiz they have played through giving scores on whether the quiz was fun, educational, can be recommended to others, and how you generally feel about the quiz. Kahoot! can be played in two modes: players vs. players and teams vs. teams. Finally, Kahoot! provides the functionality for the teacher to download the results from the quiz in an Excel spreadsheet, as well as re-playing a quiz in ghost-mode.

3.3 Data Sources

A questionnaire was developed to measure the students' perceived concentration, engagement, enjoyment, learning, and motivation. The questionnaire was adapted from the course motivation survey (CMS) (Kebritchi, Hirumi et al. 2010) to our research context, and integrated with relevant questions in the Motivated Strategies for Learning Questionnaire (MSQL) (Pintrich 1991) and (Lepper, Corpus et al. 2005). The questionnaire used a four-point Likert scale from strongly disagree to strongly agree without any neutral. In addition, we used observations during the lectures to get data on the classroom dynamics.

3.4 Research Context and Participants

The experiment was performed in the IT introductory course at Norwegian University of Science and Technology (NTNU). There were two reasons for choosing this particular course for doing the experiment. First, the IT introductory course is a large course with many students, meaning that it would be possible to collect data from many subjects. Second, due to the size of this course, the same lecture has to be taught in four parallels by the same lecturer. This means that the only variation of the parallel lecture is the students attending. The IT introductory course is a mandatory course for all first year students at the university, yielding that the groups of students in the experiment should be fairly uniform. The experiment was conducted over four days between November 9th and 12th 2015. A total of 593 students completed their questionnaire, where the gender distribution was 44% female and 56% male.

3.5 Procedures

The lecture in the experiment was conducted according to Figure 2. *First*, the teacher introduced the lecture by presenting the agenda and the current topic. *Second*, the teacher taught the topic software engineering using Kahoot! and questions instead of slides. The procedure was that first the students were asked a question in

Kahoot! and they got their chance to respond. The lecturer would then comment on how the students responded before he explained more details related to the current question. In the experiment we made variations in the use of audio and points for the four parallel lectures. In one lecture Kahoot! was used as it should with audio and points, in one the audio was turned off, in one a variant of the quiz without points was used, and in one the audio was turned off as well as the quiz without points was used. A Kahoot! quiz consisting of the same 22 questions on software engineering was used in all parallels. The students were observed during lecture from the perspective of classroom dynamics. *Third*, the students filled in a questionnaire electronically using Kahoot!.

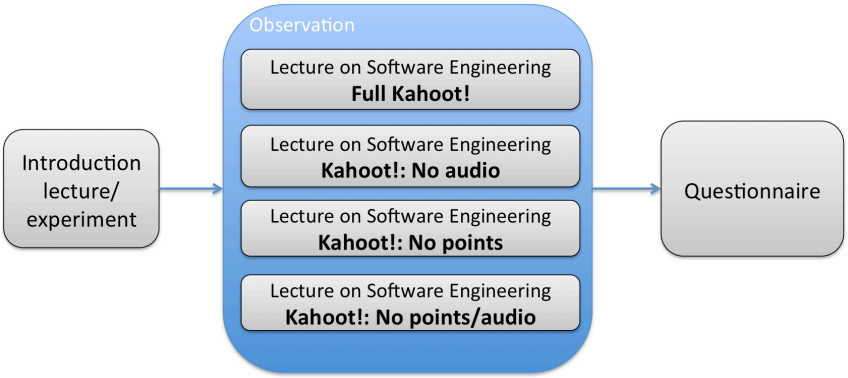

Figure 2 Experiment Procedures

3.6 Data Analysis

The Kruskal-Wallis test was ran on the data from the questionnaire to investigate the differences between the responses from the four groups Full Kahoot!, No audio, No points, and No audio or points. The Kruskal-Wallis test is a nonparametric test for the significance of the differences among the distributions of in our case four independent samples of difference sizes.

