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The Impact of Flipped Classroom and Kahoot! on Students' Motivation in Biostatistics Education: An Action Research Study

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Abstract

Background: The flipped classroom model and Kahoot! can be utilized to enhance students' knowledge, attitudes, and motivation in biostatistics.

Aim: This study investigated the impact of the flipped classroom model, integrated with interactive videos and the Kahoot! application, on the motivation levels of nursing students in biostatistics teaching.

Methods: This mixed-methods action research included a quantitative phase with 43 students and a qualitative phase with 10 students. Biostatistics was taught using the flipped classroom model and the Kahoot! application, supported by interactive videos. Data were collected using the Motivated Strategies for Learning Questionnaire and semi-structured interviews. Data analysis was conducted using paired-samples t-test and content analysis.

Results: The mean age of the students was 20.53 ± 0.76 years, and 83.7% of them were women. After implementing the flipped classroom model and Kahoot!, the students' motivation and learning strategy scores were found to be statistically higher than their baseline levels. Six main themes emerged: impact on learning, communication with peers and teachers, learning environment, contribution to self-confidence and motivation, video and game applications as new learning tools, and a positive competitive environment.

Conclusion: The flipped classroom model combined with Kahoot! increased students' motivation, facilitated learning, improved the learning environment, and positively contributed to self-confidence.

Keywords: Education, flipped classroom, Kahoot!, learning, motivation, nursing, students, teaching

Introduction

Biostatistics is one of fundamental parameters required for evidence-based practice in healthcare and nursing. It is defined as a branch of science that provides guidance on gathering information, planning experiments, establishing hypotheses, and evaluating and interpreting data to address health problems. Biostatistics education is essential for planning, conducting, analyzing, and interpreting various types of research, including clinical and field studies in medicine and health.[1,2] Incorporating technology into the education system is vital to ensure that biostatistics knowledge is reinforced, retained, and facilitates effective learning. One recommended approach to enrich learning environments with educational technologies and enhance the effectiveness and permanence of learning is the flipped learning model.[3,4]

In the flipped learning model, which reverses the two primary learning stages of traditional classroom-based education, students research theoretical topics before the lesson and are introduced to new materials individually. Subsequently, the subject is discussed in the classroom under the guidance of the teacher, and reinforcing practices are carried out, contributing to deeper learning and consolidation. Incorporating technology into education and training processes, particularly through interactive videos, is a frequently used approach within the flipped learning model. With this method, greater student participation in lessons, improved academic success, and increased motivation may be achieved. This learning model supports self-directed learning while employing active learning methods, such as interactive decision-making and problem-solving, during classroom activities.[3,5,6] The flipped learning model allows for the effective use of lesson time, enabling more applications, discussions, and activities. The flipped application

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model increases student motivation during lessons.[7-9] Systematic review studies suggest that the flipped classroom enhances nursing students' performance, study satisfaction, critical thinking, and problem-solving abilities, as well as their knowledge, skills, and attitudes.[10,11] However, challenges have been identified, including technological dependence, potential mismatches in learning styles, and difficulties in monitoring student engagement and providing timely feedback.[12] Additionally, disadvantages such as internet costs, lack of technological resources, time constraints, and inefficiencies have also been reported.[13,14]

Using interactive videos alongside the flipped model is recommended to enhance student interest in lessons and ensure they come prepared. Interactive videos include features such as in-video questions, feedback, links, and discussions.[15] Students' feedback is essential to improve the effectiveness of the flipped learning model. Studies have shown that using student response systems increases class participation and facilitates learning.[16,17] These systems enable instructors to ask questions, receive immediate answers, and analyze results.[17,18] Game-based student response systems can effectively attract students' attention, make learning more enjoable, and facilitate learning through games. One of the most widely used student response systems is Kahoot! (a game-based student response system).[4,19] In a review, the Kahoot! application was found to have a positive impact on learning performance, classroom dynamics, student and teacher attitudes, and student anxiety.[4] Positive outcomes associated with Kahoot! included increased student involvement, improved attendance, enhanced knowledge of the material, and better collaborative learning, as highlighted in a scoping review.[20] According to research conducted in New Zealand, Kahoot! improved classroom dynamics, motivation, active course engagement, and most importantly, the quality of student learning in the classroom.[6]

The flipped classroom model is a widely used educational method, yet its application in biostatistics education is scarcely explored in the literature. The combination of the flipped classroom model and the Kahoot! application can facilitate effective learning in biostatistics, increase students' motivation, ensure readiness for lessons, and promote active participation in the classroom.[3,4,21,22] In nursing, the flipped classroom and Kahoot! methods contribute positively to both psychomotor skills and the acquisition of theoretical knowledge.[10,23] In a study where the flipped classroom was applied in a short-term biostatistics lesson, students actively participated, found the lesson useful, and were motivated to learn more.[24] The flipped classroom model in biostatistics teaching also demonstrated positive contributions to students' knowledge levels and the learning environment in a mixed-method study.[25] In the literature, the flipped learning model has been applied across various disciplines such as medicine, pharmacy, dentistry, mathematics, and accounting. These studies have reported positive outcomes, including increasing student willingness to learn, higher satisfaction and course success rates, improved learning facilitation, enhanced exam grades, as well as fostering permanent learning and self-directed learning.[26-30] However, no mixed methods action research (MMAR) was identified in the literature that evaluates the combined effects of the flipped classroom model and the Kahoot! application on students' learning motivation. This study aims to assess the effects of the flipped classroom model and the Kahoot! application on student motivation while also exploring the advantages and disadvantages of using these two methods together.

