

Scientific and pedagogical evaluation of question items for an Endodontics Quiz Game

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Abstract— Introduction: Currently, the scientific and technological development has modified several areas of knowledge, including the health sciences. One such technology are the Serious Games, which are educational games that focus on specific and intentional learning to achieve effective, measurable, and continuous changes in performance and behavior. Ideally, students should receive enough training during dental school to have the skills necessary to make a correct diagnosis, and perform an effective and safe treatment. The authors believe that serious games can be applied in Endodontics, more specifically in emergency care. This study had the objective of developing and validating scientific (Endodontics) and pedagogically a quiz-type serious game within the theme "Endodontic Emergencies". **Materials and Methods:** The items on "Endodontic Emergencies" were validated by three endodontists (scientific validation) and performed with the support of the Pedagogical Center of the Open University of the Unified Health System (pedagogical validation). **Results:** Sixty evaluative items on the theme were elaborated and validated based on textbooks and scientific publications in Endodontics. The game has several motivational tools and strategies. The game also has moving characters so it is visually dynamic. **Conclusion:** The game was developed within the theme "Endodontic Emergencies" and its questions were validated for content (scientific validation) and pedagogically. The game is freely available as an application for the iOS system. From this initiative, the serious games learning approach is expected to be applied in a larger scale, since its spreading potential and social impact have been emphasized.

Keywords— Dental education; Endodontics; Diagnosis.

I. INTRODUCTION

Scientific and technological development has modified several areas of knowledge, including health sciences. Digital information and communication technologies (DICTs) have been increasingly connected to health care, with wide acceptance and incorporation by the public, health professionals, and educational institutions¹. DICTs' inclusion in teaching has become essential for students' critical thinking evolution².

One of these technologies is Serious Games. Its main feature is to support the player to achieve learning goals through a fun experience³. The fun aspect is to encompass graphics, interaction devices, collaboration mechanisms and usability, while the learning aspect uses the pedagogical approach through educational content⁴. Games using multiple-choice questions can be used so that players can improve their knowledge about a particular

topic, since to overcome it you must respond correctly and continuously each one of them⁵.

For question items' elaboration, we can use the Bloom's Taxonomy in order to align the educational goals with the students' cognitive domain⁶. It was revised in 2001 and the objectives are encompassed in six categories: meet, understand, apply, analyze, synthesize and evaluate⁷.

In oral health, the dental surgeon deals with emergency situations for pain relief, since 90% of orofacial pain's cases are related to pulpal and/or periapical causes⁸. Knowing that emergencies are a reality in the daily life of clinical service, the dental surgeon should be able to perform them, however, students refer to Endodontics as the greatest difficulty area to perform the procedures and they feel a high level of anxiety when they're about to do it⁹.

It is expected that the undergraduate program has the ability to provide to professionals in training the necessary skills to perform a correct diagnosis, implementing a treatment plan and a qualified and safe treatment. Competency-based programs can replace the traditional dental education methodology, and the aim of this modality is described as understanding skills and professional values required of a student that are essential for beginning the unsupervised practice of dentistry¹⁰.

However, we know that this is not always the reality, and knowledge democratization by means of technological resources is a powerful tool to update and inform professionals, and this is where the serious games fit. The use of games in contexts that do not normally involve game playing is called 'gamification', a methodology that employs playful and competitive elements in real life situations^{11,12}.

A review by Azevedo et al.¹³ showed that most serious games in the Dentistry field are aimed at patient distraction and anxiety reduction methods or related to clinical simulations. Studies about the effectiveness of games for diagnosis and establishment of appropriate procedures, especially in Endodontics, are not known.

We believe that serious games can be applied in Endodontics, more specifically in emergency care. This way, the objective of this study is to suggest a methodology for scientific and pedagogical validation of questions to be used in quiz-type serious games such as "Endodontic Emergencies".

