Geuciane Felipe Guerim Fernandes
(Organizadora)

ENSINO:

Tecnologias e práticas pedagógicas

Atena Editora
Ano 2022

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Dados Internacionais de Catalogação na Publicação (CIP)

E59 Ensino: tecnologias e práticas pedagógicas / Organizadora Geuciane Felipe Guerim Fernandes. – Ponta Grossa - PR: Atena, 2022.

Formato: PDF
Requisitos de sistema: Adobe Acrobat Reader
Modo de acesso: World Wide Web
Inclui bibliografia
ISBN 978-65-258-0288-6
DOI: https://doi.org/10.22533/at.ed.886220308

1. Didática - Métodos de ensino instrução e estudo – Pedagogia. I. Fernandes, Geuciane Felipe Guerim (Organizadora). II. Título.

CDD 371.3

Elaborado por Bibliotecária Janaina Ramos – CRB-8/9166

Atena Editora
Ponta Grossa – Paraná – Brasil
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Ano 2022

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A obra “Ensino: Tecnologias e práticas pedagógicas” tem como objetivo principal divulgar contribuições de docentes, pesquisadores e discentes de diferentes lugares. A coleção aborda possibilidades e caminhos para se pensar a inserção das tecnologias e práticas pedagógicas nas diferentes áreas do conhecimento.

Ao viabilizar importantes contribuições, a obra nos instiga a refletir sobre nossas práticas enquanto docentes e o uso de recursos e tecnologias pertinentes, capazes de contribuir no processo de ensino e aprendizagem e estabelecer relações significativas entre os conteúdos abordados. Destacamos assim, que as diferentes estratégias e instrumentos digitais e tecnológicos, constituem-se como ferramentas de apoio para as diferentes disciplinas em espaços educativos, em um trabalho planejado intencionalmente a partir de uma base teórica consistente.

Consideramos que a tecnologia se apresenta como um elemento constituinte da cultura, que viabiliza interação, interesse, aprendizagem e desenvolvimento. Nesse contexto, os textos apresentados nessa coleção contribuem ainda para as discussões que envolvem os jogos digitais e aprendizagem, formação de professores, avaliações e recursos tecnológicos e pedagógicos, destacando possibilidades de reflexão e ação.

Ao viabilizar importantes contribuições, a obra nos inspira a esperança de dias melhores na construção de uma educação de qualidade para todos. Como dizia Paulo Freire:

> [...] é preciso ter esperança, mas ter esperança do verbo esperançar; porque tem gente que tem esperança do verbo esperar. E esperança do verbo esperar não é esperança, é espera. Esperançar é se levantar, esperançar é ir atrás, esperançar é construir, esperançar é não desistir! Esperançar é levar adiante, esperançar é juntar-se com outros para fazer de outro modo [...] (1992, s/p)

Esperançar é construir e ir adiante, unir forças para refletir e agir. Assim, agradecemos a todos que constituíram o coletivo dessa obra, partilhando suas escritas e esperanças.

Geuciane Felipe Guerim Fernandes

SUMÁRIO

CAPÍTULO 7

THE ROLE OF GAMIFICATION AS A SUPPORT TOOL FOR NON-PRESENTIAL TEACHING FOR UNDERGRADUATION

Data de aceite: 04/07/2022

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ABSTRACT: The purpose of the present study is to evaluate the role of gamification as a support tool to the Linear Algebra discipline in an Engineering graduation course that, due to the COVID-19 pandemic, was abruptly altered from the presential format to the online. The gamification activity that most fitted to application in the class was *Kahoot!*, because of its quizzes approach. The evaluation of the game's effect in the teaching-learning process will be made analyzing: grades in the applied tests throughout the discipline; performance evolution in a diagnostic evaluation; and the anonymous answers to an online questionary submitted at the end of the course, in Likert scale.
KEYWORDS: Gamification, Online teaching, Mathematics.

RESUMO: O objetivo do presente estudo é avaliar o papel da gamificação como ferramenta de apoio à disciplina de Álgebra Linear de um curso de Engenharia que, devido à pandemia do COVID-19, foi bruscamente alterado do formato presencial para o online. A atividade de gamificação que mais se ajustou para aplicação na turma foi o Kahoot!, pela opção por utilizar quizes. A avaliação do efeito do jogo no processo de ensino-aprendizagem será feita analisando-se: as notas das avaliações aplicadas no decorrer da disciplina; a evolução do desempenho em uma avaliação diagnóstica; e as respostas anônimas a um questionário online submetido ao término do curso, na escala Likert.
PALAVRAS-CHAVE: Gamificação; Ensino online; Educação matemática.

1 I INTRODUCTION

The educational system unexpectedly suffered a big impact due to the COVID-19 pandemic. For a long time, classroom teaching has been solid and well established as the main teaching method, however, the necessity of adaptation of this model has arose to prevent the aggravation of contamination. As a solution, around the world it was proposed that the teaching at all levels, from preschool to university, over the year of 2020 would be done remotely. And the same recommendation was followed by the University of São Paulo (USP), in Brazil.

