An Analysis of Application the Kahoot! Tool in a Gamified Approach to Face-to-face and Emergency Remote Teaching and Learning of Software Engineering

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***Abstract*—This Research to Practice Full Paper presents that the use of gamified approaches in education has become increasingly common in classrooms. Aspects related to the motivation and engagement of students with a focus on learning are a constant challenge for professors, who use methodologies and tools to make the classroom a space for fun and learning. In addition, the use of tools and techniques to motivate and present more attractiveness in teaching is a constant challenge for professors. In an increasingly connected society, not using technology in the classroom is not an option. Allied to this approach through the use of gamification, the tools that support this process are highlighted, especially Kahoot!, a tool to encourage learning, is one of the main tools used by professors and students to support the teaching-learning process. The market for this application already has 24 million users. Considering the COVID-19 pandemic scenario, declared in Brazil in March 2020, and the need to continue teaching activities, the main alternative for Educational Institutions to maintain their academic activities was the change to a remote emergency teaching format. Given this scenario, this work aims to present a comparative study on the use of Kahoot! in two subjects of the Information Systems course at Federal University of the South and Southeast of Pará, in Brazil, in both classroom and remote teaching modalities. The motivation for carrying out the study was due to the need to understand and evaluate the use of the tool in the remote context, due to the COVID-19 pandemic, and to compare it with the face-to-face format. As a result, the acceptance of 83.3% in face-to-face teaching and 58.8% in remote teaching was obtained for the use of the tool, in addition to the best performance in the Kahoot! in face-to-face teaching in relation to remote teaching, with the general average of correct answers of 62.81% and 47.56% for classroom teaching and remote teaching, respectively. So, this paper presents: (i) the theoretical foundation of this work, (ii) some works related to the research object, (iii) the research methodology for the development of the work, (iv) the structuring of Kahoot!'s application in classes, (v) the results of applying Kahoot! in classes and the discussion of the main results of this work.**

***Index Terms*—Kahoot!, gamification, remote teaching and learning, face-to-face teaching and learning, software engineering.**

I. Introduction

The use of tools and techniques to motivate and present more attractiveness in teaching is a constant challenge for professors. Information and Communication Technologies (ICT) have supported the teaching and learning process through technological tools, mainly through software available on the Internet and application platforms. In this scenario, it is increasingly common to have the use of these resources by both students and professors in the classroom.

There are several tools that support teaching offered in the market, most of which are free and available on the internet. Kahoot![1], a tool to stimulate learning, is one of the main tools used by professors and students to support the teaching-learning process. According to [1], the market for this application already has 24 million users, of which 350,000 are in Brazil. With the advance of the COVID-19 pandemic, the tool maker developed integrations with the main platforms such as Microsoft Teams, Google Classroom and Zoom.

In the specialized literature, the author of the work [2] presented a literature review on the Kahoot! tool. This study indicated the considerable growth in the number of publications on the tool when analyzing temporality, from two in 2015 to forty-nine in 2018, with more than 80% of the studies related to the students' perception of the use of the tool.

Considering the COVID-19 pandemic scenario, declared in Brazil in March 2020, and the need to continue teaching activities, the main alternative for Teaching Institutions to maintain their academic activities was to switch to a remote emergency teaching format.

Making the adaptation from the face-to-face teaching format to the remote one generated the fundamental need to use ICT resources to support this process, given the outbreak of the COVID-19 Pandemic. Therefore, using consolidated tools

[1]https://kahoot.com/

in the market helps to reduce transition difficulties and can enhance the interaction of participants.

In this context, the present work is justified by the need to evaluate tools used in the remote context that are used in the face-to-face mode, specifically Kahoot!, and evaluate the level of student engagement in both contexts, both in terms of use and satisfaction with use. In addition, the present work made use of gamified approaches by adding the use of Kahoot!.

The main motivation for the development of the work, in addition to the quantitative growth of research on the Kahoot! tool, as previously mentioned, it was to evaluate the impact of using the tool in a subject that uses a gamified approach, in order to compare in two teaching modalities, face-to-face and remote (online).

Given the above, the objective of the present work is to present a comparative study on the application of the Kahoot! in two subjects of the Information Systems (IS) course at Federal University of the South and Southeast of Pará, in Brazil, in both teaching modalities, face-to-face and remote. The comparative study will demonstrate the performance of these classes in the use of Kahoot! and the evaluation of the use and difficulty of the questions.