II. MATERIALS AND METHODS

2.1 The Game

This is an educational and interactive game, using a 2D interface, enabling an environment of learning about "Endodontic Emergencies". The game was developed in partnership between the Open University of the Unified Health System – UNA-SUS/UFMA (Brazil), the school of Dentistry of the University of São Paulo (Brazil) and the Federal University of Maranhão (Brazil).

The game was idealized to dentistry students (as the issues encompass the Endodontics area). The game features different motivation tools and strategies such as: tutorial, punctuation, response time, opportunity to get tips and ranking, content of texts, images and sound, with characters in motion, so that it stays dynamic. The Figure 1 shows the game in 04 scenes that were developed to characterize it.



Fig.1: Scenes from the game quiz development flow.

Figure A shows the entry that is the showcase of the game and the player can access it, showing the credits and exit; Figure B, displays character selection; Figure C, presents the scene of the gameplay that is where the interaction occurs with the focus of the game; and Figure D reveals the completion scene that shows the final ranking.

2.2 Didactic-pedagogical project elaboration.

The game quiz is a serious game because it is based on the pedagogical principles focused on the construction of skills and abilities. Several technical-scientific and pedagogical aspects are taken into account and therefore need a prior planning that encompasses the several areas of knowledge previously described.

It was necessary the development of a Pedagogical Workshop test question construction that would compose the database of the game. This workshop was held in partnership with UNA-SUS/UFMA in the months of March and June of 2016, so that the issues were pedagogically grounded, resulting in adequate educational resources.

The questions were elaborated following recommendations for elaboration of multiple choice questions¹⁴.

Due to the importance of didactic-pedagogical planning, it was necessary to define a main thematic area, quantity of questions, its educational objectives, contents to be worked, target audience, partner institutions, besides other components of the items of evaluation such as the statement, alternatives, feedback for each alternative (correct or not), the tip to help the player and bibliographic reference link.

2.2.1 Definition of questions number on the theme "Endodontic Emergencies".

Sixty test questions were elaborated through bibliographical research in books and scientific articles of Endodontics. They were "multiple choice" type and contained one statement, five alternatives (one correct), each with its feedback or justification. In addition, the question has a "tip" that can be requested by the participant during the game, and the bibliographic reference used to construct the question. There is also the possibility of providing links on the topic involved in the statement. If the player makes a mistake, the game will not end, it will go on. They will score points for each question, and may have a final score of 100 points.

2.2.2 Educational objectives and definition of difficulty levels of questions

Educational objectives for the serious game in "Endodontic Emergency" construction were designed to contribute in an interactive and playful way in dental practice, so that users can understand and rethink their work processes with focus on emergency care.

During the construction of the test questions, we used cognitive domains inserted in the Bloom Taxonomy⁷. The issues considered at the "Easy" level are those that are within the cognitive domain "Know" and involve memorization of specific facts, patterns of procedure and concepts. The "Medium" level questions are those in the "Understanding" domain and involve meanings, translation and interpretation of problems and instructions. Finally, the "Difficult" questions are those of the "Analyze" domain and are more complex because they deal with analysis of contexts, elements, relationships and principles of organization. Twenty questions were elaborated for each level of difficulty, with the level of

"Easy" with a time of 45 seconds for answer, the "Medium" level with 1 minute for answer and the "Difficult" level with 1 min and 15 seconds for answer.

2.2.3 Content covered

The main theme is "Endodontic Emergencies", but five important sub-themes were chosen for this approach. Subjects related to routine dental care were selected, but focused on issues that deal with the emergency procedure, that is, problems that any dentist should be prepared to solve. The chosen subtopics were: Endodontic Diagnosis, Radiology applied to Endodontics, Anesthesia and Pharmacology, Characteristics of Materials, Anatomy and Technical Procedures.

2.3 Evaluative test questions and scientific and pedagogical validations

2.3.1 Scientific Evaluation

The test questions evaluation on "Endodontic Emergencies" was done by three (03) reference professionals in Endodontics with expertise and credentials to perform this task (three professors in Endodontics, from three different institutions of higher education with Dentistry courses). The questions were evaluated according to their content in the chosen theme. The number of evaluators was based on previous work found in the literature^{15,16}.