It is not new that the importance of technology in education is understood and that technological innovations need to accompany

learning, so that the quality of teaching also evolves (Taylor, 1995). In a pandemic context, the use of technology was essential to create a proper learning environment and to keep the educational system working. Despite that, it is not enough to try to recreate in virtual environment the classes that before were presential, it is needed to adapt and to improve the teaching method (Lynch and Dembo, 2004). For this reason, the gamification as a complement of the studies can be a powerful ally. And here, gamification is the process in which games are incorporated in the teaching, but not only that, mainly, stimulates motivation behind the scenes, i.e., not to give up and try again, even (and especially) after a mistake.

The process of teaching-learning in an online course is considerably distinct of the presential, mostly for the significant diminution of interaction among the students and between each student and the teacher, due to the student adjust to the way the matter is addressed (Istenic, 2010). With that being said, if the subject is taught in a creative and innovative way, the positive impact in learning will be immense, therefore using games is a great way of keeping the interest and to facilitate the student's study. Due to your characteristics, like vibrant and bright colors, the games become an adequate tool to keep the student's attention and to assist teaching (Echeverrîa et al., 2012).

One of the main advantages of games as a learning tool is the familiarity that the students already have with this kind of activity. The informal learning in this method approaches the subject content with common aspects of the student routine, creating a more familiar environment, where the students usually deal in their daily life. And, in the pandemic context, where the way of learning changed abruptly, this familiarity became a great ally (Lockyer and Patterson, 2008).

In the context of the authors experience, even in normal times (presential teaching), Linear Algebra, discipline in which the gamification was applied, and which elapsed this study, already presented high complexity and demanded an above average dedication from de students. Considering this context, the students' motivation regarding study was shaken, which repercussed in the quality of learning.

Considering all the above and the fundamental principle of education, which states that everyone can learn, each one in one's rhythm and with a method (Comenius, 2020), the motivation to circumvent this situation was to apply games (gamify the study), specifically through quizzes in the *Kahoot!* online platform, concomitantly with the formal study. The purpose was to stimulate the graduation students, through a recreative approach to work with the subject and, videlicet, allow a smoother transition throughout the discipline.

2 | METHODOLOGY

The objective of this study is to evaluate the role of gamification as a supporting tool to a traditional course of basic cycle of Engineering from the Lorena campus of São Paulo University (EEL/USP), in Brazil. The motivation was the occurrence of COVID-19 pandemic,

that in a short period of time has changed completely the dynamic of teaching-learning.

The application of the proposed methodology was in a Linear Algebra class discipline, in the 2nd semester of 2020 and this choice was not random, since in this discipline are reported difficulties even in presential course, due to its extremely theoretical aspects. Therefore, solutions were planned by the professor, that could utilize the extra resource of two monitors-students to the discipline in that semester and to minimize the additional challenge of remote teaching.

Given the conditions of the class (high number of enrolled students: 161), distribution of exams (seven over the semester), content of the course program, a conclusion was reached that a quiz approach would be more adequate to assist the professor and the student that monitor the learning evolution. The choice of the *Kahoo*t! platform was made because it has been developed for this finality. And because it was applied outside class hours, a symbolic punctuation was distributed to the best ranked in each activity.

Firstly, the main characteristics related to the game are going to be described, how it was created and applied to the students. Posteriorly, the participants of the study are going to be described, in other words, students who attended the Linear Algebra discipline. The evaluation of the game effect in the process of teaching-learning will be made through: the grade of exams applied during the discipline; the evolution of the performance in a diagnostic evaluation; and the anonymous answer to an online questionnaire submitted at the end of the discipline, in the Likert scale.

2.1 The game

Kahoot! is a platform used as an educational tool, in which is possible to create games in the form of a quiz. This applicative allows to mold evaluative tests consisting of multiple-choice questions, which the student needs to choose between up to four options (answers), with pre-determined limited time, defined by the test creator.

The tests were applied in the form of an extra class activity, with the main goal of focusing on the content studied previously, during the real-time online classes. Once each two weeks, the students accessed the *Kahoot!* platform to answer about five to six questions related to the topics approached in the classroom, and each question had a limit time varying from 2 to 4 minutes, depending on the difficulty or if the question had theoretic feature or involved account (here, called of practice question). Figure (1) brings an example of a question applied in one of the tests.