In addition to this introductory section, this paper is organized as follows: Section II presents the theoretical foundation of this work, Section III presents some related works to the research object, Section IV presents the research methodology for the development of the work, Section V presents the structuring of the Kahoot! in the classes, Section VI presents the results of the application of Kahoot! in the classes, Section VII discusses the main results of this work and, finally, Section VIII presents final considerations, limitations and future work.

II. Background

In this section, the concepts used for the development of this work will be presented.

A. Teaching in Software Engineering

Software engineering is a subject present in the bachelor's degree courses in Information Systems, Computer Science and Computer Engineering. Present in these Pedagogical Course Projects (PPC), in the Technological Training axis, this subject concentrates the main concepts on the conception, elaboration and development of a software. For [3], software engineering is about applying a systematic, disciplined and quantifiable approach to software development, operation and maintenance. In addition, in this course, students begin the process of learning about methodologies, tools and processes for building software.

The authors in [4] conceptualize software engineering as complex, relating art, meeting human needs, scientific knowledge, empirical knowledge, specific skills, natural resources, appropriate forms, devices, structures and processes.

Teaching in software engineering, for the most part, is about exposing theoretical content on methodologies and processes applied to software development.

B. Gamification

For [5], gamification is an engagement technique with the aim of motivating those involved to achieve goals. The authors of [6] indicate that the gamification strategy is a powerful and flexible framework that can be applied to any problem, influencing human motivation and behavior. By the aforementioned concept, gamification becomes a strategy that aims to motivate behaviors and facilitate people's learning.

In [7], gamification provides mechanisms used in games out of context to promote learning and support problem solving, motivating subjects to meet the results. In education, gamification is used to promote this behavior in students with the objective of learning and engagement.

For [8], gamification corresponds to the use of game mechanisms aimed at solving practical problems or arousing the engagement of a specific audience.

Given the concepts presented, it can be said that gamification practices are alternatives to increase the engagement of a particular audience, whether in a classroom, object of this study, or in a company. In the Section III, studies on gamification will be presented, specifically in the educational context, contributing to the understanding of the topic.

C. Emergency Remote Teaching

For [9], emergency remote teaching is a temporary shift from teaching to an alternative mode due to crisis circumstances. Due to the outbreak of the COVID-19 pandemic in March 2020 [10], Brazilian public higher education institutions started emergency remote teaching. This modality made it possible to adapt the contents of the subjects, previously treated in person, to the remote format.

According to [11] remote teaching is a teaching format mediated by technology, maintaining the distance between professor and student. This teaching format is possible through the use of educational platforms or platforms for other purposes, open to the sharing of school content. In this sense, emergency remote teaching was an alternative for face-to-face teaching institutions to advance in the training of students in times of a pandemic.

At the University object of this study, face-to-face activities were suspended as of March 19, 2020. In view of this suspension, in August of the same year, the academic calendar was approved, which presented the Institution with the emergency school period, using the platform to the development of all academic activities remotely.

D. Kahoot! Tool

The Kahoot! is a game-based learning platform, which can be applied in different contexts, such as: academic, work and leisure. It is a question and answer game, which features a timer for each question and the ranking of the participants, which is built according to the number of correct answers and the speed of the response. The Kahoot! sessions consist of applying a set of questions in the same virtual room.

In the question creation environment, that is, the professor's space, it is possible to select 3 types of questions, namely: true and false, multiple choice with up to 4 alternatives, and puzzle.

The tool uses the colors red, yellow, blue and green associated with the geometric shapes triangle, circle, rhombus and square, relating them to the colors, respectively, as alternatives to the questions, as seen in Figure 1 .

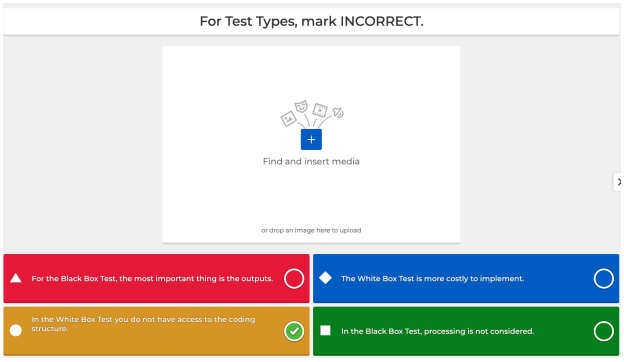

Figure 1. Question implemented in Kahoot!

