

MEDSAFE: PROTOTYPE OF A VIRTUAL GAME ON THE PREPARATION AND ADMINISTRATION OF MEDICATIONS

MEDSAFE: PROTÓTIPO DE UM JOGO VIRTUAL SOBRE PREPARO E ADMINISTRAÇÃO DE MEDICAMENTOS

MEDSAFE: PROTOTIPO DE UN JUEGO VIRTUAL SOBRE PREPARACIÓN Y ADMINISTRACIÓN DE DROGAS

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ABSTRACT

Objective: to build and validate a virtual learning object configured as a digital simulation game about the medication administration process. **Method:** a methodological study that presents the process of construction and validation of an educational game. After the construction of the prototype, questionnaires were applied to validate quality content and usability. Seven lecturers participated in the research as judges and five Nursing students as representatives of the target audience. Data were analyzed based on the content validity index and on the level of agreement between the items of the created scales. **Results:** after the creation stages of the game entitled MedSafe, lecturers were invited as judges for content validation, obtaining an index of 0.78. The quality assessment was performed by the target audience and proved a satisfactory mean value. In the usability evaluation, in which lecturers and students participated, a low level of agreement was reached, reinforcing the need for improvements in the game system. **Conclusions:** the prototype of the MedSafe game demonstrated its potential to be used in the teaching of the medication administration process and, from the results of this prototyping stage, modifications will be made and will allow for the improvement of the game that will be applied in future research studies.

Keywords: Education, Nursing; Simulation Training; Patient Safety.

RESUMO

Objetivo: construir e validar um objeto virtual de aprendizagem configurado como um jogo digital de simulação, sobre o processo de administração de medicamentos. **Método:** estudo metodológico que apresenta o processo de construção e validação de um jogo educacional. Após a construção do protótipo, foram aplicados questionários para a validação de conteúdo da qualidade e de usabilidade. Participaram da pesquisa sete professores como juizes e cinco alunos do curso de Enfermagem como representantes do público-alvo. Os dados foram analisados a partir do índice de validade de conteúdo e do nível de concordância entre os itens das escalas criadas. **Resultados:** após as etapas de criação do jogo intitulado MedSafe, professores foram convidados como juizes para a validação de conteúdo, obtendo-se índice de 0,78. A avaliação de qualidade foi realizada pelo público-alvo revelou média satisfatória. Na avaliação de usabilidade, na qual participaram professores e alunos, atingiu-se nível de concordância baixo, reforçando a necessidade de melhorias no sistema do jogo. **Conclusões:** o protótipo do jogo MedSafe demonstrou potencial para ser utilizado no ensino do processo de administração de medicamentos e, a partir dos resultados dessa etapa de prototipagem, as modificações serão realizadas e darão subsídios para o aperfeiçoamento do jogo que será aplicado em pesquisas futuras.

Palavras-chave: Educação em Enfermagem; Treinamento por Simulação; Segurança do Paciente.

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RESUMEN

Objetivo: construir y validar un objeto virtual de aprendizaje configurado como juego digital de simulación sobre el proceso de administración de medicamentos. **Método:** estudio metodológico que presenta el proceso de construcción y validación de un juego educativo. Después de la construcción del prototipo, se aplicaron cuestionarios para validar el contenido de la calidad y la usabilidad. Siete docentes participaron en la investigación como jueces y cinco estudiantes de enfermería como representantes del público objeto. Los datos se analizaron en función del índice de validez de contenido y el nivel de acuerdo entre los elementos de las escalas creadas. **Resultados:** después de las etapas de creación del juego titulado MedSafe, los profesores fueron invitados como jueces para la validación de contenido, obteniendo un índice de 0,78. La evaluación de calidad realizada por el público objeto reveló un promedio satisfactorio. En la evaluación de usabilidad, en la que participaron profesores y estudiantes, se alcanzó un bajo nivel de acuerdo, lo que refuerza la necesidad de mejoras en el sistema de juego. **Conclusiones:** el prototipo del juego MedSafe mostró potencial para ser utilizado en la enseñanza del proceso de administración de drogas y, a partir de los resultados de esta etapa de creación de prototipos, se realizarán las modificaciones y se otorgarán subsidios para perfeccionar el juego que se aplicará en futuras investigaciones.