Study Question

1. What are the effects of the flipped classroom model and the Kahoot! application on student motivation in biostatistics teaching?

Aim

In this study, it was aimed to explore the effect of flipped application model and Kahoot application on students' motivation in biostatistics teaching.

Materials and Methods

Design and Setting

This study employed a MMAR design, which utilizes a unique and innovative methodology suited to complex organizational contexts. The integration of data throughout the investigation is the foundation of this research's synergy. MMAR gathers and analyzes both quantitative and qualitative data, incorporating multiple sources of information.[31,32] This study was prepared in accordance with the SRQR guideline (Standards for Reporting Qualitative Research: A Synthesis of Recommendations) proposed by O'Brien et al.[33] The study was conducted between October and December 2021, involving nursing students attending the biostatistics course for the first time. Classes were held on Fridays from 8:30 to 10:30 AM.

Sample

The study population consisted of 210 nursing students enrolled in the biostatistics course during the fall semester of 2021. The G*Power program was used to calculate the required sample size. The effect size was determined based on Chung and Lee's (2018) study, which examined the impact of the flipped classroom model ($d = 0.56$).[7] According to the G*Power analysis, a minimum of 34 participants was required for a single group, using a t-test with an a priori power of 80%, a 95% confidence interval, and an effect size of $d = 0.56$ for dependent groups. To account for a potential 20% dropout rate, the target sample size was set at 40 participants. Ultimately, the study was completed with 43 participants who attended all 12 weeks of the course (quantitative phase). Purposive sampling was employed to ensure transferability and to generate more in-depth findings. The sample included 43 participants (83.7% female) with an average age of 20.53 ± 0.76 years. Additionally, individual interviews were conducted with 10 students who actively participated in the lessons (qualitative phase). The inclusion criteria for the study were being a third-year nursing student and attending the biostatistics course for the first time.

Data Collection Tools

In this MMAR study, both quantitative and qualitative methods were employed. The baseline data were collected prior to the intervention, and the post-test data were gathered during the 13th week following the intervention. Subsequently, individual interviews were conducted. Quantitative data at baseline and at the 13th week following the intervention were collected using the Motivated Strategies For Learning Questionnaire (MSLQ) (Figure 1).

