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Research Article

Game-based learning "Jeopardy" in dental education: A pilot study

Abstract

This randomised experimental pilot study is intended to contribute to the investigations about the learning success of students in their first clinical semester of dentistry using game-based learning in "Jeopardy"-setting. In dentistry, there are no studies available on this learning and teaching context.

All students from the first clinical semester of the dentistry course at Goethe University Frankfurt am Main were included in this study (n=25). They underwent a pre-test with 39 multiple-choice questions (MCQ) and a 15-min solution time. The students were divided into two groups (active participants/players [A; n=13] and passive participants/listeners [P; n=12]) for the duration of two game-based learning units of "Jeopardy". Both groups then completed a post-test (39 MCQ, 15 min time). The intervention was evaluated with the help of a questionnaire to determine the satisfaction and learning behaviour of the students.

An evaluation of the pre-and post-tests showed an average score increase of 2.08 points (P), with the active player group improving by 0.31P and the passive listener group improving by 4P.

On the evaluation sheet, on a scale of 1–10, the setting was assessed positively by all participants (7.64±1.8); the questions asked whether self-study was stimulated (4.2±0.9 on a scale of 1–5). In addition, students indicated that they would recommend this setting to other students (4.0±0.9 on a scale of 1–5).

In summary, game-based learning in "Jeopardy"-setting was assessed positively by both active and passive participants but did not facilitate a significant increase in knowledge in either group.

Introduction

In recent years there has been a shift in university didactics from passively mediated forms of learning, in which the focus is merely on understanding and absorbing, to active, modern learning modules [1]. The reinforcement for learners through playful, actively conveyed content increases intrinsic motivation and is increasingly carried out through game-based learning (GBL) [2]. This way of learning also promotes teamwork and the joy of acquiring knowledge [3].

Due to the increasing abundance of expected knowledge, students of medicine and dentistry are confronted with a considerable challenge in terms of workload [4]. Compared to frequently used problem-based learning setting (PBL), there are some common features and differences. Both (GBL and PBL) promote active participation and intrinsic motivation. In PBL, the independent engagement with the content of the task is assumed in order to link the existing knowledge with the new one. Whereas in GBL, factual knowledge is often asked in the tasks and transfer knowledge is less demanded from the participant. But the fun motivates them to acquire knowledge. On the other hand, PBL simulates a situation and participants have to face up to a problem and come to the solution with the help of transfer know-how [4].

GBL is implemented in many different ways, including video games, classic board games, and well-known quiz show formats. Decisive features are a given game framework and rules, as well as the indispensable active participation of the players and thus promoted intrinsic motivation [4].

In 1996, Ford et al. [5], first described the "Jeopardy" game format in a study on the didactic training of nurses [5]. More than 20 years ago, he recognised that game-based learning in a quiz-style show, such as "Jeopardy", produced an increase in knowledge [5]. There also exist a growing number of papers on this setting reporting mostly positive results [1,3,5-22], research investigating differences between traditional lectures and GBL [6,7,9,14,15], however no one examined "active" players and "passive" listeners.

In this context our pilot study focuses on the question of

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how "Jeopardy" can influence the learning ability of students as active or passive participants. In this context one group actively played the quiz show format and the other group passively played (watched) as spectators. With the help of a pre- and post-test, we determined the differences in knowledge and then interviewed the participants on their satisfaction, motivation, and learning behaviour.

The fundamental research question of this study was as follows: Can a game-based learning module, such as "Jeopardy", facilitate the acquisition of knowledge by students in their first clinical semester of dentistry and improve the satisfaction of the participants?

Materials and Methods

Participant group

This study included students in their first clinical semester of dentistry at Goethe University Frankfurt am Main. Twenty-five students took part; 16 were female and 9 were male. The average age was 23.8±2.02 (min=20 and max=28). Table 1 shows the distribution of the population.

Table 1: Distribution of study population.

	Total	Active	Passive
Age	23.8	24.6	22.9
Men	9	5	4
Women	16	8	8

Learning setting

The "Jeopardy" learning module was an extra-curricular offer that was available for the first time. The students took part in two consecutive quiz show sessions on two consecutive days. The setting provided for a division of the participants into two groups (active participants/players (A; n=13) and passive participants/listeners (P; n=12)). The selection was randomized without consideration of special criteria. The player group was further divided into four groups. Each team of players received a buzzer that emitted an acoustic and visual signal when activated. The player groups were allowed to choose 30 sequential questions that were divided into categories of varying difficulty (increasing points for correct solutions). The content of the questions referred to the learning content of the first clinical semester of the dentistry program.

Pre and posttest

In the beginning, both groups were given a practice test (pre-test, one day before the game) that consisted of 39 multiple-choice questions (MCQ). Each question had five possible answers. The content of the 39 questions was based on the content of the first clinical semester of the dentistry program. The groups were given 15 minutes to solve the tasks. At the end of the intervention (one day after the second "Jeopardy" session), a post-test was carried out (39 MCQ each with 5 possible answers; 15 min solution time).