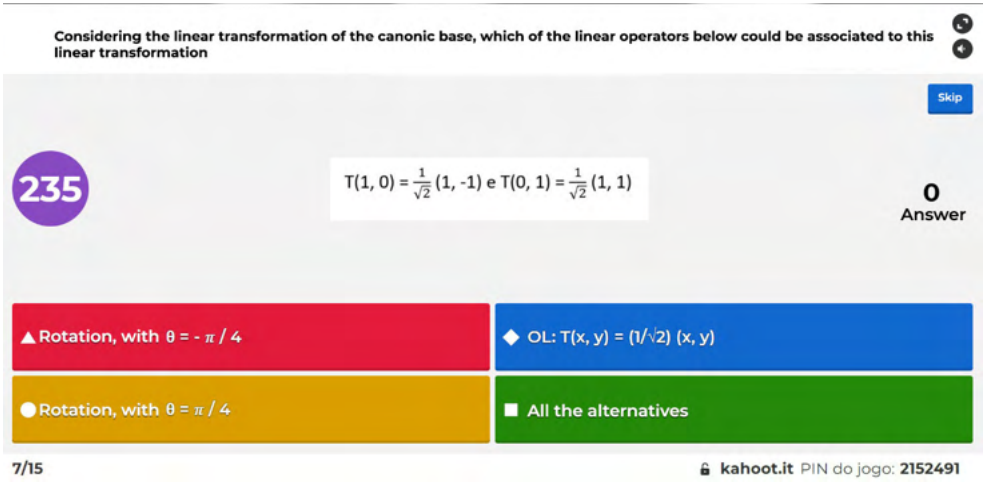


Figure 1. Example of a question elaborated for the game.

Kahoot! is not an interactive platform, therefore, during the activities, the participants accessed simultaneously the game and Google Meet real-time meeting, to keep contact with each other and with the professor (via Google Meet chat). In order for the integration between students and teachers to exist, and for learning through games to be efficient, it is necessary for the teacher to have control over aspects of the game (Echeverrîa et al., 2012). With this factor in mind, the professor was present during all quizzes and, after the students have finished each question, a moment was saved to comments and/or questions.

2.2 The Participants

The participants of this study consist of students from the first two years of graduation in Engineering (Chemical, Environmental, Biochemical, Materials, Physics and Production) which attended the Linear Algebra discipline during the 2nd semester of 2020, from August to December. The number of students in the class was 161, but, since the participation in the extra class activity was voluntary, a total of 127 students attended the quiz at least once.

During the course, the students executed conventional evaluative activities, two bimestrial exams (P1 and P2) and fives test with less content, distributed over the semester (T1 to T5). From the students' performance over them, it is going to be analyzed the impact of games in the learning of the subject and, considering that not all the students have participated of the quiz (approximately 79% of the students participated of the activity at least once), a qualitative evaluation of the game effect in the students' learning was made through:

- Comparation of performance between the students who participated and the ones who did not participate, considering from the total of students who reached earlier the minimum grade for approval in the discipline, how many had participated systematically of the quizzes;

- Evaluation of the results in a diagnostic exam: from the seven first quizzes applied over the semester, two questions with fewer hit percent were selected and replicated in the 8th quiz;
- Evaluation of the activity itself, based in a questionnaire formulated in the end of the course, answered anonymously via Google Forms, and using a Likert scale approach.

3 | THEORETICAL BACKGROUND

There is a strong relationship between the cognitive development of an individual and the social context in which it is inserted, aspects that substantiate Lev Vygotsky's (1896-1934) main theories and became striking ideas in which various teaching methods structured themselves. Generally, Vygotsky bases his theories in the context of intellectual development of children, nonetheless, it is possible to comprehend its relevance in numerous levels of education.

Due to the COVID-19 pandemic, the environment around the student changed drastically and this new relationship with its environment affected the learning structure of students, one of Vygotsky's theory important characteristics to support this study.

The interaction between the environment and the individuals it is an essential factor for the learning process and the development, because through them children make symbolic mental representations of what was assimilated during their real interactions (Vygotsky, 2012). Culture plays a memorable role to shape the mental development, as it enables to assimilate external stimuli from different social contexts, forming a connection with the environment surrounding the individual (Vygotsky, 1978). This idea is meaningful inside a classroom, as if the student is stimulated in a way different than usual, using games, for example, it is possible to potentialize its individual learning process.

4 | RESULTS

4.1 The Activity's Impact in Students' Performance.

In order to examine the impact of the activity in students' academic performance throughout the semester, they were divided in three groups:

- **G1**: students approved before T5 and P2;
- **G2**: students approved before P2; and
- **G3**: students approved after P2 (without the need to take the retake test)

The class was composed by161 enrolled students and were considered students that did the activity the ones present in at least 5 of the 8 activities. The Tab. (1) shows the association of these 3 groups with their percentage of approved students, respectively.

Group	N° of approved students	N° of students that did *Kahoot!*	Percentage of students that did *Kahoot!* (%)
G1	8	8	100
G2	27	21	77
G3	87	31	35

Table 1 Analysis of students' attendance in *Kahoot*! in the approved groups.

From Tab. (1), it is noticed a larger impact of the activity in the groups of anticipated approval (G1 and G2 groups) and a significantly decrease of the impact in the groups that only were approved taking all tests (G3). The students' perception about the activity's impact in their performance validate the data from Tab. (1), as said by themselves, in the quotes bellow in Tab. (2).