For each question created, it is possible to indicate the time for the answers, with the options: 5 seconds, 10 seconds, 15 seconds, 20 seconds, 30 seconds, 1 minute, 1 minute and 30 seconds, 2 minutes and 4 minutes. In addition, it is possible to add a picture or video and the scoring level (default, double points and no score).

After the construction of the questions, the professor can perform the application in two formats, synchronous and asynchronous. The synchronous format is suitable for the face-to-face classroom or virtual classrooms, so the user can project the questions on the screen. Participants access and answer the questions on the internet browser or mobile device through the Kahoot! application. For asynchronous mode, the professor defines the deadline for viewing and the set of questions, similar to the synchronous mode, however the professor needs to provide the link for students to access the questions. In addition, in this format there is the possibility of shuffling the order of the answers and activating the timer in the questions or not.

At the end of the application of the questions, the tool allows the generation of the student performance report for each question, indicating the correct answer, the response time and the score. In both application formats it is possible to generate the Podium (ranking) of the application with the three highest scores, as shown in Figure 2. In the synchronous format, the participant receives notification of the total points obtained and the position in the Podium. As for the asynchronous format, the professor can share the score report, either on screen or in a spreadsheet, which is an existing data export functionality in the tool.

The participant's score is calculated by the tool taking into account the correct answer in less time, that is, the student who gets a certain question right in the first few seconds will get a higher score than the participant who got the question right and used all the time available for the answer.

Figure 2. Podium in Kahoot!

III. Related Works

This section aims to present some works related to the research object. The methodology used to carry out the research of related works followed the steps: (1) identification of keywords about the research object, (2) definition of knowledge bases for carrying out the research and (3) selection of relevant works.

The work [12] presented a study on the use of technologies to evaluate the development of gamification for a group of students. The Kahoot! Tool was used in the experiment and the findings of this work suggest that gamification can be effectively integrated into classes using the Kahoot! application. Unlike [12], this paper made the application of the Kahoot! in synchronous and asynchronous modalities, and the case study included an in-person class and a class in remote teaching.

The work [13] presented a bibliographic study on the use of Kahoot! in Education, highlighting the advantages of using this tool to increase motivation, concentration in classes, real-time assessment and collaborative work.

For [14], the Kahoot! leveraged the use of gamification in the classroom by facilitating the use of games elements, such as immediate feedback, clear rules, fun, inclusion of errors, pleasure and motivation. In this work there was the evaluation of the group as a team, divided into teams, which differed from the analysis carried out in the present paper, which deals with the application in an individual way.

The work [15] presented the application of Kahoot! and GoConqr for gamification in high school mathematics. The highlight of this work is the index that 93% of the participants really liked the Kahoot! tool.

Finally, in [16] the Kahoot! tool was used in a subject of scientific methodology in the Law course. A survey was carried out on the use of the tool and 94.74% of the participants indicated that they enjoyed using it. In addition, the

study identified among the responding students a stimulus to competition, dynamism and a better understanding of the content.

Note that the [15], [16] works showed approval indicators for the use of the tool close to 100%, which is related to the results of this research, as indicated in the Section VI.

Table I presents a comparison of related works, in order to identify the main relationships and differences between the cited works.

TABLE I
RELATED WORKS

Features	[12]	[13]	[14]	[15]	[16]	This Paper
Evaluation on using Kahoot!	X	X	X		X	X
Team training			X			
Classroom teaching	X			X	X	X
Remote teaching						X
Student Performance Analysis						X

IV. RESEARCH METHODOLOGY

The scientific research of this paper is characterized in terms of approach as qualitative, as the researcher performs interpretations of students' behavior at the time of application without quantifiable indicators. It can also be defined as quantitative, as it presents a tabulation of student performance and makes use of the evaluation questionnaire with objective questions applied to students.

As for the nature, it is an applied research, as it aims to generate knowledge for practical applications. Regarding the research procedure, we framed it as a Case Study, as it was applied to a specific set of subjects and students, in order to understand their behavior in relation to the use of the Kahoot! tool. In addition, a questionnaire survey was used to evaluate the opinion on a given attribute.