Evaluation

Finally, the students evaluated the strategy using an evaluation form. The questionnaire contained 113 questions divided into four sections (A: general information; B: concept "game-based learning"; C: information about each student's personal way of learning; D: general information "game-based learning"). Section A contained 16 questions and dealt with general information about the participant and the learning unit "Jeopardy"; section B dealt with the concept of game-based learning "Jeopardy" and contained two questions. Information on the personal nature of students' learning was collected through 84 questions in Section C. The last section included a free text field and 11 general questions about the learning concept. The questionnaire was collected one week after the second "Jeopardy" session.

Statistics

The following analyses were conducted:

1. quality criteria of the multiple-choice tests (analysis of item difficulty and discrimination, reliability).
2. mixed-model analysis (analysis of variance), taking group effects into account (significance level $p \leq 0.05$).

All data were statistically analyzed using the software SAS 9.1 (SAS Institute Cary, NC, USA).

Results

Pre and posttest

The results are summarised in Tables 2,3 and Figure 1. In the pre-test, students achieved an average score of 21.88 ±5.68 (active participants: 23.07±6.61; passive participants: 20.58±4.38). In comparison, the students increased their overall score by 2.08 points to 23.96±4.44 in the post-test. However, the difference between the active and passive participants was not significant. The active participants increased their score by 0.31 points to 23.38±5.38; the passive participants by 4 points to 24.58±3.26, without a statistical significant difference (p=0.0905).

Table 2: Results of pre- and post-test comparisons between active and passive participants.

	Total	Active	Passive
Pre-test (n = 39)	21.88±5.68	23.07±6.61	20.58±4.38
Post-test (n = 39)	23.96±4.44	23.38±5.38	24.58±3.26
Difference Post-Pre-test	2.08	0.31	4.00

Table 3: Results of pre- and post-test comparisons (C: Cronbachs Alpha; ID: Total Item difficulty; TD: Total Discrimination).

	C	TID	TD
Pre-test (n = 39)	21.88±5.68	23.07±6.61	20.58±4.38
Post-test (n = 39)	23.96±4.44	23.38±5.38	24.58±3.26

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Evaluation

The response rate to the evaluation questionnaires was 100%; only five students used the free text field. With the help of 113 questions, divided into categories, the students were able to evaluate the teaching unit. Overall, the students evaluated the learning module "Jeopardy" as good with 7.6±1.8 (on a scale of 1–10; 6=sufficient and 10=excellent). Group-specific values for the player group (A) were 7.5±1.9 and the listener group (P) 7.8 ±1.7.

Sixteen participants from the entire population used game-based learning in their studies for the first time; 9 participants already had initial experience. The following results can be seen in Table 4. The groups indicated on a Likert scale (1: disagree; 2: disagree; 3: undecided; 4: agree; 5: fully agree) that the course unit stimulated them to pursue self-study (mean 4.2±0.9). They also found the intervention to be positive in terms of feedback on their learning progress (mean 4.4±0.7). Game-based learning was described by the majority of participants as a good supplement to the lecture (mean 4.4±0.5) and was also an effective part of their studies (mean 4.2±0.8). The majority of participants indicated that they would recommend this learning setting to other students (mean 4.0±0.9).

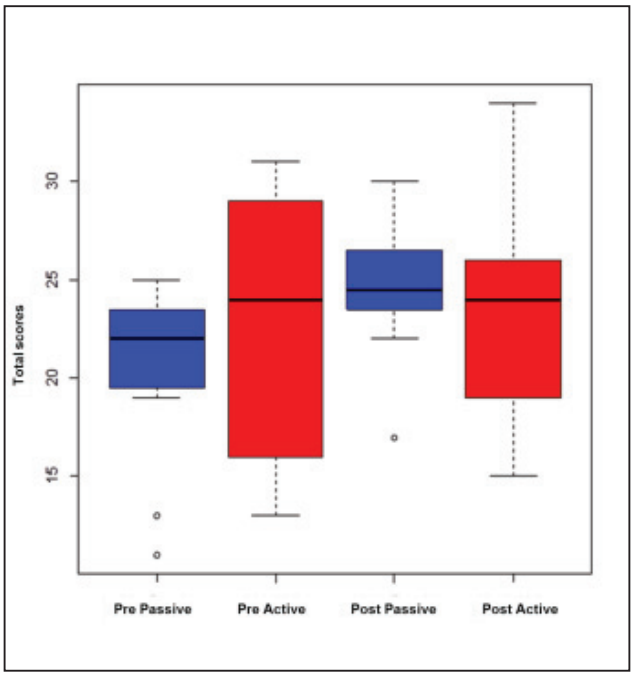

Figure 1: Results of pre- and post-test comparisons.

Discussion

Traditionally, in university didactics, lectures are used to convey content [6]. However, studies repeatedly show that new formats of knowledge acquisition offer clear benefits for students [6-9]. The content of knowledge is often at the centre of the teaching, which neglects the learning experience. For this reason, students find the teaching boring [10,11].