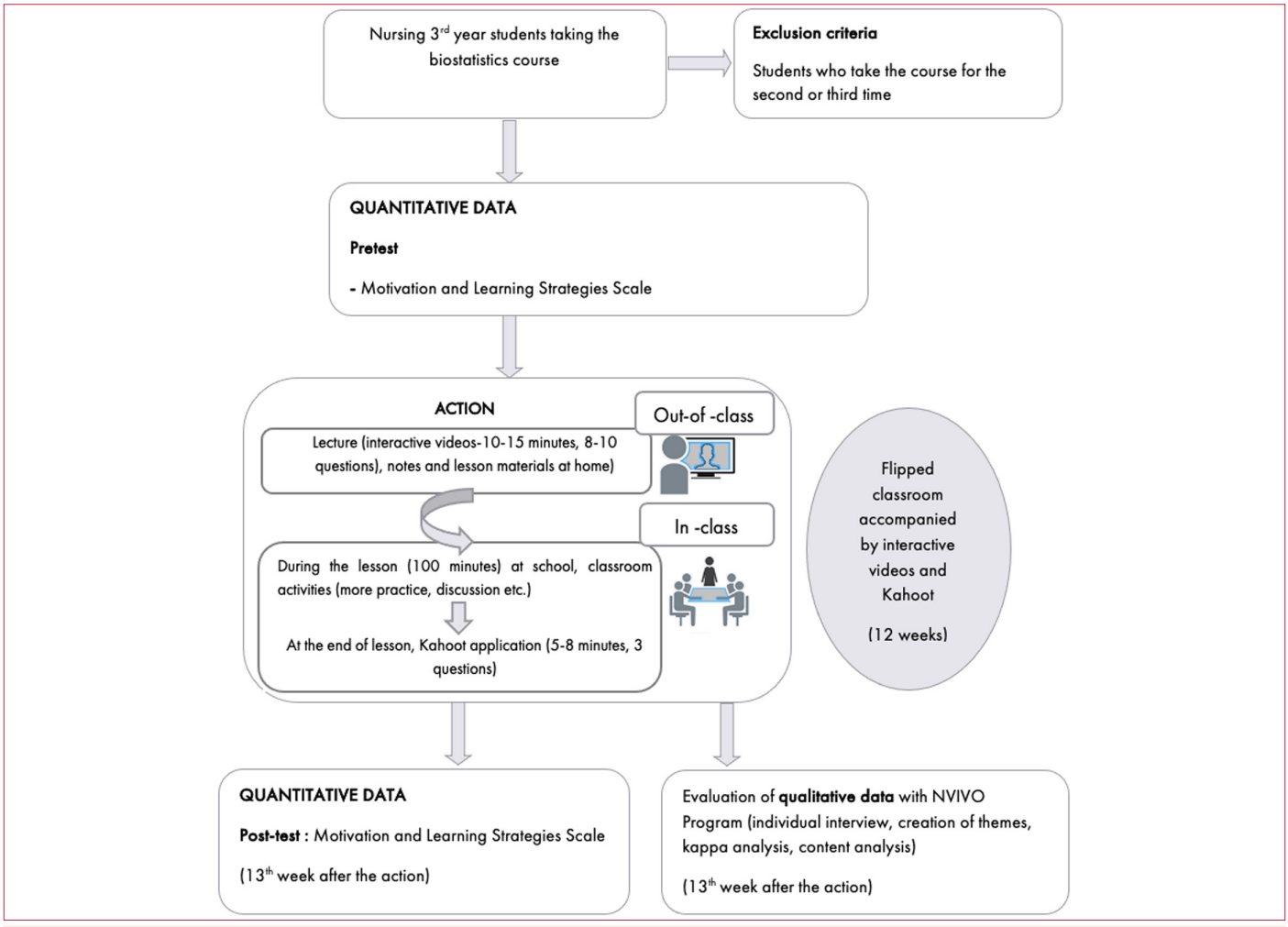

Figure 1. Research procedure of this study.

Motivated Strategies For Learning Questionnaire

The Motivated Strategies for Learning Questionnaire (MSLQ) was developed by Pintrich, Smith, Garcia, and McKeachie (1991) to measure university students' motivation and learning strategies for a specific course. The Turkish validity and reliability of the scale were established by Büyüköztürk et al.[34] The MSLQ consists of 81 self-report items divided into two categories: "Motivation Section" and "Learning Strategies." These sections are detailed in Table 1. The scale is a seven-point Likert-type measure, with responses ranging from "not at all true of me" (1) to "very true of me" (7). Higher scores on the total scale and its subscales indicate higher levels of motivation and the use of learning strategies. The Cronbach's alpha coefficients for the Turkish version ranged from 0.86 to 0.41.[33] In the present study, the coefficients ranged from 0.72 to 0.89.

Qualitative data were collected during the 13th week after the intervention through in-depth individual interviews conducted by the researcher, adhering to qualitative research methods (Figure 1). The interviews were conducted online via the Zoom platform, and video calls were recorded for analysis. Semi-structured, open-ended questions posed to students during the interviews are presented in Table 2.

Intervention

During the 2021-2022 academic year, the biostatistics course was conducted as a single group and delivered online. This course utilized the flipped classroom model and the Kahoot! application, complemented by interactive videos. The interactive videos, containing questions and notes prepared by the researcher, along with lesson materials related to each week's topic, were shared with students prior to the lessons. During the live sessions, students and the instructor focused on practicing and discussing the lesson topics. Students were asked questions, and the instructor provided explanations for the parts they did not understand. The interactive videos, prepared using the Edpuzzle program, included multiple-choice questions, feedback, notes, and links to relevant websites. In the first session, students were introduced to the Edpuzzle program and were instructed to register using their email address. The class code provided to students was sufficient to access all videos. Links to the videos were sent to students one week before each session.

At the end of each lesson, three questions were posed through the Kahoot! application to evaluate students' understanding of the

Table 1. Subscales of MSLQ

	The number of items	Cronbach's alpha coefficient (Büyüköztürk et al.[34])	Cronbach's alpha coefficient (in this study)
MSLQ total		81 items and 2 sections	
Motivation section		31 items and 6 subscales	
Intrinsic goal orientation	4 items	0.59	0.78
Extrinsic goal orientation	4 items	0.63	0.79
Task value	6 items	0.80	0.81
Control belief of learning	4 items	0.52	0.73
Self-efficacy	8 items	0.86	0.86
Test anxiety	5 items	0.69	0.87
Learning Strategies section		50 items in 9 subscales	
Rehearsal	4 items	0.62	0.77
Elaboration	6 items	0.74	0.88
Organization	4 items	0.61	0.79
Critical thinking	5 items	0.74	0.75
Help seeking	4 items	0.49	0.72
Metacognitive slf-regulation	12 items	0.75	0.75
Managing time and study environment	8 items	0.61	0.77
Effort regulation	4 items	0.41	0.83
Peer learning	3 items	0.46	0.73

material. Correct and incorrect answers were discussed during these sessions. The intervention lasted for a total of 12 weeks.