Student	Feedback
#4	*The activity helped a lot, cause a lot of the times clarified something that was confusing in the classes or exercises.*
#6	*The activity helped substantially, it encouraged me to study subjects in advance, helping my performance in the tests.*
#7	*Kahoot helped discover the contents that need to be reinforced, besides, it is a different, creative and fun form to learn.*
#13	*The activity helped understand the basic /fast part of exercises that I wasn't used to study as much as the complex/ long parts. With that, in the tests I didn't get the begging of the exercise wrong, being a factor that helped a lot in my grades.*
#14	*A proposta de realizar atividades no Kahoot foi muito proveitosa, no sentido de que possibilitou que os alunos pudessem absorver e aprender com os erros também. The proposal to take part in Kahoot's activities was very useful, it made it possible for students to absorb and learn with their mistakes.*

Table 2. Anonymous feedbacks from students about the *Kahoot*! activity.

These quotes validate the positive feedbacks from their comprehension of the course, the quality and quantity of their learning experience, as shows in Fig. (2) to (4).

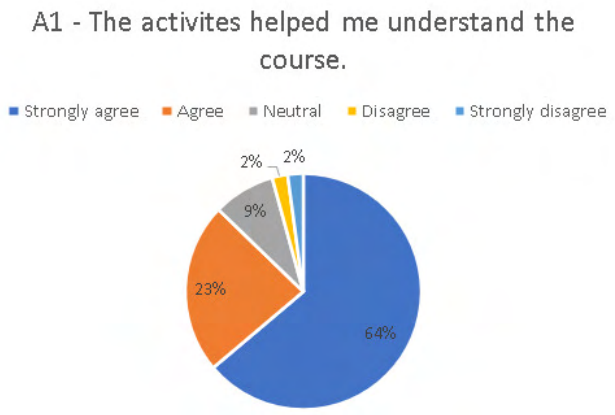


Figure 2. Chart with answers regarding the impact of the activities in the comprehension of the course, in Likert scale.

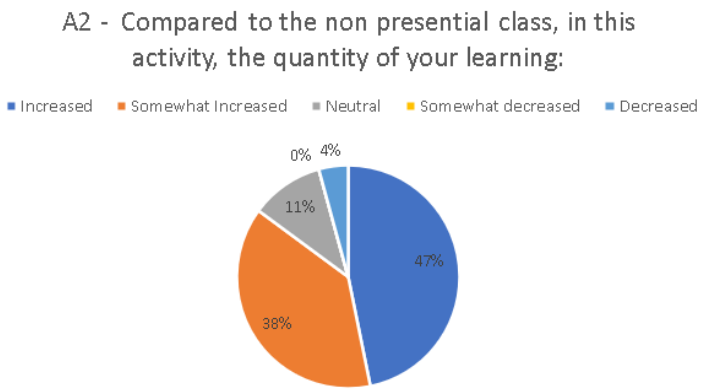


Figure 3. Chart with answers about students' quantity of learning, in Likert Scale.

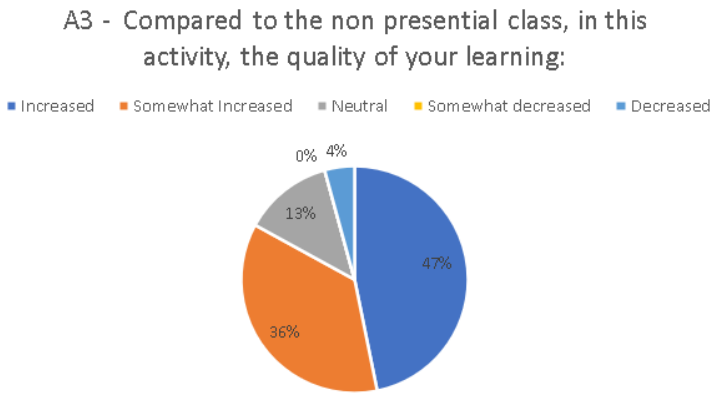


Figure 4. Chart with answers about students' quality of learning, in Likert Scale.

Tab. (3) next, presents one last analysis, made to quantitatively assess the impact of the activity on students' learning. The acronym *Ki* represents the *i*-th activity of *Kahoot!*,

from where were taken 2 questions. This activity was a diagnostic evaluation, composed by the two questions with the smaller hit rate in which of the seven first activities (questions highlighted with (*) were considered *tricky questions*, which could explain the worst performance, with little significant performance improvement, or even reduction in the hit rate). Therefore, a last analysis was made concerning a development in the percentage of correct answers in these questions, resulting in an average percentage increase of 43% in the hit rate, per question. Therefore, as a diagnostic evaluation, in other words, analyzing the quality of the proposed activity developed throughout the semester, one could say that the activity was very well succeeded, as shown in Tab. (3).

Kahoot! **'s number of the original question**	**% Hit rate**	**% Hit rate in the reapplied activity**	**Percentage change**
***K*1**	12	32	+167%
***K*1**	23	23	0
***K*2**	22	35	+59%
K*2	27	29	+7%
***K*3**	19	39	+105%
***K*3**	26	50	+92%
***K*4**	19	24	+26%
***K*4**	21	34	+62%
K*5	13	13	0
K*5	28	24	-14%
***K*6**	27	44	+63%
***K*6**	38	47	+24%
***K*7**	28	45	+18%
***K*7**	45	40	-11%

Table 3. Comparison in the correct answers percentage of questions applied in the diagnostic evaluation.

