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ECG Tutor: a gamified intelligent tutoring system for electrocardiogram teaching

ECG Tutor: desenvolvimento e avaliação de um sistema tutor inteligente gamificado para ensino de eletrocardiograma

Larissa Acioli Pereira[1] laraacioli84@gmail.com
Lisley Lylás dos Santos Leão[1] lisleylylasleao@gmail.com
Diego Dermeval[1] diego.matos@famed.ufal.br
Jorge Artur Peçanha de Miranda Coelho[1] jorge.coelho@famed.ufal.br

ABSTRACT

Introduction: New methodological approaches have been suggested in an attempt to improve the acquisition of skills in electrocardiogram (ECG) interpretation, known to be complex and difficult to assimilate. Considering the expansion of active methodologies and the encouragement of technological innovations for medical education, the use of internet technologies (e-learning) has gained strength, highlighting the use of artificial intelligence platforms, such as intelligent tutoring systems (ITS), for their capacity to promote adaptive instruction. Researchers have used gamification (game design techniques) in conjunction with ITS, reporting greater engagement.

Objective: Seeking to improve ECG learning performance among medical students through the development of new methodologies and considering the benefits of ITS and the use of gamification in medical education, the present study aimed to explore the interest and motivation of medical students in the use joint use of these technologies to study ECG.

Method: This is an exploratory, quantitative study, in which graphic design prototypes of a gamified ECG instructor ITS were created by teachers of the medical course and evaluated by medical students from a public university and another private university after improvement into an interactive format, with the contribution of an interdisciplinary team.

Result: At first, 53 undergraduate students from the 5th to the 11th semesters of the course participated in the study. That number was reduced to 14 in the second stage. The analysis showed approval of aspects related to perceived easy-to-use format, perceived usefulness, attitude towards use and intention to use. On the other hand, an urgent need to adapt to mobile devices and improve gamification and aesthetic elements was observed.

Conclusion: The obtained results allowed us to conclude that medical students intend to use the ECG Tutor in the future, implying the need to develop a computational solution for the system and measure its impact on student learning.

Keywords: Electrocardiography, Medical Education, Educational Technology. Artificial Intelligence

RESUMO

Introdução: *Novas abordagens metodológicas têm sido sugeridas na tentativa de aprimorar a aquisição de habilidades em interpretação de eletrocardiograma (ECG), comprovadamente complexa e de difícil assimilação. Diante da expansão das metodologias ativas e do estímulo às inovações tecnológicas para o ensino médico, o uso de tecnologias de internet (e-learning) ganha força, destacando a utilização de plataformas com inteligência artificial, como os sistemas tutores inteligentes (STI), por sua capacidade de promover instrução adaptativa. Pesquisadores têm utilizado gamificação (técnicas de design de jogos) em conjunto com os STI, reportando maior engajamento.*

Objetivo: *Buscando melhorar o desempenho de aprendizagem em ECG entre graduandos de Medicina por meio do desenvolvimento de novas metodologias e considerando os benefícios dos STI e do uso da gamificação na educação médica, o presente estudo objetivou explorar o interesse e a motivação dos acadêmicos de Medicina na utilização conjunta de tais tecnologias para estudar ECG.*

Método: *Trata-se de uma pesquisa exploratória e quantitativa, na qual protótipos do design gráfico de STI gamificado instrutor de ECG foram idealizados por professores do curso médico e avaliados por acadêmicos de Medicina de uma universidade pública e outra particular após aprimoramento para um formato interativo, com a contribuição de uma equipe interdisciplinar.*

Resultado: *No primeiro momento, participaram da pesquisa 53 graduandos do quinto ao 11º período do curso. Reduziu-se esse número para 14 na segunda etapa. A análise mostrou aprovação nos aspectos relacionados à facilidade de uso percebida, à utilidade percebida, à atitude em direção ao uso e à intenção de uso. Evidenciou-se a premência de adaptação também para dispositivos móveis e aperfeiçoamento nos elementos de gamificação e estética.*

Conclusão: *Os resultados obtidos permitem concluir que os alunos de Medicina demonstraram intenção de uso futuro do ECG Tutor, implicando a necessidade de desenvolvimento de uma solução computacional do sistema e mensuração do seu impacto no aprendizado dos estudantes.*

Palavras-chave: *Eletrocardiograma; Educação Médica; Tecnologia Educacional; Inteligência Artificial.*

[1] Universidade Federal de Alagoas, Maceió, Alagoas, Brazil

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INTRODUCTION

In recent decades, it has been demonstrated that students in the medical area have insufficient knowledge on the interpretation of Electrocardiograms (ECG)[1]. Since then, the likely limitations in the current pedagogical approach have started to emerge all over the world, seeking to identify effective teaching-learning methodologies, as well as to develop new teaching methods.