Based on the related works highlighted in the Section III, the following research questions were identified:

1) How satisfied are students with the use of Kahoot! in relation to the type of environment?
2) There is a difference in the performance of students in performing Kahoot! synchronously and asynchronously?

Structuring the research, the development of this work followed the following steps:

1) Application of the Kahoot! for the two subjects and observation of the scenario,
2) Quantitative analysis of students' performance regarding the correct answers, and
3) Application of the evaluation questionnaire for the subject and selection of questions regarding the use of Kahoot! and difficulty in the questions.

The Section V will present the context of the research application, as well as the characterization of the groups and the number of participants, step 1. The Section VI will bring the quantitative results of the research referring to steps 2 and 3.

V. THE DYNAMICS OF THE RESEARCH

The scenario of using the Kahoot! is described in Table II. The Software Project Management course was taught in person and the Software Engineering course was taught remotely. The subjects, objects of this study, belong to Information Systems (IS) courses and have a total workload of 68 hours, 100% of which are theoretical hours.

TABLE II
CLASSES USING THE KAHOOT!

Year	Type	Subject	Subject Period	Enrolled Students
2019	In Person	Software Project Management	08/12/2019 to 12/11/2019	21
2020	Remote	Software Engineering	09/17/2020 to 12/22/2020	31

In the Software Project Management subject, the dynamics of the Kahoot! happened completely synchronously, being held at the end of classes on theoretical content presented, totaling 12 sessions. In these sessions, the professor projected the questions using a data-show and the students connected to the platform using their cell phones or notebooks. Due to the dynamics of the development of the subject with the presentation of works by the students and evaluative activities, the number of sessions applied was limited, compared to the total number of classes held.

It was observed that at that moment the application of Kahoot! brought greater interaction in the class, as for each question presented, students saw the results, correct answers and number of points, the correct alternative and its Podium position. At the end of the application, the students, still in the adrenaline of the Kahoot! application, left the room talking about the application and playing games with each other.

Sessions on Kahoot! applied had an average of 7.5 questions, with a variation of 70% of multiple choice questions and 30% of true and false questions. In this application, puzzle-type questions were not used because of the applicability to the contents dealt with in the subject.

In the Software Engineering subject, 9 sessions were applied, with an average of 9.8 questions per session, in asynchronous format, with the link providing access to Kahoot! sent to students through the institution's Virtual Learning Environment (VLE). In this format, students had a deadline of up to 3 days to access the tool and answer the questions. With remote teaching, student interaction was not observed, as student access occurred at different times.

The number of sessions was different in each subject, as in Software Engineering, the online class schedule was adapted since the academic period in the pandemic had the reduced number of days in the semester. As for the availability of computing resources, such as notebooks and cell phones with internet access, in both classes all students had the equipment to carry out the Kahoot! sessions.

The adaptation of the application format (synchronous and asynchronous) was necessary, because in the remote period there was flexibility in terms of student attendance, not including it as a mandatory element. In addition, the recording of synchronous meetings in the remote period was made possible and made available for students to watch at another time.

VI. Results Analysis

The results analysis of the Kahoot! application in the face-to-face and remote teaching modalities were carried out under four views:

1) Percentage of correct answers by students,
2) Students' perception of the application of the tool,
3) Question difficulty level, and
4) Comments on using Kahoot!.

Table III shows the average percentage of correct answers by students in each Kahoot! for the subject of Software Project Management, class 2019, under the context of face-to-face teaching.

TABLE III
AVERAGE PERCENTAGE OF CORRECT ANSWERS OF CLASS 2019

Kahoot Session!	Questions	% Hit	Standard Deviation
01	7	50.00%	0.33
02	8	76.88%	0.11
03	8	51.88%	0.24
04	10	60.00%	0.30
05	10	48.89%	0.36
06	7	60.71%	0.26
07	7	70.00%	0.25
08	6	65.00%	0.24
09	7	70.83%	0.30
10	7	65.71%	0.31
11	6	62.00%	0.36
12	7	72.50%	0.31

Figure 3 presents a chart with the percentage of correct answers summing the 12 sessions of Kahoot! plays. The general average of correct answers in this class was 62.81%, with the students with the highest and lowest average of correct answers being 86.18% and 44.44%, respectively.