4.2 Interaction

In the context of non-presential education, interaction is a very important factor for the students' experience, and the activity made it possible to have interaction in quality and quantity larger than usually presented in non-presential classes. The students' perception about interaction during the activity was measured by four questions, whose result, in the Likert scale, can be verified in Fig. (5) and (6).

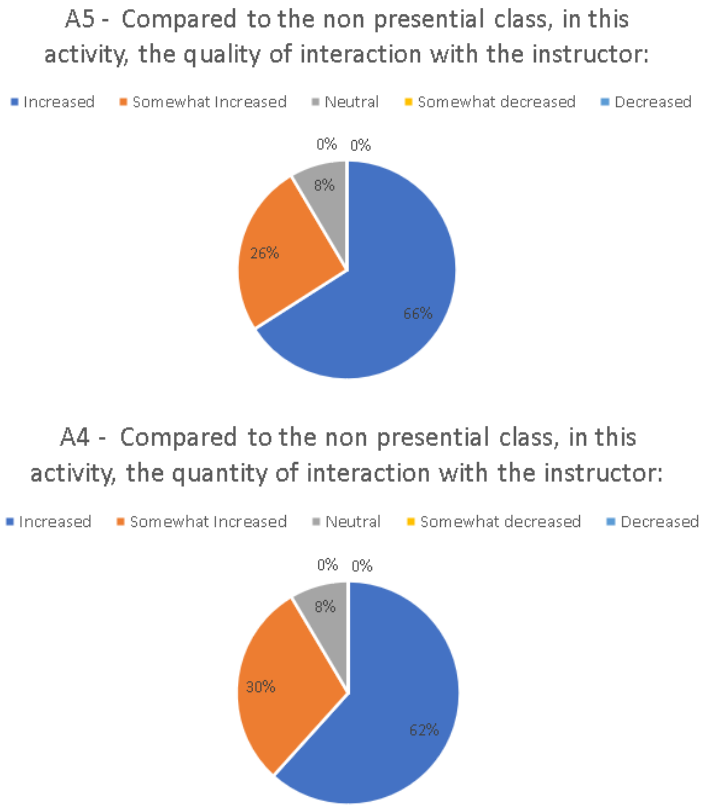
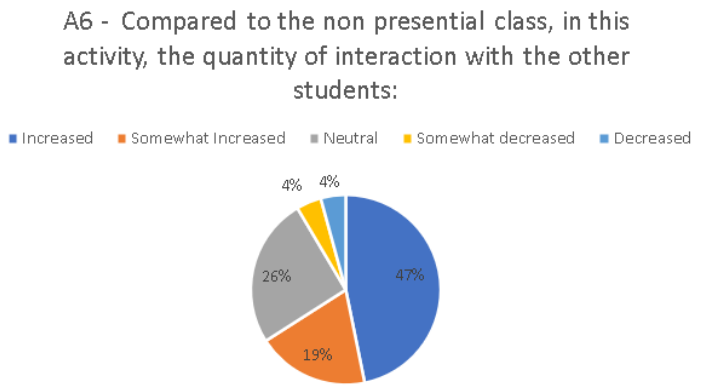


Figure 5. Chart with answers from students' perception of the interaction with the professor during the activity, in Likert scale.



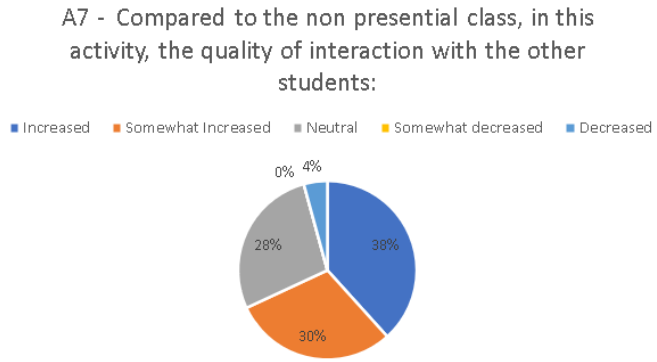


Figure 6. Chart with answers from students' perception of the interaction between themselves during the activity, in Likert Scale.

Regarding the interaction, an average of 4.28 in Likert scale was obtained, which is an extremely positive result. For comparison, the results concerning students' perceptions were considered positives for 4.00 average in Likert scale, with the same statements used in this work (Picciano, 2002). This positive perception in the interaction of the activity was also expressed by the students, as presented in Tab. (4).

Student	Feedback
#1	*The use of Kahoot was essential, not just for improvement of distance learning, but for the interaction between the students and themselves, and them and the professor as well.*
#29	*The activity helped understand better the theorical part of the course, besides, it helped with fixing knowledge in the recent taught subjects, which were the focus of the activity of the day. It also made the interaction between the students better, in consequence of the relaxation of these moments.*

Table 4. Anonymous feedbacks from students about interaction.