Some of these studies have evaluated currently used techniques and aspects that seem to positively influence learning: contextualization of electrocardiographic tracings with a clinical scenario, correlating the tracings to patient history[2-4], implementation of an evaluation process measuring student knowledge, particularly when credits or scores are attributed to it, inferring that the reward stimulates interest and improves student performance[4,5], use of repetition strategies and feedback of a given concept in different contexts [3,4].

Methodological approaches with the capacity for individualization and interactivity, as well as those feasible especially for students who learn better in informal environments, have also shown to be effective[4,6,7]. The teaching strategy based on the use of games and problems to learn ECG interpretation improves the students' interest and engagement[8].

In the context of methodological innovations, electronic learning (e-learning) [9-10] stands out as a modern and promising approach in the teaching-learning process in ECG interpretation. It has been demonstrated that the acquisition of the skills to interpret an ECG is greater when in-person teaching is associated with computer-assisted instruction, either online or offline, in a hybrid learning environment. Moreover, learning while using computers may be superior to the in-person method alone, when there is unrestricted access to study material and assessment questions with immediate feedback[4].

Intelligent Tutoring Systems (ITS) are computer programs that incorporate artificial intelligence techniques for individualized teaching, understanding student knowledge to promote adaptive instruction with immediate feedback[11]. ITS can benefit from design elements that favor appropriate interventions aimed at increasing student motivation and engagement during the teaching-learning process[12]. Game-based approaches encompass a wide range of these technologies[13].

Gamification is defined as the use of game elements and game design techniques in non-game contexts[14]. McCoy et al.[15] report the advantages of gamified platforms in medical education, namely: greater engagement, improved collaboration, application to the real world (contextualized problem solving), clinical decision making, remote training, analytical learning (scoring systems and statistical reports to provide feedback) and quick feedback (opportunity to review concepts, try again and get a better score).

It is possible to observe that both the ITS and the gamification adapt to this scenario, providing strategies for individualized and adaptive instruction, interactivity, contextualization, repetition and feedback, evaluation and reward, an informal environment and the possibility of application to simulated practical scenarios. Considering the benefits, this study proposes the development and evaluation of the usability of a gamified intelligent tutoring system aimed at optimizing the current practices for teaching ECG interpretation.

METHODS

Methodological trajectory

This is a descriptive survey study, with a quantitative approach, related to the development and evaluation of interactive prototypes of a new pedagogical tool for teaching ECG interpretation by medical students from a federal public university and a private institution.

Participants

Medical students attending the 5th semester in a federal public university and a private university center were invited to participate. Therefore, the population consisted of 779 students, 351 from the public institution and 428 from the private one, according to data provided by the course coordination of the respective schools.

The choice of students from the 5th semester of the course is based on the Medical Course Pedagogical Projects (CPPs) of the respective institutions, which refer to the intensification of contents related to cardiology from that moment onwards, although there is no direct citation to the ECG.

The inclusion criteria were: students of any gender and age attending the 5th to the 12th semesters of the medical course at the public University under assessment and from the 5th to the 11th semesters at the aforementioned private institution. The exclusion criteria were voluntary withdrawal from the program and non-completion of the process evaluation.

Data production

The interactive prototypes were evaluated through a structured questionnaire created using Google Forms®. All students were invited to answer the questionnaire via e-mail and telephone messages. Before accessing the screens, the student had access to the first part of the questionnaire, which deals with the characteristics of the respondent, such as sociodemographic data and information about the student's learning about ECG throughout their academic life, according to the model presented by Kopeć et al.[16].

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Access to the final prototype was available exclusively online through a link configured for web access by computers and mobile devices (e.g., smartphone or tablet). Thus, it is not an application for a mobile device, but a web software that can be accessed by different platforms.