Data Analysis

Quantitative data were analyzed using the Statistical Package for the Social Sciences version 23.0 (SPSS Inc., Chicago, IL, USA). A paired samples t-test was conducted to compare the mean scores between two time points (baseline and the 13th week after the intervention). Correct and incorrect answers to the weekly Kahoot! questions were summarized using numbers and percentages. In-depth interviews were conducted, and data analysis was performed using content analysis and inductive approach procedures to uncover the genuine experiences, perspectives, and perceptions of nursing students. The audio recordings were then transcribed and coded by the researcher using the NVIVO program.

Rigor

To ensure the reliability of the findings, the criteria of credibility, transferability, and confirmability were applied. To strengthen credibility and confirmability, two experts in qualitative research, who were not part of the research team, evaluated the relevance of the themes and subthemes. Internal consistency of the experts' evaluations was

Table 2. Semistructured Interview Questions

1	You received training in a flipped classroom and a Kahoot application. Can you explain your experience in this class to me?
2	What do you think about the flipped classroom model and Kahoot implementation used in your classroom?
3	When you compare the flipped classroom and Kahoot application with traditional learning method which is used in other lessons, what are the advantages and disadvantages of this method?
4	What is the contribution of your teacher's use of the flipped classroom model and Kahoot application to your learning? Can you explain?
5	Has there been a change in your motivation in the Biostatistics course where the flipped classroom and Kahoot application were used? Can you explain?
6	What do you think your teacher could have done to make your learning easier?

Metaphor question: How would you describe taking a flipped classroom model and Kahoot application?

assessed using Kappa analysis, resulting in a Cohen's kappa coefficient of 0.91, indicating a perfect level of internal consistency.[35] One participant was asked to review the findings of the study to mitigate potential researcher bias. Additionally, participant statements corresponding to each subtheme were included to ensure the reliability and transferability of the findings. The research processes, data collection tools, and data analysis procedures were described in detail to facilitate the replication of the study.

Ethical Considerations

Ethics committee approval was obtained from Akdeniz University Clinical Research Ethics Committee (Approval Number: KAEK-705, Date: 29.09.2021). Institutional permission to conduct the study was granted by Akdeniz University Faculty of Nursing. Written permission to use the *Motivated Strategies For Learning Questionnaire* was also secured. Informed consent was obtained online via Google Forms due to pandemic restrictions. The informed consent form outlined the purpose of the research, the study process, the right to withdraw from the research at any time, and the voluntary nature of participation. Although the study was conducted only with students who provided consent, all students who took the course utilized the flipped classroom model and Kahoot! application, as the biostatistics course was delivered using these methods. The researcher adhered to the principles of the Declaration of Helsinki throughout the study.

Researcher Characteristics

This qualitative study reflects the positionality of the researcher. The researcher, who works in the field of public health nursing, holds two master's degrees, has completed a doctorate, and has been teaching biostatistics for four years. She has previously conducted qualitative research on the flipped classroom model and the Kahoot! Application, published related studies, and continues to work in this area. Expert opinions on themes are sought for every study she conducts. Drawing from these experiences, the researcher utilized her positionality and prior expertise to adopt a knowledgeable and comprehensive approach to data analysis.

Results

The mean age of the participants was 20.53 ± 0.76 years, with 83.7% being women. Table 3 shows the scores from the MSLQ. After

Table 3. The Mean Scores of the Motivation and Learning Strategies Scale according to the Total and Sub-Dimensions at Baseline and After the Intervention

	Baseline		13th week after intervention		Mean difference			
	Mean	SD	Mean	SD	Mean (SD)	95% CI	t	P*
Motivation section total	4.77	0.57	5.74	0.76	0.97(0.81)	0.72-1.22	-7.83	**<0.001**
Intrinsic goal orientation	5.11	1.19	6.18	0.59	1.07(1.03)	0.75-1.39	-6.78	**<0.001**
Extrinsic goal orientation	4.74	1.23	5.88	0.86	1.14(0.84)	0.88-1.40	-8.89	**<0.001**
Task value	5.08	0.84	6.05	0.64	0.96(0.77)	0.72-1.20	-8.18	**<0.001**
Control belief of learning	5.10	0.90	5.44	0.97	0.34(1.03)	0.02-0.66	-2.17	**0.035**
Self-efficacy	4.94	0.97	5.96	0.78	1.02(0.93)	0.73-1.31	-7.15	**<0.001**
Test anxiety	3.56	1.32	4.31	1.37	0.75(1.44)	0.30-1.19	-3.42	**0.001**
	Baseline		13th week after intervention		Mean difference			
	Mean	SD	Mean	SD	Mean(SD)	95% CI	t	P*
Learning strategies section total	4.73	0.72	5.68	0.81	0.95(0.73)	0.71-1.17	-8.40	<0.001
Rehearsal	5.15	0.99	6.18	0.65	1.03(0.73)	0.80-1.25	-5.53	**<0.001**
Organization	5.21	0.98	6.06	0.85	0.85(0.89)	0.57-1.12	-6.27	**<0.001**
Elaboration	5.21	1.07	6.18	0.53	0.96(0.95)	0.67-1.25	-6.65	**<0.001**
Critical thinking	4.52	1.08	6.05	0.60	1.53(0.95)	1.23-1.82	-10.49	**<0.001**
Help seeking	4.61	1.01	6.12	0.56	1.51(0.98)	1.20-1.81	-10.10	**<0.001**
Peer learning	3.53	1.29	4.94	1.02	1.40(1.34)	0.99-1.82	-6.83	**<0.001**
Metacognitive self-regulation	4.77	0.80	5.26	0.82	0.48(0.80)	0.24-0.73	-3.96	**<0.001**
Effort regulation	4.11	0.83	5.26	0.87	1.14(0.97)	0.84-1.44	-7.67	**<0.001**
Managing time and study environment	4.67	0.57	5.81	0.59	1.14(0.75)	0.91-1.37	-9.91	**<0.001**