Palabras clave: Educación en Enfermería; Entrenamiento Simulado; Seguridad del Paciente.

INTRODUCTION

Constant advances in technology directly influence both the education sciences and the health sciences, requiring the training of qualified and flexible professionals to act in the various modern practice scenarios. Among these advances are the innovations of information and communication technologies, which accelerate the dissemination of information in a globalized and instantaneous way, making it easy to access the most varied contents that provide learning.

In this way, postmodern society requires, therefore, new practices in the teaching and learning process, aiming at the development of knowledge and competences, from the conscious use of new didactic and technological resources, for the formation of critical and opinion maker professionals.¹

This raises the question regarding which strategies can be used to train qualified health professionals with preserved moral and ethical values and high critical-reflexive thinking skills to provide safe and quality care. The Nursing team must be trained to be able to follow such changes, using the teaching methodologies provided by informatics that allow the apprehension of contents and more participatory learning.²

The strategies for associating technology with health education include virtual learning objects (VLOs), defined as learning units composed of images, sounds, animations, documents and hypertext, which can be hosted in the Internet.

In this context, digital games are evident, as they allow for the use of the principles of simulation.³

Simulation is one of the most widely used active teaching methodologies in health courses today.⁴ It has been developed to facilitate the clinical learning process and has been increasingly applied in undergraduate Nursing course.⁵

Given the relevance of Nursing professional training for patient safety, it is essential to highlight the impact of errors related to medication use, which constitute a serious problem in health services, considered one of the main adverse events suffered by hospitalized patients.⁶

The medication administration process involves several professional categories until its realization. However, the preparation and administration phases, directly related to the patient, are mostly the responsibility of the Nursing team, which makes them vulnerable to errors. This fact reveals the need to improve the training of Nursing professionals, aiming at safe care.

Thus, the study aimed to develop a virtual learning object, configured as a virtual simulation game of the medication administration process. This study is the first result of an "umbrella" project funded by MCTI/CNPq universal public notice Nº 01/2016 entitled "Building a virtual simulation technology based on the web for teaching semiology and semio-techniques in adults".

METHODOLOGY

This is a methodological research, carried out in two stages. In the first, the development of the VLO was performed and the second refers to the process of evaluation and validation of the virtual object.

The development stage was based on the methodology of construction of digital games proposed by Heather Maxwell Chandler,⁷ with four phases: pre-production, production, testing and post-production.

Pre-production is the first phase of the production cycle and its main objective is game planning. At this stage, a literature review was performed to define the educational design, case construction and elaboration of the screens. Information was also included about the concept of the game, the resources required, as well as the cost of the project, the time required to complete and define the work team.

After the construction of the case and definition of the contents of the VLO, the sketches of the screens that would serve as the basis for the production phase were elaborated. In this stage, the environments, the characters and the sequence of activities that would form the simulation were idealized.

Once the sketching of the screens was over, and in possession of the sequence of the activities that form the game, the production phase of the game itself was started. The process

of designing the proposed game took place with the help of a team of computer experts from October 2016 to March 2017.

For the validation process, the second phase, the recommendations for digital teaching tools were followed, which include the validation of content, quality and usability of the VLO.⁸

In this stage expert Nursing lecturers were included in the sample as judges with a master's degree as minimum and teaching experience in the Semiology, Semio-technique and Nursing Care Process discipline; and, as evaluators representing the target audience, students that are tutors of the discipline, both selected for convenience. Participants who had insufficient Internet access to run the virtual game were excluded from the sample.

The participants were invited by e-mail. Eight lecturers were invited and seven agreed to participate in the study. As for the students, 14 tutors were invited and five agreed to participate in the research. All the participants signed a Free and Informed Consent Form. The 12 members of the final sample (seven lecturers and five tutors) answered all the study phases, with no sample losses during the data collection period. The validation process took place from March to May 2017.