4.3 Motivation

The activity combined the intrinsic and extrinsic aspects of motivation. The challenge, intrinsic aspect, defined by Malone (1981) as a primary factor to a motivating activity was highly present in the form of competition for the better rankings. Extrinsic motivation (Vallend *et al.,* 1997) was also present, through the symbolic grade given to the best at the ranking in each activity, as stated by some students in the anonymous feedbacks registered in Tab. (5). The competition, although, does not represent something positive to the unanimity of the class, as shown in the quote from Student #28, highlighted in red in Tab. (5).

Student	Feedback
#13	*The weekly rankings motivated me to participate and dedicate myself in the studies of the subject, the points helped me be approved in the course.*
#26	*It was a fun activity and my competitiveness made me study more to win points.*
#28	*The activity didn't help me because I felt pressured by the competitiveness that it creates. The focus was not learning, but just the possibility to win extra points.*

Table 5. Anonymous feedbacks from students about the competitive aspect of the activity

The students' motivation was also positively shown in their answers in the questionary, as shown in Fig. (7).

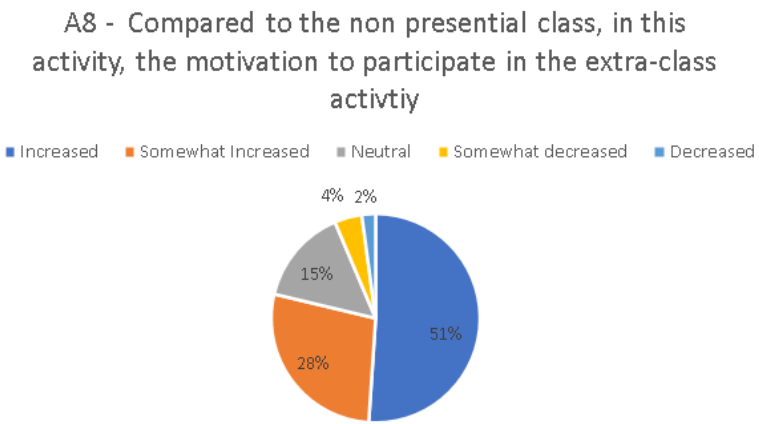


Figure 7. Chart with students' answers about their motivation, in Likert scale.

4.4 The fun aspect of the game.

The activity provided the students with a moment of great relaxation, that added to the interaction of students between themselves and the professor in a lighter environment, in comparison to the non-presential formal classes, as a consequence of the playfulness tone of the game. This fun aspect of the activity could have positively influenced the motivational factor of the students. Their feedback was extremely positive in relation to their participation in the activity, being the most positive average answer between all questions asked in the questionary (4.53 in Likert scale), as shown in Fig. (8) and Tab. (7).

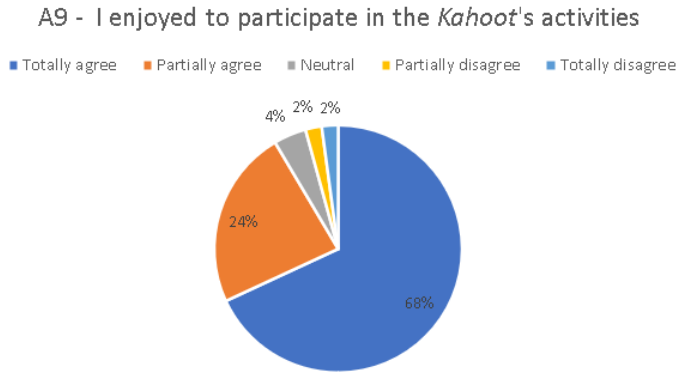


Figure 8. Chart of students' answers about their satisfaction in taking part in the activity, in Likert scale.

The aspect of recreation was also mentioned several times by the students in the space for voluntary, anonymous and free feedback from the questionary, where the aim was simply to listen to the purest perception of the students, as shown in Tab. (6).

Student	Feedback
#3	*It helped and it was very fun.*
#9	*The activities in Kahoot helped a lot, as treated the subject in a more laid-back way, which helped understand the subject.*
#15	*The activity helped a lot and it was fun to be a part of, I hope to have more activities like that in the future.*
#18	*It was really nice, I loved the activity.*

Table 6. Anonymous feedbacks of students about their satisfaction in taking part in the activity.

To finish, is shown Tab. (7), which contains the average of answers in each affirmation (numbered from A1 to A9) in the questionary, in Likert scale.

Afirmation	Avarage in Likert sacle
A1	4.45
A2	4.23
A3	4.21
A4	4.53
A5	4.57
A6	4.04
A7	3.98
A8	4.21
A9	4.53

Table 7. Average Likert scale answer for each affirmation in the proposed questionary.

As related before in this work, for the same affirmations used in this work, the results were considered positive for an average of 4.00 in Likert scale (Picciano, 2002). Based on this, it is possible to state that the proposed activity was extremely positive, as all affirmations obtained an average of more than 4.00 in the Likert scale, expect affirmation A7, that still remained close to this value with 3.98. This positive perception about the activity was shown in terms of: learning (A1, A2, A3); interaction with the professor (A4 and A5); interaction with the other students (A6 and A7); motivation to participate (A8); and appreciation for the activity (A9).