*Paired Samples t test

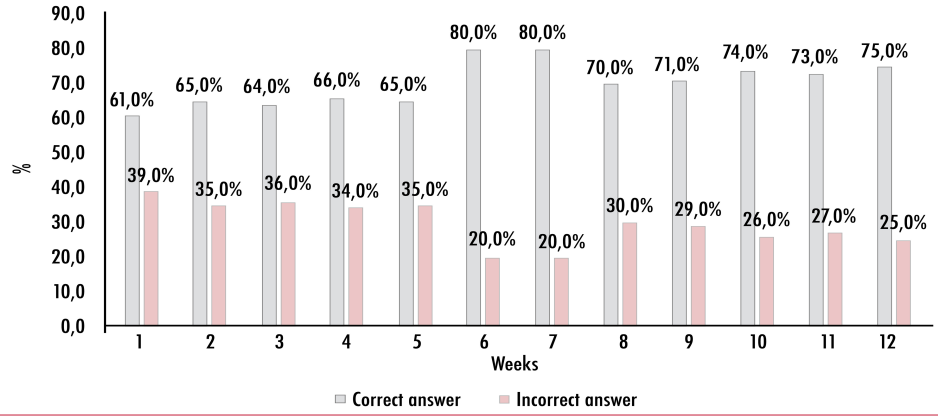

Figure 2. The percentage of correct and incorrect answers to Kahoot questions.

implementing the flipped classroom model and the Kahoot! application, the total scores in both the motivation and learning strategies sections increased (Table 3). Significant improvements were observed in the subscales of the motivation section, including intrinsic goal orientation, extrinsic goal orientation, task value, control beliefs about learning, self-efficacy, and test anxiety at the 13th week post-intervention compared to baseline ($P < 0.05$). Similarly, increases were found in the subscales of the learning strategies section, which included rehearsal, elaboration, organization, metacognitive self-regulation, critical thinking, help-seeking, managing time and study environment, effort regulation, and peer learning at the 13th week after the intervention ($P < 0.05$) (Table 3). The percentage of correct answers to the Kahoot! questions showed an increase until the seventh week, followed by a decrease in the eighth week. This percentage then resumed an upward trend in subsequent weeks (Figure 2).

Six main themes emerged from the content analysis: impact on learning, communication with peers and teachers, learning environment, contribution to self-confidence and motivation, video and game applications as new learning tools, and positive competitive environment (Table 4).

The metaphors shared by the students are presented in Figure 3.

Theme 1: Impact on Learning

Students reported that the flipped classroom model and the Kahoot! application positively impacted their learning. Subthemes included:

- Facilitation of Learning,
- Reinforcement of Knowledge/Permanent Learning, and
- Usefulness.

Many students stated that these tools facilitated their learning. For instance, one student noted that although the course was difficult, the teaching method made it easier to understand (P5). Another student stated that while biostatistics topics became increasingly difficult each week, flipped classroom and Kahoot! applications helped her grasp the material more effectively (P8). Students emphasized that the applications were useful and reinforced the course content (Table 4).

Theme 2: Communication with Peers and Teachers

The flipped classroom model and Kahoot! application also influenced students' communication with their peers and teachers. Subthemes included:

- Discussion with Peers,
- Meeting Peers, and
- Student-Teacher Communication.

Students reported discussing topics they did not understand and the answers to Kahoot! questions with their friends (P2, P4). One student mentioned that participating in class activities helped him learn the names of his classmates when he stepped onto the podium (P1). Many students expressed that they enjoyed attending the lessons. Furthermore, students emphasized that communication between themselves and the teacher was effective, unclear points from the lesson were discussed with the teacher, and feedback was provided regarding their answers to the questions in Kahoot! (Table 4).

Theme 3: Learning Environment

Participants highlighted several factors related to the learning environment. Subthemes included:

- Reduction of Anxiety,
- Attention, and
- Classroom Dynamics.

One student shared that playing games at the end of the lesson reduced anxiety (P3). Another noted that they felt less anxious about answering questions because they had participated in the lesson by watching the videos beforehand (P5). Students expressed a desire to listen more attentively to answer the Kahoot! questions correctly at the end of the lesson. They stated that the educational methods used positively impacted the dynamics of the lesson (P6, P9), and they attended not out of obligation but because they wanted to learn while having fun (P6) (Table 4).