For the content validation of the VLO, collected with the lecturers, the content validity index (CVI) was used. The index was calculated by summing the agreement of the items marked "4" (partially agree) and "5" (totally agree) by the lecturers, divided by the total number of answers. The minimum value considered for validity was 0.78.⁹

For quality assessment, performed by the target population (tutors), the Savi *et al.*⁸, referential was used, which proposes to evaluate motivation, user experience and learning.

For the analysis of the usability evaluation data, performed with lecturers and tutors, the points with at least 80% of answers between partially agree and totally agree were considered valid.

Data were entered and tabulated in the Excel for Windows 2016®. For analysis, descriptive statistics was used and from the results of each item evaluated it was possible to identify strengths and improvement opportunities for the game.

The precepts of Resolution 466/2012 of the National Health Council (*Conselho Nacional de Saúde*) were followed,¹⁰ related to the execution of research involving human beings, being approved by the Research Ethics Committee of the *Universidade Estadual do Ceará* under opinion N° 1,761,166/2016.

RESULTS

DEVELOPMENT OF THE MEDSAFE GAME

The prototype was named MedSafe in reference to medication (Med) and Safety (Safe), to provide the student with the idea of safe medication and remind him that every health process should involve patient and professional safety.

MedSafe is a simulation-based game in which the player must perform actions in the role of nurse. The actions have a pre-set sequence that the player must follow to advance to the next stages of the game.

In pre-production, the first phase of the production cycle, three patient safety protocols, proposed by the National Health Surveillance Agency (*Agência Nacional de Vigilância Sanitária*, ANVISA), were used as the basis for the development of the game:¹¹⁻¹³ patient identification, safe prescribing, use and administration of medication, and hand hygiene.

A hypothetical case associated with a drug prescription was established, which the player should follow. From the selected protocols, the objectives to be achieved in the simulation were defined: a) correctly identifying the patient before preparing the medication and before performing any procedure; b) selecting the material needed to perform a peripheral venipuncture; c) selecting the material for preparation and administration of the medication; d) performing the correct sequence of hand hygiene with soap and water and 70% alcohol; e) preparing the prescribed medicine; f) performing peripheral venipuncture and administering medication; g) making the correct disposal of the waste produced.

Still in pre-production, an on-line tool for the elaboration of the environments and characters was used to assist in the screen sketching stage. It is the Pixton® tool for creating comic books, available for free in which various images from different contexts are available for storytelling. Therefore, images referring to the hospital setting were selected.

After the conclusion of the sketching of the screens and in possession of the sequence of activities that would form the game, the game's production phase began, the stage in which the game is effectively developed.¹⁴ In it the source code, graphic design, animations, among others, were created.

The computer technical team was responsible for the graphic design, programming and animation of the entire game prototype. The graphic design was based on screen sketches and public domain images available on the Internet and developed based on the Inkspace® (open source vector graphics editor) and Gimp® (free distribution program for tasks such as photo retouching, image composition and image creation) tools.

After the final approval of the images, the process of animation and programming of screens and activities began, using the game engine called GDevelop®. Images of the final design can be seen in Figures 1 and 2.

The testing phase to verify VLO compatibility and playability was performed by the computer technical professional and the study authors on the major web browsers currently used: Google Chrome®, Mozilla Firefox® and Internet Explorer®. The tests were satisfactory and showed that it was possible to access the link, load the game page, start the simulation and perform

all the proposed activities until the conclusion of the simulation, obtaining the final score without interruptions.

After the tests, in the post-production phase, the prototype of the MedSafe game was submitted for review by the judges and the target audience.

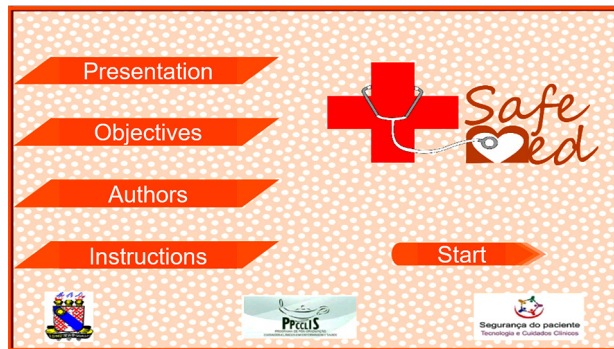


Figure 1 - MedSafe prototype home screen – Fortaleza-CE, Brazil, 2017.