In the subject carried out remotely, the average percentages of correct answers are described in Table IV.

TABLE IV
CLASS 2020 AVERAGE PERCENTAGE OF CORRECT ANSWERS

Kahoot Session!	Questions	% Hit	Standard Deviation
01	13	46.15%	0.50
02	10	46.59%	0.27
03	9	48.51%	0.28
04	9	46.34%	0.27
05	10	47.56%	0.33
06	9	46.61%	0.31
07	10	49.02%	0.28
08	9	53.39%	0.31
09	10	57.07%	0.29

Figure 4 presents a chart with the percentage of correct answers, adding up the 9 sessions of Kahoot! plays. The general average of correct answers was 61.65% and the students with the highest and lowest average of correct answers was 92.22% and 16.67%, respectively.

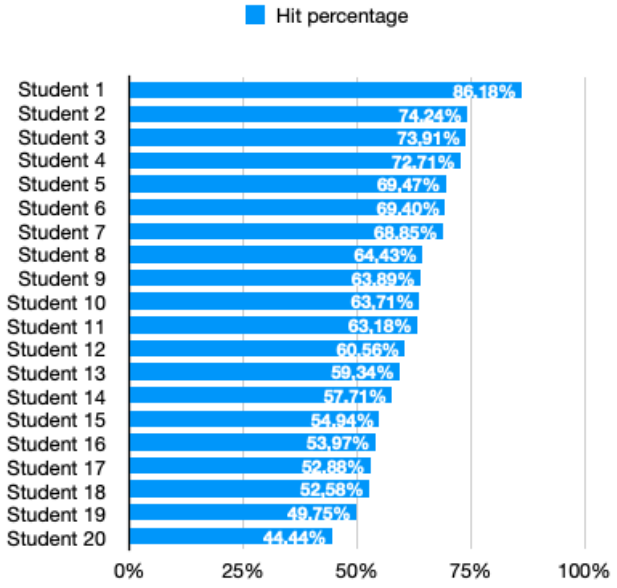

Figure 3. Percentage of correct answers per student - Class 2019

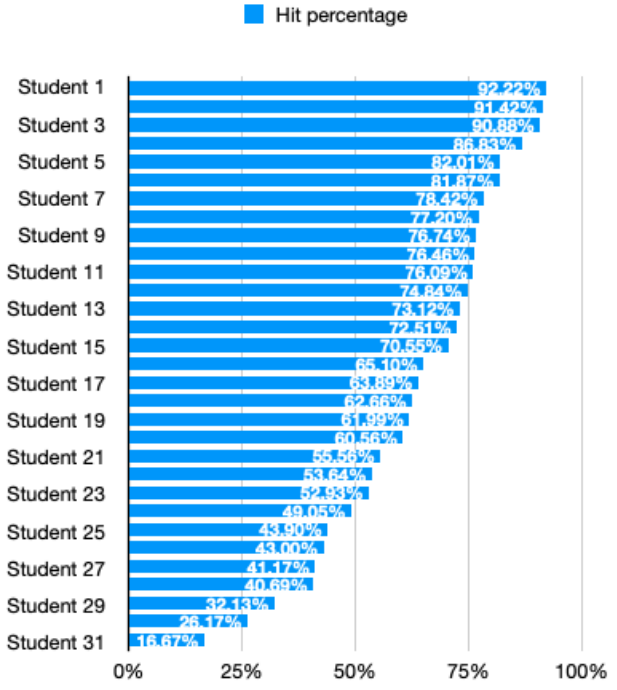

Figure 4. Percentage of correct answers per student - Class 2020

In this first view, it is noted that face-to-face teaching presented a higher average of correct answers, compared to remote teaching. Another relevant aspect was the higher percentage of individual success in face-to-face (86.18%) and remote (92.22%) teaching. It is also noted that the standard

deviation of the Kahoot! in person was close to the remote application.

At the end of both subjects, an evaluation questionnaire was applied on the progress of the subject regarding aspects related to the use of the gamified approach, positive points, negative points and two questions related to the application of Kahoot!, namely:

- **Q1** How do you rate Kahoot!?
- **Q2** How difficult are the questions in Kahoot!?

The evaluation questionnaire was applied in the last week of the course, with an optional, non-identifiable character, using the Google Forms tool to provide the questions and collect the results. In terms of participation, the class of 2019 had a rate of 28%, while the class of 2020 had 54%.