After answering the first part, the user was directed to view the prototype screens. Instructions on how to navigate the ECG Tutor were given by the virtual assistant, Cora, as the user interacted with the screen functions. A button with the phrase "Assess the ECG TUTOR" was located on the top bar of the screen and available at any time to access the questionnaire after interacting with questions about screen analysis.

The post-interaction questionnaire was based on the metrics of simplicity, usability, attitude towards use, intention to use and satisfaction validated through the TAM (technology acceptance model) methodology in the context of online educational environments[17,18]. The TAM model, fully applicable to the research problem as it is specific to technology users, has the advantage of having a strong theoretical basis. This model was also used in several studies carried out in the Portuguese language[19,20,21]. The answer pattern chosen for questions 1 to 13 was built using a Likert-type scale, with four response options, avoiding the neutral point, as suggested by Garland[22]. The proposed semantic differential is: "I totally disagree", "I disagree", "I agree" and "I totally agree".

At the end of the post-interaction questionnaire, questions were included about student interaction with the used prototype, which were extracted from the pilot study by Rubinstein et al.[6], namely: 1. To what degree would the ECG Tutor be useful for your learning (1=not useful to 5=extremely useful), 2. Would using the ECG Tutor be stressful (yes/no), 3. Fun (yes/no), 4. Engaging (yes/no). 5. Do you consider that by using it you would make good use of your time (yes/no).

Creation of early low-fidelity prototypes

The initial prototypes of the graphic design of a gamified ITS for teaching ECG interpretation were developed from March to July 2018. The Adobe XD® program was used to create the screens.

The system was named ECG Tutor with its logo. An assistant (tutor) representing a physician/teacher (Cora) was chosen to guide the student during navigation and was available on all platform screens. All contents, when accessed, show study options through text or video lessons, in addition to offering questions to assess the knowledge acquired on the subject (Figure 1).

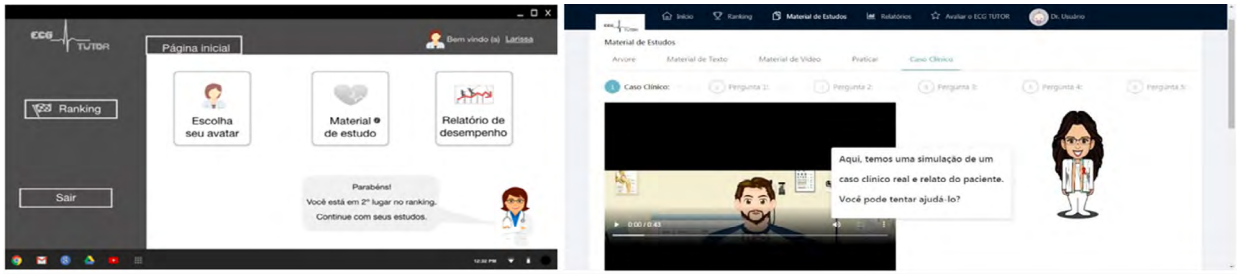
It was thought to display the user progress level in relation to the total content offered, through an individual performance report and a scoring system with the possibility of participating in a ranking involving all users. The choice of an avatar that represented the user was also conceived as a gamification element.

Development of high-fidelity interactive prototypes

With the support of the research group of the Center for Excellence in Social Technologies (NEES, *Núcleo de Excelência em Tecnologias Sociais*), which suggested adaptations and improvements in the initial prototypes, new prototypes were designed. A team consisting of Information Systems and Computer Science students was responsible for the development of new prototypes with the necessary adjustments in the system requirements. These are high-fidelity prototypes, which means they have the highest possible fidelity in relation to the final product. Therefore, the created prototypes are interactive and navigable, facilitating the analysis and evaluation by the users.

Current reusable web technology was used to implement the graphic interface of the designed ITS (React® - the same programming language used on Facebook and Instagram). The development of functionalities used a ready-made platform of programming languages (Firebase®, which belongs to Google). ECG Tutor's gamification design started to promote gamified instruction using: reward tools – system of scores and medals; fun – ranking and avatar representing the user (which evolves

Figure 1. Homepage – Avatar, study material, performance report and ranking and screen containing video with the clinical case simulation and guidelines.