Figure 2 - MedSafe prototype Nursing station design – Fortaleza-CE, Brazil, 2017.

VALIDATION AND EVALUATION OF THE VIRTUAL LEARNING OBJECT

The game was submitted for evaluation through questionnaires that attested to the content validity, quality evaluation, usability and suggestions for improvement for the next versions.

In the content validation stage, lecturers from the Semiology, Semio-technique and Care Process discipline participated. Of the seven lecturers in the sample, only one was male, five were masters and two doctors; four of them reported teaching or have previously taught in specialization courses. One participant had teaching experience in the technical degree and one professor reported that he also taught in masters and doctorate courses.

A questionnaire was sent to the academic judges (A1-A7) composed of 17 items distributed in three criteria: content evaluation; organization and presentation of content; and learning assessment. According to Table 1, nine of the 17 items were considered positive in VLO (CVI > 0.78).

It was emphasized that the items related to the objectives and content of the game obtained maximum agreement among the evaluators. In addition to these items, another two obtained unanimous agreement. These items refer to the content worked in the game, which was considered updated and consistent with the intended audience.

Table 1- Calculation of the CVI from the answers of the content evaluation questionnaire. Fortaleza-CE, Brazil, 2017

Assertive	A1	A2	A3	A4	A5	A6	A7	CVI*
1. The objectives of the VLO are clearly defined	4	4	4	5	5	4	4	1
2. The VLO is consistent with the objectives it proposes	5	4	4	5	5	5	5	1
3. The content is updated	5	5	4	5	4	5	4	1
4. The content is consistent with the target audience	5	4	4	5	5	5	5	1
5. The information is clear and concise	3	3	2	4	4	4	4	0.57
6. The information is sufficient for the users	4	1	2	4	4	4	4	0.71
7. The content has a logical organization	4	3	4	4	5	5	4	0.86
8. The virtual learning object simulates reality well	5	3	3	5	5	5	5	0.71
9. Easy to read texts	4	2	4	4	5	1	4	0.71
10. The interaction during the simulations of clinical cases is satisfactory	3	2	3	5	4	2	4	0.43
11. The presentation of the content draws the attention of the users	5	3	3	5	5	4	5	0.71
12. The presentation of images is relevant for the information included in the text	5	4	4	5	5	5	2	0.86
13. The presentation of sounds is relevant for the information contained in the virtual system/object	3	5	3	5	4	2	3	0.43
14. Correct use of grammar	5	2	4	5	4	5	4	0.86
15. The virtual system/object stimulates learning	5	3	4	4	5	5	5	0.86
16. The virtual system/object allows for learning based on the previous experience of the user	5	3	3	4	4	4	4	0.71
17. The virtual learning system/object facilitates the retention of content in the memory of the student	5	4	3	5	5	5	5	0.86
Total score of the questionnaire	0.76	0.41	0.53	1	1	0.82	0.88	0.78

It is noteworthy that eight items received scores below 0.78. All the suggestions regarding the clarity of the information were adjusted; however, as the material sent to the judges was still in the prototype phase, some evaluations regarding sound presentation and user interaction were low.

Regarding the individual final score, attributed to each evaluator, it is observed that five of the seven judges considered the content appropriate, which generated a total score of 0.78. This final score, according to the adopted reference,⁹ is sufficient to validate the content of this first version of the VLO, indicating that it is adequate and coherent.

For the evaluation by the target audience, performed with tutors of the discipline, the game quality evaluation model proposed by Savi *et al.* was used,⁸ which defines that the components that must be evaluated in a game are: motivation, user experience and learning.