The lowest average in affirmation A7, related to the quality of interaction with the other students is most probably due to an elevated number of students in the class (161) and in each activity (more than 50). And the affirmations that has shown higher average were related to: quality of learning (A1); interaction with the professor (A4 and A5); and appreciation for the activity (A9). This is an excellent indicative that the proposal reached its main goal: assist the students to study a discipline in which they often present difficulties, even in the presential format; and strengthen the bonds with the professor.

5 | CONCLUSIONS

The goal of the present study was to evaluate the role of gamification as a support tool to the subject of an Engineering course that, as a consequence of the pandemic of COVID-19, had its configuration abruptly altered from presential to online. The activity that better fitted for application was *Kahoot!* and the evaluation of the game's impact was made through: grades of applied tests throughout the subject; development in the performance on one diagnostic evaluation; and the anonymous answers to an online questionary submitted at the end of the course, analyzed in the Likert scale.

The proposal of this activity had the goal to assist the students to study a matter in which they presented difficulties, even in presential format, and strengthen the interaction with the professor, which is compromised in the non-presential format.

It was noted that the activity functioned as a support role to the teaching, especially as the students that needed to take less tests to be approved (as in, were approved before the attainment in the last two or the last one test), mostly, participated in the quizzes.

Another quantitative factor, also important, were the averages obtained to each affirmation on the questionary, in Likert scale. From 9 affirmations, 8 reached an average of higher than 4.00 and only one, average of 3.98, what justifies itself on the size of the class and the quantity of students that took part in the activity.

A third factor, more subjective, but not less important, was the quotes wrote by the students themselves, anonymously, which has shown not just high acceptance related to the activity but the fulfillment of the proposed goals as well. These reports also have the role to refine the activity, for a future second application, considering that generate memory of

what has been done, in addition to diagnose what has been made properly and what needs to be improved.

Based on what was shown, it is possible to state that this type of approach works very well on the non-presential format, and should be applied in larger scale, especially because it gives support to the process of teaching-learning and allows more interaction with the teacher, fundamental part in this process.

ACKNOWLEDGEMENTS

The authors would like to thank the School of Engineering of Lorena (EEL/USP), for providing all the conditions necessary for this work to be accomplished. In special to the Pro-rectory of Graduation, through the Edict PEEG 20202; and to the Department of Basic Sciences and Environmental, through the Edict of Tutoring of the second semester of 2020.

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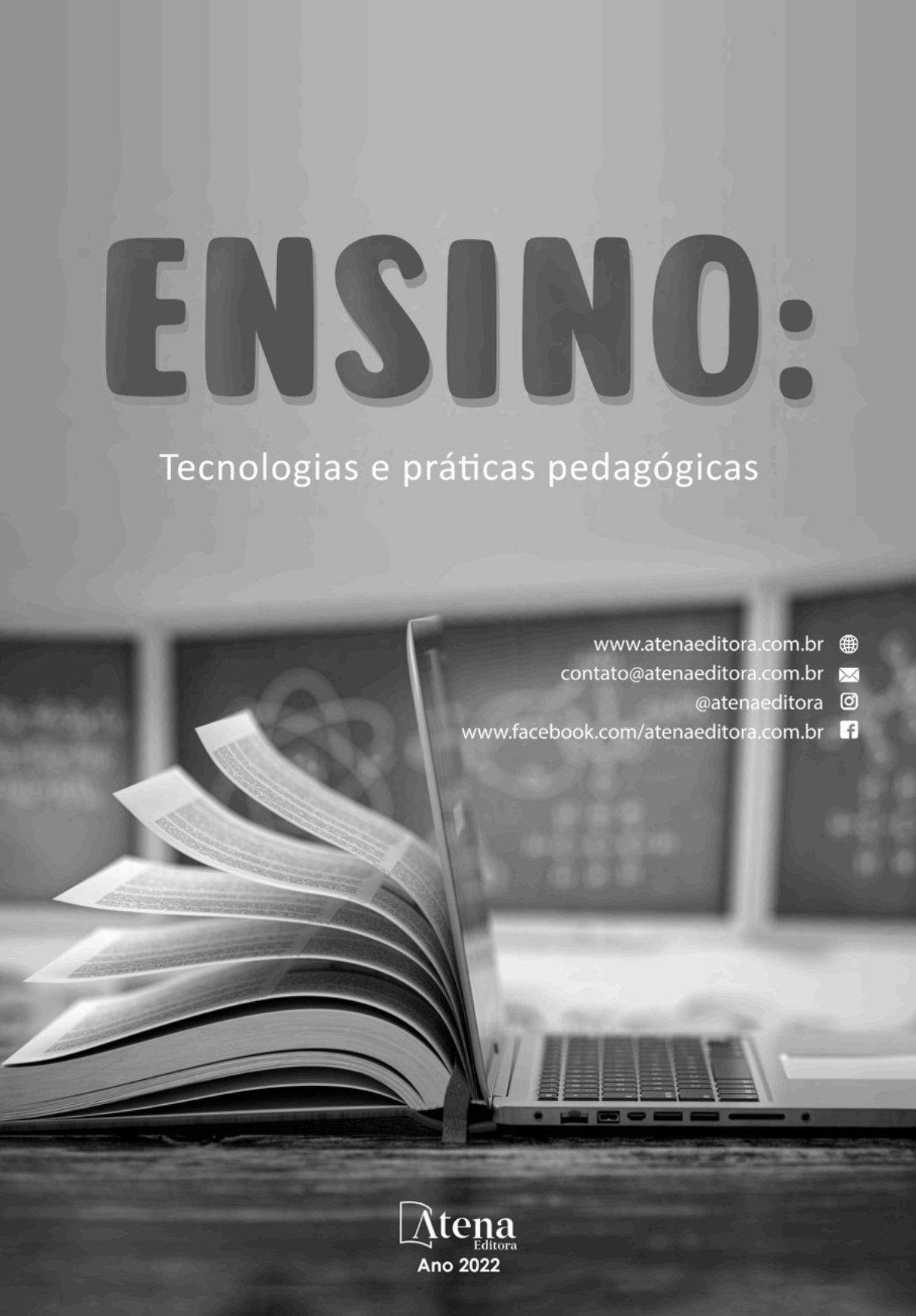