Source: screenshots of the ECG Tutor system.

through the completion of missions); feedback – performance report and, finally, persuasion – assistant Cora (to interact directly with students, bringing messages of encouragement, curiosities and study tips). The interactive version allowed providing a clinical case on video, simulating a real practical scenario with clinical decision-making.

The Voki® program was used for the video construction. The video shows a virtual patient reporting his complaints in a doctor's office environment (Figure 1). Afterwards, the patient's ECG and direction icon to five questions about the clinical case become available.

The educational content inserted in the interactive prototypes was created with the help of a group of medical students. Only a small sample of the content developed on electrocardiogram (ECG) interpretation was implemented in the interactive prototypes, without aiming at covering the entire curricular matrix related to the topic and exclusively as a demonstration of the presentation format of the ECG Tutor study material. Thus, the content UNDERSTANDING NORMAL ELECTROCARDIOGRAPHIC TRACING was made available, with an approach on **ECG leads** and **Einthoven's Triangle**, containing text material, video, questions and clinical case related to the topic.

After the end of the research, the ECG Tutor® was registered as a computer program at the Brazilian National Institute of Industrial Property (INPI, *Instituto Nacional da Propriedade Industrial*), under process number BR512019002788-4, and made available on an online platform with public and free access, especially for students that were research participants. Access to the prototypes of the ECG Tutor® and also to the clinical case video with the virtual patient can be obtained respectively through the links: https://ecgfront-b11dd.firebaseapp.com and https://firebasestorage.googleapis.com/v0/b/ecgfrontb11dd.appspot.com/o/WhatsApp%20Video%202019-08-07%20at%2010.29.21.mp4?alt=media&token=effb355b-9699-4621-8b0c-31316969ec38.

Data analysis

All questionnaire data were evaluated through descriptive statistical analysis based on the collected absolute frequencies. The obtained data were separated into two parts: pre-interaction questionnaire and post-interaction questionnaire with the ECG Tutor prototypes.

Ethical aspects

The study was submitted to and approved by the Research Ethics Committee of Universidade Federal de Alagoas (UFAL), meeting the requirements of CNS Resolution N. 466/2012 and N. 510/2016, under CAAE number 91656318.7.0000.5013. All participants signed the Free and Informed Consent Form (TCLE).

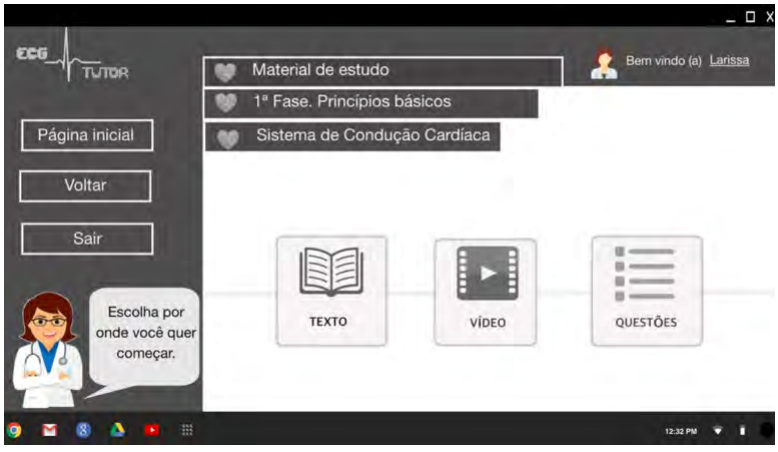
RESULTS

The obtained results will be disclosed, according to the use of the ECG Tutor, in two stages: pre-interaction and post-interaction.

Pre-interaction questionnaire (student profile)

The calculation of the non-probabilistic (or convenience) sample size was performed using the simplified formula proposed by Yamane[23], seeking to guarantee a confidence level of 95% and p=0.5. According to the sample calculation, 187 students from *Universidade Federal do Alagoas* (UFAL) and 207 students from UNIT/AL would be required, aiming at a confidence interval of 95% and p=0.5. However, among all 779 medical students to whom the survey invitation was sent, only 53 agreed with the TCLE and answered the questions. Of these, 15 students were from UFAL and another 38 students from UNIT/AL. Thus, the minimum sample size was not reached

Figure 2. Cardiac Conduction System Screen.