For the accomplishment of scientific evaluation, the professionals received the questions and added comments and suggestions. The data obtained were distributed in a table adapted to each question¹⁶ and the items were evaluated according to textual clarity, practical relevance and suitability to the public. Each category was assessed and thereafter considered adequate, partially adequate or inadequate. In addition, there was the possibility of adding comments and suggestions to change or even discard the issue after the returns.

2.3.2 Pedagogical Evaluation

The pedagogical evaluation was carried out by experts of the Pedagogical Nucleus of the Open University of the Unified Health System of the Federal University of Maranhão. These experts received the elaborated evaluation test questions and suggested changes. The data obtained were also distributed in a table adapted to better visualize the results¹⁶, and it evaluated the categories: number of characters, cognitive domain and textual clarity.

2.4 Database

After pedagogical and scientific evaluation, the test questions were registered in an online platform form called SigU Activities. This platform is a questioning aid subsystem that allows the insertion of questions, answers and feedbacks and represents the optimization of a learning object to assist in continuing education in health¹⁷.

III. RESULTS

3.1 Scientific Evaluation

After questions analysis and evaluation for such stage, the data were distributed in a table adapted for better visualization of the results ¹⁶. Table 1 shows the results of each evaluator.

Table 1 - Data obtained by the evaluators in scientific validation

	Evaluator 1			Evaluator 2			Evaluator 3		
	Textual Clarity	Practical Relevance	Public Adequacy	Textual Clarity	Practical Relevance	Public Adequacy	Textual Clarity	Practical Relevance	Public Adequacy
Adequate	58,3%	100%	100%	56,6%	100%	100%	80%	98,3%	96,6%
Partially adequate	36,6%	0	0	38,3%	0	0	20%	1,7%	3,4%
Inadequate	5%	0	0	5%	0	0	0	0	0

The results maintained a consistency between the first two experts. All test questions were considered appropriate with respect to the practical relevance and adequacy to the public for them, but the third expert encountered some issues with interpretation difficulties related to these two items. Thus, the initial definition on the subject addressed in each evaluation was improved, along with adjustments in the writing of the utterance, according to the evaluator's suggestions.

The most important finding was with regard to textual clarity. For the first expert, 58.3% of the questions were considered adequate, for the second, 56.6% and for the third, 80% in the same category. For the first expert, 36.6% of the questions were considered partially adequate,

38.3% for the second and 20% for the third. The first two experts considered 5% of the questions inadequate.

The issues considered inadequate had to be completely modified, as they presented some kind of ambiguity in their content. The partially adequate ones obtained suggestions of improvements in the writing to facilitate the understanding of the player and the adequate ones did not need any changes.

3.2 Pedagogical Evaluation

The Pedagogical Nucleus of UNA-SUS/UFMA validated the questions regarding didactic-pedagogical aspects and this evaluation was carried out in pairs. The data were compiled in a table adapted to better visualize the results ¹⁶. Table 2 shows the results obtained.

Table 2 - Data obtained by pedagogical validation

	Number of characters	Cognitive Domain	Textual Clarity
Adequate	51,6%	66,6%	11,6%
Partially adequate	13,3%	1,6%	85%
Inadequate	35%	31,6%	3,3%

The questions considered partially adequate (13.3%) were within the limits required by the SigU Activities platform, some alternatives were in disarray in size, it was considered a heuristic in game. Therefore, the questions should be modified. The test questions considered to be inadequate had the number of characters outside the SigU Platform boundaries and limits and should be modified.

Only one question (1.6%) was considered partially adequate, meaning that the level of difficulty it was correct, but the type of domain covered was not, so the question was modified.

The test questions considered inadequate (31.6%) had to be reinterpreted in the level of difficulty. That is, initially 20 questions were obtained for each level of difficulty and after the pedagogical validation there were

22 questions of the "Easy" level, 24 of the "Medium" level and 14 of the "Difficult".