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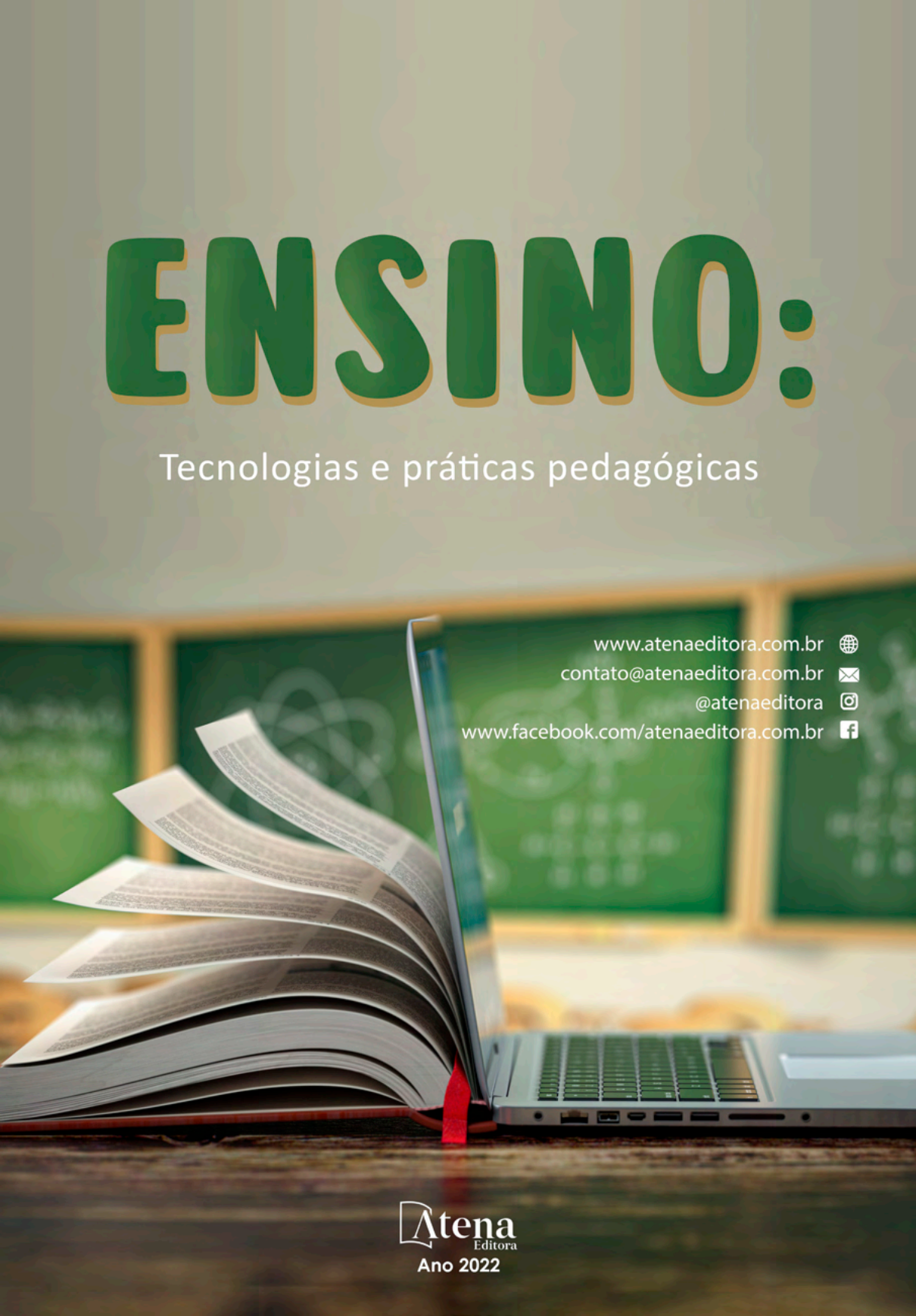

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