Source: screenshot of the ECG Tutor system.

for the lowest precision levels (±10%) necessary for a 95% CI and p=0.5, according to calculations suggested by Yamane[23]. On the other hand, according to Roobaea & Pam[24], for usability assessment, a sample of five people would be enough to identify more than 80% of usability problems.

Of the total number of students, 34 (64.1%) were female and their mean age was 24 years. The responses to the pre-interaction questionnaire are summarized in Table 1.

Regarding extracurricular classes and courses on ECG, 25 students (47.1%) answered that they had never attended one, 23 (43.4%) had already participated in classes and 5 (9.4%) in courses on the subject, either online or in person. As for the conferences offered by the curriculum of the educational institutions, 16 students (30.1%) denied having participated, while 22 (41.4%) experienced this activity only once, 8 of them (15.1%) twice and 7 (13.2%) more than twice.

When asked about the two study/teaching techniques most often used by students to learn about ECG, 20.7% of them (11 students) restricted themselves to choosing only one technique among all those available in the question.

Table 1. Pre-interaction questionnaire with absolute values and percentages, per higher education institution.

	Private HEI		Public HEI	
	Value (N)	**Value (%)**	**Value (N)**	**Value (%)**
Gender				
Male	9	17.0	10	18.9
Female	29	54.7	5	9.4
Age				
< 20 years	1	1.9	0	0
20-25 years	31	58.5	12	22.6
> 25 years	6	11.3	3	5.6
Course semester				
5th and 6th	11	20.7	4	7.5
7th and 8th	18	34.0	6	11.3
9th and 10th	9	17.0	4	7.5
11th and 12th	0	0	1	1.9
Participation in Academic League				
Never	6	11.3	3	5.6
Cardiology	3	5.6	2	3.7
Urgency and emergency	3	5.6	2	3.7
Internal Medicine	4	7.5	1	1.9
Intensive Therapy	3	5.6	0	0
Others	19	35.8	7	13.2
Regular classes about ECG outside the HEI				
Never	20	37.7	5	9.4
Class (s)	13	24.5	10	18.9
Course (s)	5	9.4	0	0
Conferences about ECG at the HEI				
Never	4	7.5	12	22.6
Once	19	35.8	3	5.6
Twice	8	15.1	0	0
> twice	7	13.2	0	0

Continua...

Table 1. Continuation.

	Private HEI		Public HEI	
	Value (N)	Value (%)	Value (N)	Value (%)
Most used study techniques				
Self-directed study	20	37.7	13	24.5
Lecture	20	37.7	5	9.4
Clinical case in a theoretical environment	9	17.0	1	1.9
Clinical case in a practical environment	5	9.4	1	1.9
Online environment	5	9.4	1	1.9
Video class	18	34.0	10	18.9
Evaluations / exams about ECG at the HEI				
Never	14	26.4	7	13.2
Once	22	41.5	8	15.1
Twice	2	3.7	0	0
> twice	0	0	0	0
Number of classes about ECG at the HEI				
Few	37	69.8	14	26.4
Enough	1	1.9	1	1.9
Many	0	0	0	0
Self-assessment of skill in ECG interpretation				
Very bad	17	32.0	4	7.5
Bad	14	26.4	5	9.4
Regular	6	11.3	5	9.4
Good	0	0	1	1.9
Excellent	1	1.9	0	0

HEI, higher education institution; ECG, electrocardiogram.
Source: the authors.

However, another 20.7% (11 students) chose to check more than two options. The study/teaching methods mentioned by the students as the most frequently used ones were: self-directed study (33 students, 62.2%), video lessons (28 students, 52.9%), lectures (25 students, 47.1%) , clinical case discussions in a theoretical environment (10 students, 18.9%), clinical case discussions in a practical environment (6 students, 11.3%) and study in an online learning environment (6 students, 11.3%) .

Regarding periodic assessments on ECG, 39.6% of students (21 of them) stated they had never taken a test on ECG basic notions or interpretation at their educational institution, while another 56.6% (30 students) underwent this type of assessment only once during the course.