4. Results

This section presents the results from the controlled experiment. In the analysis we looked at differences in students' motivation, enjoyment, engagement, and concentration in regards to the used quiz method. This section also reports on differences in the learning outcome. Note that the descriptive statistics has summarized the four-point Likert scale into the two categories Disagree and Agree for improved readability.

4.1 RQ1: Effect on Concentration

Table 1 shows the descriptive statistics and the results from the Kruskal-Wallis test for statements related to *concentration*. The results show that there is a statistically significant difference in how Kahoot! kept the students concentration during the lecture related to the use of points and audio (statement 2). When no audio or points were used, the concentration during the lecture was significantly lower compared to the other variants. This shows that for holding the students concentration during a lecture both the use of points and audio are important. Interestingly, there was no noticeable difference in concentration while playing the quiz for variations in using audio and/or points (statement 1). In general above 80% of the students expressed that Kahoot! helped on the concentration both during the quiz and during the lecture.

Table 1 Results on Concentration

Statement	Group	Disagree	Agree	H	P
1. Playing the quiz did not hold my attention	Full Kahoot!	85%	15%	0.23	0.9726
	No audio	84%	16%		
	No points	84%	16%		
	No audio/points	82%	17%		
2. The quiz kept my concentration during the lecture	Full Kahoot!	18%	82%	60.25	**<0.0001**
	No audio	16%	84%		
	No points	16%	84%		
	No audio/points	**28%**	**72%**		

4.2 RQ2: Effect on Engagement

Table 2 shows the descriptive statistics and the results from the Kruskal-Wallis test for statements related to *engagement*. The results show that there is a statistically significant difference in whether the students felt pulse answering the questions related to the use of points (statement 4). When points were used, 68-69% agreed that they felt increased pulse, compared to 32-39% when points were not used. Interestingly, there is also a tendency that this effect is stronger when Kahoot! is played without both audio and points. The results did not reveal any statistically significant difference on the students' perception of the quiz being boring (statement 3). However, there is a tendency that more students who played Kahoot! without audio and points were to a larger degree bored (16%) compared to the others (4%-9%). On engagement, the most important factor is the use of points, but there is also a tendency that audio play a vital role.

Table 2 Results on Engagement

Statement	Group	Disagree	Agree	H	P
3. I thought playing the quiz was boring	Full Kahoot!	93%	7%	2.42	0.4899
	No audio	96%	4%		
	No points	91%	9%		
	No audio/points	84%	16%		
4. I felt increased pulse when answering questions	Full Kahoot!	31%	69%	50.56	**<0.0001**
	No audio	32%	68%		
	No points	**61%**	**39%**		
	No audio/points	**68%**	**32%**		

4.3 RQ3: Effect on Enjoyment

Table 3 shows the descriptive statistics and the results from the Kruskal-Wallis test for a statement related to *enjoyment*. The results show that there is a statistically significant difference on the students' perception of the quiz being fun. A smaller percentage of the students who played a Kahoot! without audio and points agree that the quiz was fun (75%) compared to other groups of students (91-94%).

Table 3 Results on Enjoyment

Statement	Group	Disagree	Agree	H	P
5. Playing the quiz was fun	Full Kahoot!	8%	92%	9.68	**0.0215**
	No audio	6%	94%		
	No points	9%	91%		
	No audio/points	**25%**	**75%**		

4.4 RQ4: Effect on Perceived Learning

Table 4 shows the descriptive statistics and the results from the Kruskal-Wallis test for a statement related to *perceived learning*. The results show that there is no statistically significant difference in how the students perceived whether they learned something from playing the quiz. The large majority of the student (over 90%) perceived that they learn something from playing the quiz. Interestingly, there also seam to be a weak tendency that students perceive that they learn more when there is no points (98% agree) involved, and they learn less when they play a Kahoot! with points but without audio (90% agree).