Table 4. Main Themes, Subthemes and Examples of Quotations

Main theme 1: Impact on learning	
Facilitating of learning	The biostatistics course was a difficult course.... The applications made it easier for me to understand the lesson better. After reading the lecture notes, I was watching the videos in Edpuzzle. There were questions and notes in the videos. I was learning about my shortcomings with the information here. When I came to the lesson, it was easier for me to understand (P5).
	Although the course topics were difficult week by week, I was able to grasp the topics more easily thanks to applications such as Edpuzzle and Kahoot. (P8).
	I had not seen either application before in lectures. So it felt very different and made it easier for me to learn (P9).
Reinforcing of knowledge / permanent learning	In addition to the questions in Edpuzzle, we also solve extra questions with the Kahoot application. The applications made allowed us to consolidate the knowledge (P2).
	Until today, our instructors said that enough repetitions were needed for the lessons to be understood. But we were not doing enough repetitions. I watched the videos in the Ed puzzle app and then when I entered the class, I could say that I had seen it before. After the lesson, I used to listen to the videos whenever we wanted. The information in the lesson was getting better (P1).
	The lesson was difficult for me. These helped me to understand the lesson reinforcement lesson better (P6).
Usefulness	Kahoot was a practical application. The flip side application was really nice, I think it provides a preliminary preparation for the lesson and it is useful applications for us to learn (P3).
	I have never used the SPSS program before. Both the videos, the discussions in the lesson and the questions with SPSS screenshots in Kahoot were very useful for us (P5).
	I found the practice before and during the lesson very useful and informative for us (P6).
Main theme 2: Communication with peers and teachers	
Discussion with peers	I was watching the videos on Edpuzzle simultaneously with my friend. Later, I was talking with my friend about the answers to the questions. I marked this, we were asking each other questions such as what did you answer... (P2)
	We were discussing the subjects I did not understand with a group of friends on social media before the lesson (P4)
Meeting peers	I had friends that I did not know during the pandemic process.... When we got on the podium with kahoot, we learned their names. (P1)
	Our education system has been affected by the pandemic process.... I didn't know the names of some of my friends. The names of the students participating in the class appeared on the screen and we started to get to know them when someone stepped on the podium every week... (P6)
Student-teacher communication	It was not possible to hide in the online environment because the teacher was asking questions when the lesson was more about discussion. (P2)
	We were enjoying the lesson, if there was something I did not understand in the video, I would ask in the lesson. I think we have a good communication with our teacher. (P4)
	The teacher was always asking questions in class. Edpuzzle also had feedback on questions I got wrong. In the classroom, the teacher was explaining the answers to the questions in the kahoot and we were getting feedback from the teacher. (P8)
Main theme 3: Learning environment	
Reduction of anxiety	I knew that the course was a math-based course. I heard it's a tough lesson. Watching the videos of the lesson and playing games at the end reduced my fear (P3).
	I was hesitant to ask any questions in the lessons. I used to sit in secluded areas so that the teacher would not see me and ask questions. But in this lesson, I wasn't worried when you asked questions. Because I participated by watching the video, I knew the answer and wasn't worried about answering. (P5).
Attention	I wanted to listen to the lesson more carefully, as I knew that the teacher would make a Kahoot at the end of the lesson. I always thought that I should listen to the lecture during the lesson (P1).
	I knew that to be successful in Kahoot, I had to listen more carefully and never miss a point. (P7).

(*Continued*)

Table 4. Main Themes, Subthemes and Examples of Quotations (*Continued*)	
Classroom dynamics	We were all willing to attend the lecture. We had to learn and pass this lesson. But we entered not out of necessity, but because we wanted to learn by having fun (P6).
	I think that the participation in the course is more than other courses. Because we were learning while having fun (P9).
Main theme 4: Contribution to self-confidence and motivation	
Increasing self-confidence	I was shy to ask questions before. With your videos, my self-confidence has increased to ask questions (P4).
	In the videos on Edpuzzle, you were telling me as if you were giving private lessons to me. That's why I agreed as if I knew you. I wanted to answer your questions comfortably (P7).
	When I watched the videos on Edpuzzle, I attended the lesson with more confidence, knowingly and confidently (P10).
Effect on motivation	In order to answer the questions in Edpuzzle correctly, I had to learn the subjects. Being able to understand the subject and answer all the questions correctly was the point that motivated me. In addition, the energy of the teacher in the lesson in the video increased my motivation. (P2).
	Kahoot application attracted our attention because it was in the game style. It increased our motivation to learn. He needed to listen to the end of the lesson (P6).
Major theme 5: Video and game application as a new learning content	
Benefits of video	This is the first time we have used this type of application. We could pause the videos at any time and watch them over and over again. It was very valuable for us to watch the videos before the exam (P3).
	Edpuzzle and Kahoot is a fun program that motivates learning... I was jotting down the questions and notes in Edpuzzle in a notebook. It's really good practice to learn by watching videos with notes and questions online... (P6)
	Like Edpuzzle, this method allowed me to use time more effectively. I didn't need much time to prepare for the exam. (P8)
	I was taking notes from the videos, sometimes we had difficulties in taking notes in the lessons. Because we had to be fast. But here it was possible for us to take notes slowly at our own pace in the video. (P10).
Learning with game application.	I found the kahoot application at the end of the lesson enjoyable and was looking forward to it. It was a lot of fun waiting for the class to end and answering the questions. It's really nice to learn with play... (P2)
	I have never heard or attended such programs before. I remember we didn't play games in any class. I felt like I was playing a computer game. I was playing and learning. (P5)
Major theme 6: Positive competition environment	
The desire to reach the goal	I had a goal of making three out of three questions once I made it three out of three. (P6)
	I was trying to know all the questions in both Edzpuzzle and Kahoot. (P9)
To be on the podium or to be first on the podium	I wanted to be first on Kahoot, or at least be in the top three and be on the podium.. (P1)
	Getting on the podium was amazing. You don't know how I felt once I took the first place on the podium.. (P7)
	Before my friends I wanted to mark the answer in Kahoot app. Although I answered the questions correctly most of the time, I had to be quick to mark the answer to get on the podium. That's why I wanted to listen to the lecture carefully and be one of the fastest responders... (P7)