Regarding the classes on ECG offered by all disciplines together, 51 students (96.2%) classified them as quantitatively insufficient for their learning. Finally, when the students self-evaluated their abilities to interpret the electrocardiographic tracings, the worst grades (very bad and bad) were chosen by 75.4% of them (40 students), regardless of the course semester.

Post-interaction questionnaire (ECG Tutor assessment)

Few students answered the questionnaire after interacting with the prototypes. Some of these students got in touch, by email or telephone message, reporting difficulties in finding the link to access the post-interaction questionnaire using a smartphone. Considering this information, new

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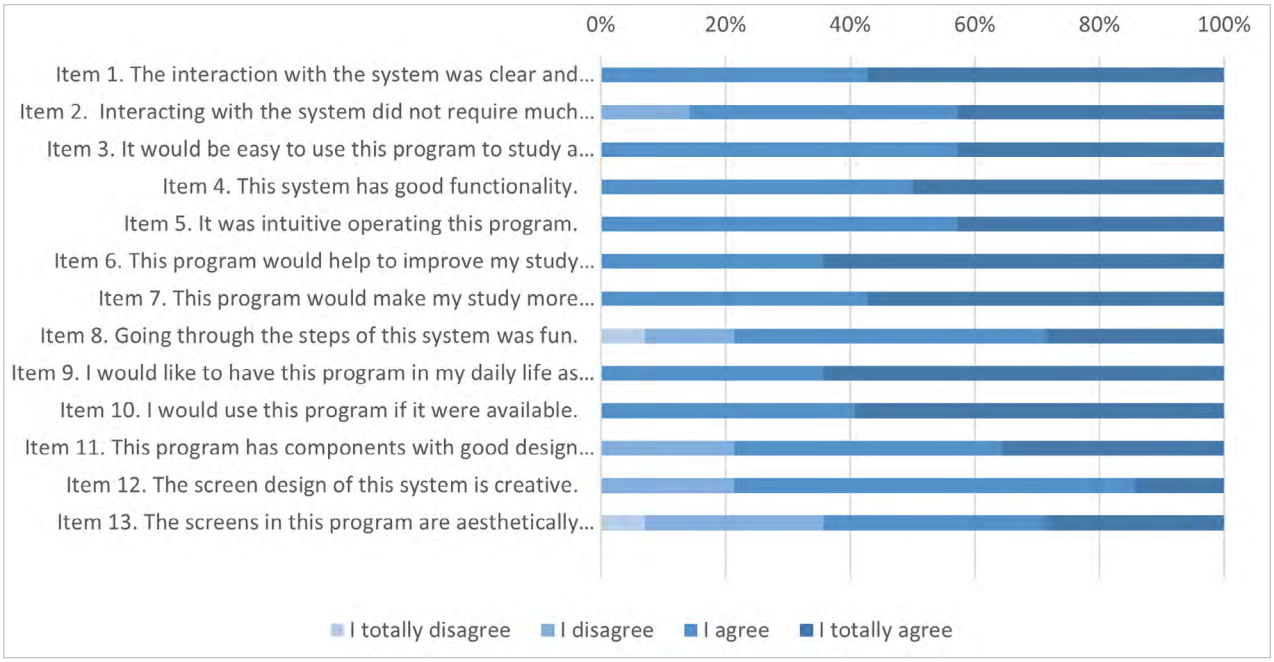
instructions were sent and a direct link was provided by email and telephone messages.

After sending new instructions, of the 53 undergraduate students who agreed to participate in the study, only 14 answered the questionnaire after interacting with the prototypes; 50% of them were male, with a mean age of 24 years. The answers to the items in the first part of this assessment are available in Graph 1.

All students agreed, to different degrees (I agree and I totally agree), that the interaction with the system was clear and understandable and that it would be easy to use it to study a content. The majority (12 students, 85.7%) thought that interacting with the prototypes did not demand much effort.