The transfer of knowledge requires an interaction among the learners in order to anchor content in the long term. Game-based learning can be used by dental students to uncover gaps in knowledge and allow the students to quickly absorb content. The students are playfully introduced to the wealth of knowledge in the field of dental preservation and the students' intrinsic motivation is stimulated [2]. The present study shows that game-based learning experiences are consistently positively assessed by students. In addition, recent studies show that gamebased learning has achieved good results in the training of dentists and physicians [7,12,13] with every type of game (board games, screen-based games, video games, etc.), leading to an increase in knowledge [14]. As in this study, similar experiments have shown an increase in knowledge in the short term after the intervention; the long-term anchoring of knowledge has not yet been investigated by us [8]. Only Khan et al., [15], have studied the long-term anchoring of knowledge by its participants. In a second post-test, two months after the learning module, he examined the participants and found a more consistent acquisition of knowledge among the test persons who had participated in game-based learning [15].

In the literature, the comparison is often made between two groups whose intervention consists of a lecture on the one hand and game-based learning on the other [6,7,9,15]. One group of participants would receive classical frontal instruction, while the other group would receive knowledge with the help of the "Jeopardy" quiz format. However, this study aimed to find out to what extent active players (n=13) differ from viewers (n=12) of the quiz in terms of knowledge gain and satisfaction. Both groups followed the quiz game, but only the players, spread over four teams, were allowed to play actively. Comparative literature on the setting that we chose was not available at that time. Due to the small size of the cohort (n=25) in this pilot study, future investigations with further cohorts are indispensable. The small number of subjects causes difficulties

Table 4: Questions targeting game-based learning using a five-step Likert-Scale (1: Totally disagree; 2: Disagree; 3: Undecided; 4: agree; 5: Totally agree; SD: Standard Deviation; Min: Minimum; Max: Maximum).

Item	Scale	Median	SD	percentiles			Min	Max
				25th	50th	75th		
The questions stimulated me to self-study.	Likert 1 –5	4	0.9	4	4	5	1	5
The game-based learning was a good feedback to my learning progress.	Likert 1–5	4	0.7	4	4	5	2	5
Game-based learning was a useful addition to the content of the lectures.	Likert 1–5	4	0.5	4	4	5	4	5
I consider the implementation of game-based learning to be a useful part of my studies.	Likert 1–5	4	0.8	4	4	5	3	5

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in statistical evaluations of data and may lead to inaccurate results. Comparative studies have included 45, 82, and 34 participants, respectively [1,15,16].

Contrary to the initial hypothesis that active participants would experience a significantly higher increase in knowledge, it was subsequently shown that the passive participants in the post-test experienced a greater increase in knowledge than the active players. A possible reason for this observation is that the players felt stressed by the time limit for answering the questions and that anchoring of the question content did not take place to the same extent as that of the listeners. The literature shows that learning under stress has a strong influence on playback quality, regardless of the content of the learning [17,18].

The interval between the individual game sessions was chosen to be very tight (two consecutive days) to avoid, as far as possible, falsifying the results in terms of knowledge growth since the students were shortly before the examination phase and acquired knowledge in lectures and self-study. The long-term effect of the intervention was not investigated. It is possible that the two-day learning module is too short and would be more effective if the rounds were distributed over several weeks.

To exclude any further influence, the experimental setup was chosen to be very simple and clearly structured. Only four buzzers and a visual transmission of the question presentation were needed. Jenkins et al., [19], described the demands of game-based learning and stressed the need to keep the financial and economic framework low. Thus, the far-reaching feasibility is to be guaranteed, and the focus on the essential content is to be clearly structured. Furthermore, the friendly competition between the groups is an important point in the acquisition of knowledge and an important part of the self-motivation of the participants [20].

Due to the simple structure, it is conceivable to use the quiz questions for all areas of adult education. This format is very suitable especially in the medical field because a lot of information can be conveyed to the students in a stress-free manner. Similar studies are repeatedly mentioned in the medical context [1,3,5-8,12-16,21,22]. This study was limited to 30 questions (six blocks, five questions each) per quiz round; each quiz round took one 45 min lesson. Contrary to the study by Jirasevijinda et al., [16], we did not divide the blocks into categories but only assigned the letters A–F to them. Behind the blocks A–F hid randomly mixed questions from the field of operative dentistry. A possible categorisation of questions could influence students as students tend to choose areas in which they are already familiar. It has not yet been investigated whether categorisation or random selection of the questions would lead to differences in knowledge growth.

Conclusion

After completing the pilot study, it can be stated that both the active player group and the passive listener group reflected consistently positive evaluations for the learning module "Jeopardy" (7.6±1.8).

Due to the increase in the scores from the pre- to post-tests (+2.08P), a positive effect on the anchoring of knowledge was seen. The small population limited being able to determine a clear significance and leads to a repetition to enlarge the cohort. The simple feasibility of the game setting and the recommendation of the participants to subsequent students (mean 4.0±0.9) speaks for establishing game-based learning in the curriculum of dentists. Alternative learning modules must be offered in the modern training of dentists in order to motivate students in their careers and encourage continuous education and training.

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