Theme 4: Contribution to Self-Confidence and Motivation

The flipped classroom model and Kahoot! application significantly increased students' self-confidence and motivation levels. Subthemes included:

- Increasing Self-Confidence,
- Effect on Motivation.

Students explained that interactive videos created a personalized lesson experience, which positively impacted their self-confidence

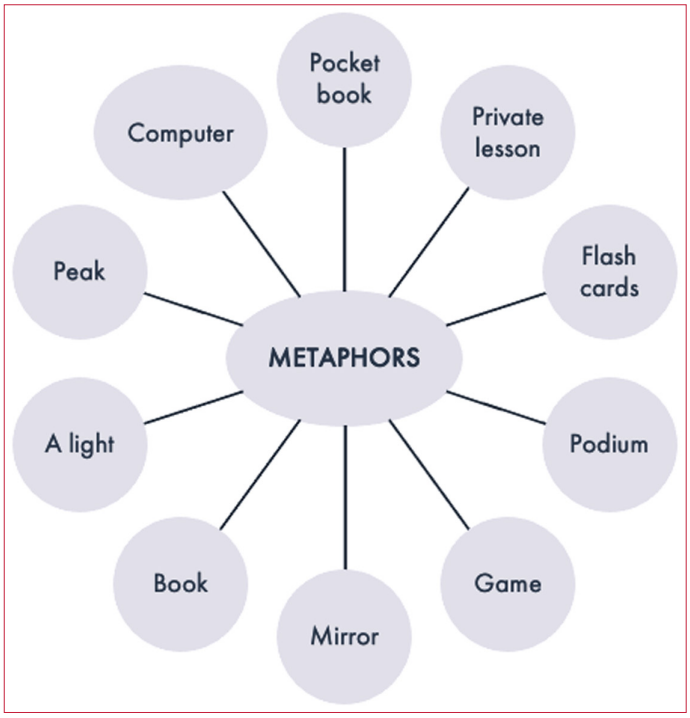

Figure 3. Metaphors of the participants' flipped classroom and Kahoot! Application.

(P7). Many participants reported that the Kahoot! application captured their attention. One student emphasized that answering all questions correctly was particularly motivating (P2) (Table 4).

Theme 5: Video and Game Applications as New Learning Tools

Participants described encountering the flipped classroom model and the Kahoot! application for the first time, sharing their experiences and perceived benefits. Subthemes included:

- Benefits of Video,
- Learning with Game Application.

One student mentioned that this was their first time using such an application and highlighted the importance of being able to rewatch the videos as needed (P3). Another student noted that the application helped them use their time more effectively (P8). Many students reported taking notes from the videos in their notebooks, emphasizing that these notes were very useful and valuable. They also expresses that the Kahoot! application at the end of the lesson was enjoyable and facilitated learning through playing.

Theme 6: Positive Competitive Environment

The flipped classroom model and the Kahoot! application fostered a positive competitive environment. Subthemes included:

- The Desire to Reach the Goal,
- Aspiration to Be on the Podium or to Be First on the Podium.

Students who aimed to answer all the questions in Edpuzzle and Kahoot! correctly expressed a desire to rewatch the video to ensure they could answer the questions without making errors. Many students were motivated by the goal of reaching the podium, aiming to secure first, second, or third place in the Kahoot! application to achieve this disctinction.

Discussion

Innovative teaching methods are increasingly used promote active student participation in the technology-driven era. The flipped classroom model, one of the most commonly applied methods, has been widely utilized across various educational fields.[26-29,36,37] Similarly, Kahoot!, a popular student response system, is used globally. However, studies combining these two approached are relativelyrare.[38,39] In this study, both the flipped classroom model and the Kahoot! application were employed to make the online biostatistics course more interactive.