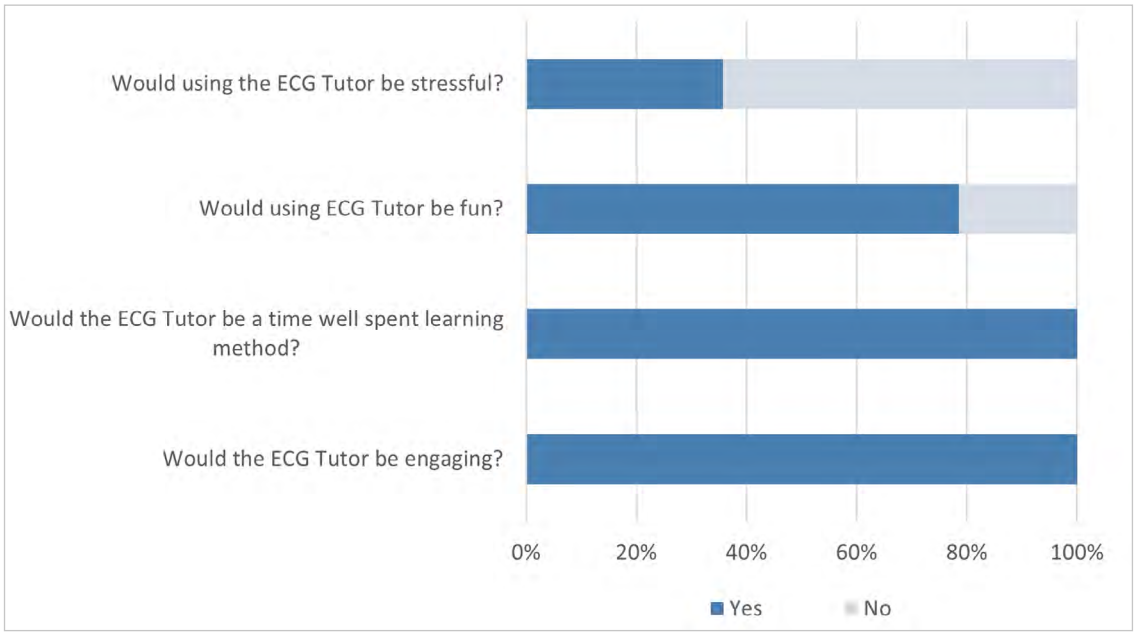
The characteristics related to perceived usefulness, addressed in questions 4, 5 and 6, were very well evaluated by the students, with full approval (I agree and I totally agree) in

Graph 1. First part of the evaluation, by the students, of the interactive prototypes of the ECG Tutor through the usability questionnaire based on the Technology Acceptance Model.



Source: the authors.

Graph 2. Second part of the evaluation, by the students, of the interactive prototypes of the ECG Tutor through the questionnaire based on the model by Rubinstein et al.[6]



Source: the authors.

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all questions. Questions 7, 8 and 9, which portray the attitude towards use, also showed high acceptance. All students answered that the ECG Tutor would make their study more interesting, as well as that they would like to have this program in their daily lives as a student. However, 3 students (21.4%) did not see the interaction as something fun.

When answering the tenth statement of the questionnaire, all students indicated that they would use the ECG Tutor if it were available, with a high percentage of total agreement (10 students, 71.4%).

The last variable of the TAM model to be evaluated was the aesthetics of the prototypes, encompassing questions 11 to 13. Both statements of assertions 11 and 12 (program components have good design and style; screen design is creative) attained 21.4% of disagreement (3 students). Rejection was higher for the last question, in which 5 students (35.7%) objected to the claim that the program screens would be aesthetically attractive.

After interacting with the prototypes, the students also answered the questions with feedback, based on the model by Rubinstein et al.[6]. To the first one, all students answered that the ECG Tutor would be very or extremely useful for their ECG learning.

Then, the participants answered a sequence of questions, with yes or no answers (Graph 2). Thus, 64.2% of the students (9) stated that using the ECG Tutor would not be stressful and 78.5% (11) considered that it would be fun. Finally, the entire group that interacted with the prototypes decided that the ECG Tutor would be a learning method that would make good use of their time and that it would be possible to remain focused and active while studying with the system.

DISCUSSION

The results of the present study demonstrated that the students of the medical course approve the use of intelligent tutoring systems, suggesting that this technology should be better explored as an auxiliary tool for the learning of ECG interpretation.