The main reason that led to low adherence to completing the questionnaire was its optional nature. However, it was decided to treat it this way to obtain the qualified participation of the respondents, as well as a higher level of demand and criticism of the progress of the subject and application of Kahoot!.

Figure 5 presents the results for question Q1, including the evaluation of the year 2019 and 2020. The answer scale for question Q1 used: 1 - Little Important and 4 - Very Important. Note that there is a concentration of positive responses, if we consider alternatives 3 and 4.

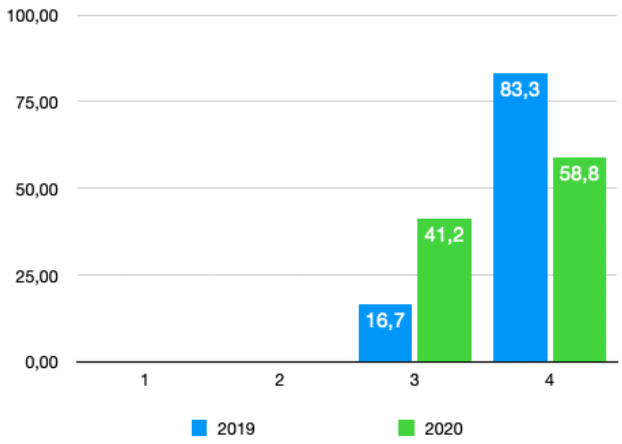

Figure 5. Percentage of Q1 answers

Figure 6 presents the results referring to question Q2, following the same grouping used in Figure 5. The Q2 scale used: the value 1 for Very Easy and 4 for Very Difficult. In this question, option 3 stands out with a percentage higher than 65% of the respondents, indicating a certain degree of difficulty for the Kahoot! questions.

Despite the indication of level of difficulty in the questions of 94.2% (answers 3 and 4 - Very difficult) of the class of 2020, the data of correct answers for the number of questions are similar when compared to the class of 2019.

Regarding the last view, the comments provided by the students in the same questionnaire used for feedback on the subject stand out. In the subjective questions, the students evaluated the gamified approach in general, but there were indications of positive and negative points specifically about Kahoot!. The selected comments were exclusively those that had references to Kahoot! in the text.

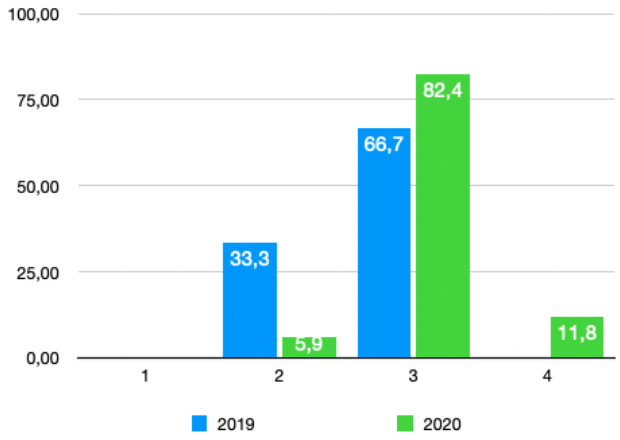

Figure 6. Percentage of Q2 answers

In the class of 2019, who took the course in person, there were the following comments:

1) "*Application of Kahoot! as an evaluation method during the course of the subject*"
2) "*Kahoot! made it fairer in the distribution of Cherrys*"
3) "*Use the Kahoot! tool in all classes*"

Based on the comments from the class of 2019, although few students provided subjective feedback, there is a positive evaluation regarding the use of the tool and in comment 3 there was an indication of its use in all classes. Regarding comment 2, as the students had already participated in another course with a gamified approach, Kahoot! was inserted as an alternative for the distribution of Coins for participation in the class, which was previously carried out by the professor himself.

For the class of 2020, which took place remotely, the comments were:

1) "*As for Kahoot!, I find it very interesting because it's a quick activity and tests how much attention we were paying in class, I just wish there was some information pointing out the error when we marked an error answer so that we don't just know the right answer, but let's also understand the error.*"
2) "*If it's online, think about how guys can't cheat on kahoot!*"

Note that Class of 2020 comments have another focus of discussion, being the tool itself. In comment 1, for example, there is positive feedback regarding the use of the tool, but there is also an indication of a new functionality that points out the error of the alternative. Comment 2 indicated a threat to the execution of Kahoot! asynchronously, as in this modality, students who carry out the evaluation in advance can indicate the correct and alternative subjects to other colleagues.