The test questions considered inadequate (3.3%) were elaborated using negative expressions such as NO or EXCEPT (distractors), and this fact should be avoided, since it impairs the player's understanding and resolution. Thus, the issues needed to be completely changed, from the statement to the alternatives.

IV. DISCUSSION

The test questions for the quiz game "Endodontic Emergencies" were evaluated by pedagogical and endodontics experts, thus suggesting this methodology as a model for new serious games. Bloom's Taxonomy purposes have been successfully followed overtime in a variety of curricula, disciplines, and contexts, including the

field of health science education. Recent studies in the health field have been published involving the construction of question items (multiple choice) based on Bloom's Taxonomy^{18,19,20,21}.

The teaching performance should understand the levels found in the Taxonomy of Bloom, which in Dentistry are practically encompassed only those related to the cognitive domains²², among them "to know", "to understand" and "to analyze" that were used in this work.

Based on the selected theme, it is possible to note the practical relevance, since pain of dental origin interferes in the quality of life of the patients, since it causes social and professional damages such as sleep disturbances, physical and emotional fatigue, loss of social contact, food, limitation of daily activities, and absenteeism at work²³.

Learning motivation is an important element in students education. The use of technology is facilitated by the upcoming of the digital era, and the easy access to various resources and media²⁴. In addition, quiz-type educational games can be based on previous knowledge²⁵ and the game presented herein provides feedbacks in each response with additional information for the player, enriching the learning experience.

The search for knowledge is a widespread reality today. For the new generations, the access to technologies is part of everyday life, and this way, the motivation for using technology in education can increase meaningful learning. Consequently, game playing using this resource while, above all, enriching the learning experience can be stimulating, especially to students used to traditional methods of teaching, which often lack major innovations^{26,27}. A great advantage of learning through games is the reinforcement of intrinsic motivation and engagement, which can generate opportunities for further knowledge seeking^{28,29}.

The construction of educational strategies based on serious games is feasible, as long as it has the support of professionals from the areas of knowledge needed to reach the competencies and abilities defined for the theme. The pedagogical support of experts who validate the knowledge involved and the adequacy of the content guarantees the appropriateness of serious game learning strategies.

With the game "Endodontic Emergencies", we expect that the users can test their knowledge, and thus be induced to seek further learning that is one of the main objectives of continuing education. This component is promoted by the instigation resulting from the game playing, besides the access to links and bibliographical references that can provide support for the search of knowledge.

The use of serious games has a fertile ground in formal education, as students are already inserted in a social context surrounded by media and technologies. The strategy can provide new and different ways of teaching and learning than the passive traditional methods³⁰.

As a limitation, the level of difficulty of the game questions was a subjective definition, since it depended on each player involved. In addition, the work of Diab and Sartawi³¹ has shown that there is an expressive use in the academic environment of Bloom's Taxonomy for questioning, but suggests that there is an ambiguity behind this classification and a need for more accurate verbs that aid in mental acuity.

In this perspective, the UNA-SUS / UFMA has planned a more objective evaluation through the game's analytics that will identify, for example, which questions were more often answered correctly overtime, and thus be adjusted as "easy", accordingly. Similar analysis could be done to classify the "intermediate" and "difficult" items.

The use of serious games has grown and it is necessary that this approach is increasingly exploited, since we are inserted in a society in which scientific and technological advances go hand in hand. More research is needed to carry out a more complete assessment of the acceptance and verification that the use of serious games increases the effectiveness of learning training.

V. CONCLUSION

The test questions for the quiz game "Endodontic Emergencies" were evaluated by experts, thus suggesting this methodology as a model for future quiz games. The game was made available in the form of application to the Android system. This way, the user has easy access and is free to play. From this initiative, the serious games learning approach is expected to be applied in a larger scale, since its spreading potential and social impact have been emphasized.

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DISCLOSURE STATEMENT

No competing financial interests exist

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