According to a review article on computer programs aimed at teaching ECG[10] and until the conclusion of the data analysis of this study, no evidence was found in the literature of the existence of an ITS associated with gamification for the teaching of ECG. Although no studies were found that explicitly use ITS and gamification technologies, it is worth emphasizing some associated studies that have investigated the use of other technologies for the teaching of electrocardiogram interpretation with usability evaluation by students[7,25,26]. In particular, the results of the usability test of the application proposed by Lima et al.[25] indicate excellent usability acceptance by the students. The study by Montassier et al.[7], who conducted a randomized controlled trial to evaluate an e-learning strategy for the learning of electrocardiogram interpretation, showed to be effective for the acquisition of ECG interpretation skills by medical students. This study differs from the related ones, as it develops and evaluates an application based on artificial intelligence that seeks to promote an individualized pedagogical strategy, at the same time that it encourages greater student engagement with the use of game elements, thus constituting original characteristics in relation to the literature.

The study by Kopeć et al.[16] evaluated the competence in ECG interpretation of 536 medical students, using an online questionnaire. The educational profile of the participants was also analyzed. Although there is an agreement with studies from several institutions worldwide on the deficiency in learning ECG interpretation, the students' perception of their own knowledge was rarely addressed. When addressing the evaluation activities on ECG, most Polish students (90%) reported having taken tests containing electrocardiographic interpretation. However, 40% of the students in this research stated they had never taken a test on the basic concepts or interpretation of ECG in their educational institution. This information, in addition to being divergent, is a matter of concern, since the submission of students to regular assessments on ECG, according to Raupach et al.[5], positively contributes to their performance.

According to Fent et al.[9], the most effective method for teaching ECG interpretation cannot be determined. Apparently, the association of multiple techniques is necessary.

In general, interactive prototypes were highly rated by medical students regarding the fact they were easy to use, their usefulness, attitude toward use, and intention to use. This last variable of the technology acceptance model (TAM), according to Fathema et al.[18], indicates the intention to use the system in the future and will determine the actual use of the system.

However, the gamification elements and aesthetics did not attain satisfactory approval ratings. Possibly, the gamification elements that include reward strategies and an informal environment were not as evident in the ECG Tutor prototypes, as advocated by some authors[15].

Despite the possibility of interacting with an innovative technology for the teaching of ECG interpretation, few students participated in the study. Among the study limitations, the small sample size stands out, which can be justified by the difficulty of access through mobile devices and functionalities, rudimentary elements of gamification and aesthetics, and the short time interval of research application. However, as previously mentioned, Roobaea & Pam[24] suggest that a sample of five individuals would be enough to identify more than 80% of usability problems and that, with 15 participants, it would

be enough to identify, on average, more than 97% of usability problems of an application.

CONCLUSIONS

The results found in this study indicate that, despite the dissatisfaction with aspects related to design and gamification, a new tool for teaching ECG based on the structure of a gamified ITS would be used by medical students as an aid in the teaching-learning process, if it were available. Sequential changes and evaluations will be helpful in refining and completing the final computational solution. Hence, the study team intends to improve the prototypes of the ECG Tutor, transforming it into a product that can be fully functional, including an adapted version in the form of an application for mobile devices. Finally, we plan to test the impact of the program final solution on medical students' learning, as well as to evaluate in which contexts of use a gamified ITS could be more effective for ECG teaching.

New studies are required to evaluate students' acceptance, the existence of improvement in ECG learning after using the program, to propose other gamified strategies aimed at increasing student engagement and to compare the gamified ITS with other approaches based on e-learning for electrocardiogram teaching. It is expected that this academic study can contribute to future research and culminate in the development of new tools for ECG teaching.

AUTHORS' CONTRIBUTION

Larissa Acioli Pereira: wrote the final paper that constituted her Master's Degree dissertation, which provided the basis for the article. She supported the research planning, the creation of the screen prototypes, data collection and analysis, as well as the writing of the article. Lisley Lylás dos Santos Leão: assisted in the preparation of the material that originated the article (first author's Master's Degree dissertation and Undergraduate Research) and in writing the article. Diego Dermeval: He was the Advisor of the first author's Master's Degree dissertation, which provided the basis for the article. He participated as a supervisor in all stages of development of the study. He guided and revised the writing of the manuscript. Jorge Artur Peçanha de Miranda Coelho: He was the co-advisor of the first author's Master's Degree dissertation, which provided the basis for the article. He participated in the data analysis.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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