VII. Discussion

Using Kahoot! as an alternative to support the implementation of a gamified approach in the development of the subject, either in person or remotely, as shown in Figure 5, in the students' opinion, it was important for the learning process.

Regarding the performance view of the two groups, the difference in the number of correct answers for the subject in the face-to-face format compared to the remote format was on average 1.16%, therefore, there was a similarity in the indicator in this regard.

Despite the similarity in the average of correct answers between the two classes, there was a considerable difference in terms of the percentage of students with more and less correct answers, which is confirmed by the average standard deviation, which for the 2019 class was 0.06 and for the class of 2020 was 0.28. If we consider the average of the five students with the most hits and the five with the least hits, we will have a difference of 58.76% referring to remote teaching to 21.33% in face-to-face teaching.

One hypothesis for this difference between the two modalities may be the engagement of students in the classroom in the face-to-face format. In an observation about the execution of the face-to-face modality, greater collective enthusiasm was noted when Kahoot! were done. In addition, conversations between students during the break between questions and the Partial Ranking display boosted the competitiveness and engagement of the class in search of better grades for each session.

In remote mode, each student could perform the activity at their convenience. Thus, there is a hypothesis of expansion of individualism, which can be expressed by the difference in the percentage of maximum and minimum hits of this modality, as presented in the Section VI.

Due to the percentage of respondents to the subject evaluation questionnaire, it is necessary to carry out new comparative studies to increase the percentage of respondents, as well as to verify if the behavior will remain similar to that of this work.

As for the analysis of the percentage of correct answers in the sessions, we have the totality of participation, which makes the comparative analysis in line with the hypothesis that game tools, such as Kahoot!, can be applied to the context of education as a way of encouraging the engagement of students with the subject, aiming at greater learning.

Another important aspect for discussion is how to use Kahoot! in remote learning. Could it be that if the application in remote mode were synchronous, the results would be the same as in the face-to-face format? From the results presented in the Section VI, it can be noted that the application in the synchronous format generates greater competitiveness among students.

Finally, in the answers to the subjective questions, there was a difference in the direction of the comments, being in the class of 2019 positively and wanting to be applied in all classes and in the class of 2020 on purpose, with regard to providing feedback for wrong alternatives and indication of the "cheating" threat running remotely.

VIII. Conclusion

The present paper presented a comparative study on the use of Kahoot! in two subjects of the Information Systems course in two teaching modalities, face-to-face and remote.

As a result, it was observed that the use of Kahoot! it has an acceptance rate of 83.3% in face-to-face teaching and 58.8% in distance learning, as shown in Figure 5.

In the analysis of students' performance in the execution of Kahoot! of the sessions, there is an overall average of 62.81% correct answers for face-to-face teaching and 47.56% for distance learning. However, the average standard deviation was lower in the face-to-face group compared to the remote mode, which may be related to the form of application, with face-to-face synchronously and remote asynchronously. It is also worth mentioning that the face-to-face involvement in the execution of Kahoot! brought greater relaxation and integration of students in the post-session.

The subjective questions presented positive answers for the application of the tool, propositions regarding the functionality of the tool and a threat when using it online.

Although this study indicates the face-to-face approach that promotes greater engagement of the class with the subject, with better performance in relation to the remote approach, more studies must be carried out in order to evaluate the application of Kahoot! tool with more classes. However, this paper starts the discussion in search of the best application strategy of the tool.

As limitations, the paper observed only two groups and the tool use format was specific for each teaching modality. In addition, the number of participants who responded to the survey did not meet the researchers' expectations, however, as it is optional and unidentified, it is an indicator of reliability in the answers.

Regarding the proposal for future works, we intend to make observations on other subjects in order to compare the results using the four views presented in Section VI . In addition, there is another action to evaluate in the same teaching modality the two forms of application of Kahoot! (synchronous and asynchronous).

Acknowledgments

We thank the students of the Information Systems course at Federal University of the South and Southeast of Pará, in Brazil, of the two subjects who participated and contributed to the applied gamification approach and provided feedbacks for improvement in future applications.

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