Table 4 Results on Perceived Learning

Statement	Group	Disagree	Agree	H	P
5. I learned something from playing the quiz	Full Kahoot!	5%	95%	1.17	0.7602
	No audio	10%	90%		
	No points	2%	98%		
	No audio/points	2%	98%		

4.5 RQ5: Effect on Subjective Motivation and Effort

Table 5 shows the descriptive statistics and the results from the Kruskal-Wallis test for a statement related to *motivation* and *effort*. The results show that there is statistically significant difference for statement 8 on

motivation for doing well on the quiz, where the students who played Kahoot! with points but without audio to a less extent agreed that they did not try very hard to do well on the quiz (7%) compared to the other groups (23%-36%). Among the students who played Kahoot! without audio or points 36% said that they did not try very hard to do well on the quiz. Based on some oral feedback from the students, the motivation for doing well on the quiz with points but without audio increased as it felt more like a formal test.

Table 5 Results on Motivation

Statement	Group	Disagree	Agree	H	P
6. It was important to do well on the quiz	Full Kahoot!	28%	72%	2.8	0.4235
	No audio	22%	78%		
	No points	34%	66%		
	No audio/points	34%	66%		
7. Playing the quiz could be of some value to me	Full Kahoot!	7%	93%	0.78	0.8542
	No audio	7%	93%		
	No points	6%	94%		
	No audio/points	11%	89%		
8. I did not try very hard to do well on the quiz	Full Kahoot!	77%	23%	11.74	**0.0083**
	No audio	**93%**	**7%**		
	No points	74%	26%		
	No audio/points	**64%**	**36%**		
9. Playing the quiz made me less motivated about the subject	Full Kahoot!	93%	7%	0.25	0.9691
	No audio	91%	9%		
	No points	90%	10%		
	No audio/points	90%	10%		

4.6 RQ6: Effect on Classroom Dynamics

We did not include any statements on classroom dynamics in the questionnaire, but the results reported here are based on observations of the student behaviour in the lecture hall. Here is a summary of the observations for the various groups:

- **Full Kahoot!**: High spirit in the classroom, laughter, focused students, loud discussions between the questions in the quiz, loud cheering when getting the correct answers, some students started to dance in their seats, and there were open questions to the teacher during and at the end of the lecture. The class was highly responsive.
- **No audio**: Quiet classroom, concentrated students, no cheering, no discussion among students, and no questions during the lecture.
- **No points**: High spirit in the classroom, laughter, quiet cheering when getting correct answers, some discussions between questions, open questions during the lecture, and some students were dancing in their seats.
- **No points/no audio**: Low energy in the classroom, totally quiet, no celebration on correct answers, low response, and now open questions from students.

Based on the observations it was obvious that the use of audio in Kahoot! had the largest impact on classroom dynamics in terms of interaction, response and spirit. The audio simply produced more energy in the room, and opened up for a more interactive environment. The best effect on classroom dynamics was achieved through the combination of both points and audio/music.

5. Discussion and Conclusion

In this article, we have presented an experiment where we investigated the effect of using audio and points in the game-based learning platform for the classroom – Kahoot!. In the experiment, the same lecture on software engineering was taught to four parallels where Kahoot! was used throughout the lecture to facilitate questions and answers instead of using slides or more traditional teaching tools. The only variation between the four parallel lectures was the use of audio and points in Kahoot!. At the end of the lectures, the students were asked to fill in the same questionnaire with statements related to concentration, engagement,

enjoyment, learning, and motivation. The Kruskal-Wallis test was used to test the hypothesis that there was no difference in the students' attitudes for variations of audio and points. The results show that variation in use of audio and points had a statistically significant difference for concentration (RQ1), engagement (RQ2), enjoyment (RQ3), and motivation and engagement (RQ5). Observations in the classroom also revealed that audio and music affects the classroom dynamics in a significant positive way, and points also contribute to improve the classroom dynamics but to a more limited extend.

In this first treatment, we have focused our efforts on a broad analysis of positive/negative single item responses, and given little attention to more complex relationships within the data such as between subject relationships and moderation by factors like gender found in other research on points and music, which may be revealed with deeper factorial analyses of the thus far promising dataset.

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