These methods led to an increase in the students' total motivation scores and its subscales. A study conducted with education faculty students at a university in Spain also found that the flipped classroom model enhanced self-perceived intrinsic and extrinsic motivation.[36] Additionally, prior research has shown that the Kahoot! application increases learning motivation and reduces exam anxiety.[6,40] The findings of this study, consistent with those in the literature, demonstrate that both the flipped classroom model and the Kahoot! application contribute positively to students' motivation and learning strategies.

The percentage of correct answers to Kahoot! questions increased overall during the study period. However, in the eighth week, there was a decrease in the percentage of correct answers. This decline was attributed to the introduction of statistical analysis as a new topic during this week. A study found that nursing students using the Kahoot! application demonstrated higher learning performances compared to those in non-game-based learning groups.[41] Another study highlighted that the Kahoot! application was easy to implement and facilitated the learning of laboratory skills.[42] Overall, it can be concluded that the Kahoot! application is more user-friendly and effective for learning compared to other technological tools.[43]

Impact on Learning

The flipped classroom model and the Kahoot! application positively influenced students' learning experiences. In a meta-analysis study examining the use of flipped classrooms in nursing education, it was noted that this approach positively contributed to students' knowledge, skills, attitudes, and self-learning.[11] Another meta-analysis study found that the flipped classroom model significantly enhanced students' learning performance compared to traditional methods.[3] In a mixed-method study, the flipped classroom practice was shown to be beneficial for learning, reinforcing knowledge, and improving comprehension.[25] Additionally, a study found that the Kahoot! application positively influenced the learning experience and enhanced students' understanding.[6] In a comparative study of different technological tools, Kahoot! Was identified as the most effective for reviewing learned concepts, supporting learning, and being easy to use.[43]

Communication with Peers and Teachers

The flipped classroom model, combined with the Kahoot! Application and interactive videos, strengthened students' communication with their peers and teachers. Some students watched the videos simultaneously with their friends from their homes, discussing unclear

points via phones or WhatsApp groups to facilitate learning. A study found that when Kahoot! was integrated into a classroom utilizing the flipped classroom model, it encouraged students to share information with their peers.[39] The flipped classroom fosters active learning, strengthens the student-teacher relationship, and facilitates lessons through examples and discussions.[25] Consistent with these findings, the flipped classroom and Kahoot! applications were shown in the literature to enhance student-teacher interaction.[6,44]

Learning Environment

The flipped classroom model and the Kahoot! application positively contributed to the learning environment by reducing students' anxiety, increasing their attention, and enhancing classroom dynamics. Studies on the flipped classroom model have shown that it reduces anxiety, encourages student participation in lessons, increases tattendance, and allows more time for in-class discussions.[25,44-46] Similarly, studies have highlighted that the Kahoot! application positively impacts classroom dynamics and increases student engagement during lessons.[6,18,47]

Contribution to Self-Confidence and Motivation

The educational methods applied enhanced students' motivation and self-confidence. The flipped classroom approach has been shown to boost students' self-confidence, particularly in speaking English.[48] One study found that the Kahoot! application motivates students to interact with their peers and participate in tests.[49] Quantitative findings also support these conclusions, demonstrating that these educational methods encourage students to attend class prepared, ask questions without hesitation or embarrassment, and feel more motivated to learn.

Video and Game Applications as New Learning Tools

Students reported that they experienced the interactive video and Kahoot! application for the first time prior to the lesson. In a study, a drug literature evaluation course allowed learners to study anytime and anywhere while accessing video lessons through the flipped classroom model, enabling them to learn at their own pace.[5] Another study found that the Kahoot! application offered a unique learning experience, providing a different perspective and making learning fun.[6] The results of the current study align with the literature, showing that the use of interactive videos and Kahoot! reduced students' exam anxiety, supported self-paced learning, and facilitated learning through gamified experiences.

Positive Competitive Environment

A positive competitive environment was fostered by student' desires to answer all the questions correctly or to secure a spot on the podium. One study revealed that most participants enjoyed the competitive feature of Kahoot!, which boosted their energy and engagement in lessons while the desire to win motivated them to study in advance.[6] Another study found that Kahoot! created a competitive atmosphere that was both more engaging and motivating for students.[22] Additionally, Kahoot! has been recognized as one of the most widely used student response systems and one of the most effective among different technological educational tools.[4,19,43] As evidenced by the results of this study and supporting literature, the creation of a positive competitive environment has a beneficial impact on students' learning.

Limitations

The strength of the study is that the qualitative findings support the quantitative results. The main limitation of this research is that the participants were exclusively students from a single faculty taking only one course (biostatistics). Therefore, it does not account for the opinions of students who do not actively participate in the lessons, as they were not included in the qualitative interviews. Another limitation is that it is a study based on participants' responses.

Conclusion

Students' motivation and learning strategy scores increased after implementing the flipped classroom model combined with Kahoot!. This educational method facilitated learning and reinforced the knowledge, strengthened the communication with peers and the teacher, contributed positively to the learning environment, self-confidence and motivation. This educational approach made learning through games possible and created a positive competition environment. Future research should explore randomized controlled trials that combine both approaches. Applying these educational techniques in further nursing education sessions and evaluating their impact is strongly advised.

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