The instrument proposed in the model has 43 statements, which should be evaluated on a Likert agreement scale. For the evaluation of this prototype, five assertions that were unrelated to the current version of the game were excluded, as they related to the interaction (which is not present in this prototype). Therefore, an instrument with 38 statements was applied (Table 2).

Table 2- Responses to the Likert scale for VLO quality assessment by tutors. *Fortaleza-CE, Brazil, 2017*

	Assertive	MEAN	MIN	MAX	SD
Motivation	1. There was something interesting at the beginning of the game that drew my attention	4.8	4	5	0.45
	2. The design of the game interface is appealing	4.4	4	5	0.55
	3. It was clear to me how the content of the game is related to what I already knew	5	5	5	0
	4. I enjoyed the game so much that I would like to learn more about the subject it addressed	4.8	4	5	0.45
	5. The content of the game is relevant to my interests	5	5	5	0
	6. I could relate the content of the game to what I already saw, did or thought	4.8	4	5	0.45
	7. The content of the game will be useful to me	5	5	5	0
	*8. The game was harder to understand than I would like	2.8	1	5	1.64
	*9. The game had so much information that it was difficult to identify or remember the important points	4	2	5	1.22
	*10. The content of the game is so abstract that it was hard to keep attention on it	4.8	4	5	0.45
	*11. The activities of the game were too difficult	4.2	3	5	0.84
	*12. I could not understand a good portion of the game material	4.2	2	5	1.30
	13. Completing the game exercises gave me the feeling of accomplishment	4.8	4	5	0.45
	14. I learned some surprising or unexpected things from the game	4.2	4	5	0.45
	15. The feedback texts after the exercises or other game comments helped me feel rewarded for my effort	3.8	1	5	1.64
	16. I felt good when completing the game	4.6	3	5	0.89
User's experience	17. I didn't notice time passing while playing	3.2	2	4	0.84
	18. I lost consciousness of what was around me while playing	2.8	2	4	0.84
	19. I felt more in the game environment than in the real world	3.2	1	5	1.64
	20. I did my best to get good results in the game	5	5	5	0
	*21. There were moments when I would have liked to give up on the game	2.8	1	5	1.64
	22. I was stimulated to learn from the game	5	5	5	0
	23. I enjoyed the game and didn't feel anxious or bored	4.2	2	5	1.30
	24. The game kept me motivated to go on playing	4.2	3	5	0.84
	25. My skills gradually improved as I overcame challenges	4.4	3	5	0.89
	26. The game offers new challenges at an appropriate pace	4.4	3	5	0.89
	27. This game is an adequate challenge for me: the tasks are neither too easy nor too difficult	4.4	4	5	0.55
	28. I felt successful	4.6	4	5	0.55
	29. I conquered the game's objectives quickly	2.8	1	4	1.30
	30. I felt competent	4.2	4	5	0.45
	31. I like playing this game for quite a long time	3.8	2	5	1.10
	32. I would like to play this game again	4.6	4	5	0.55

Continue...

... continued

Table 2- Responses to the Likert scale for VLO quality assessment by tutors. *Fortaleza-CE, Brazil, 2017*

	Assertive	MEAN	MIN	MAX	SD
	*33. Some things in the game irritated me	2.2	1	4	1.10
	*34. I was hoping the game would be over soon	4	3	5	1
	*35. I found the game a little slow	4.2	3	5	0.84
Knowledge	36. After the game I can remember more information related to the subject matter it presents	4.8	4	5	0.45
	37. After the game I can better understand the subject matters it presents	4.6	4	5	0.55
	38. After the game I feel I can better apply the subject matters related to it	4.8	4	5	0.45

The results of the quality assessment by the tutors revealed that most of the assertions obtained a satisfactory mean value in the students' evaluation, indicating that, in relation to the points evaluated, the constructed VLO can be used by the Nursing students as an educational tool.

The items with the most positive highlight, which presented a maximum mean value, can be identified in Table 2, as the items with a mean value of 5. This result indicates that the students felt that the game content is relevant and is related to the previous knowledge already learned, and also that the content covered is useful. Regarding immersion, all students were motivated to achieve the proposed objectives and stated that the game encouraged learning.

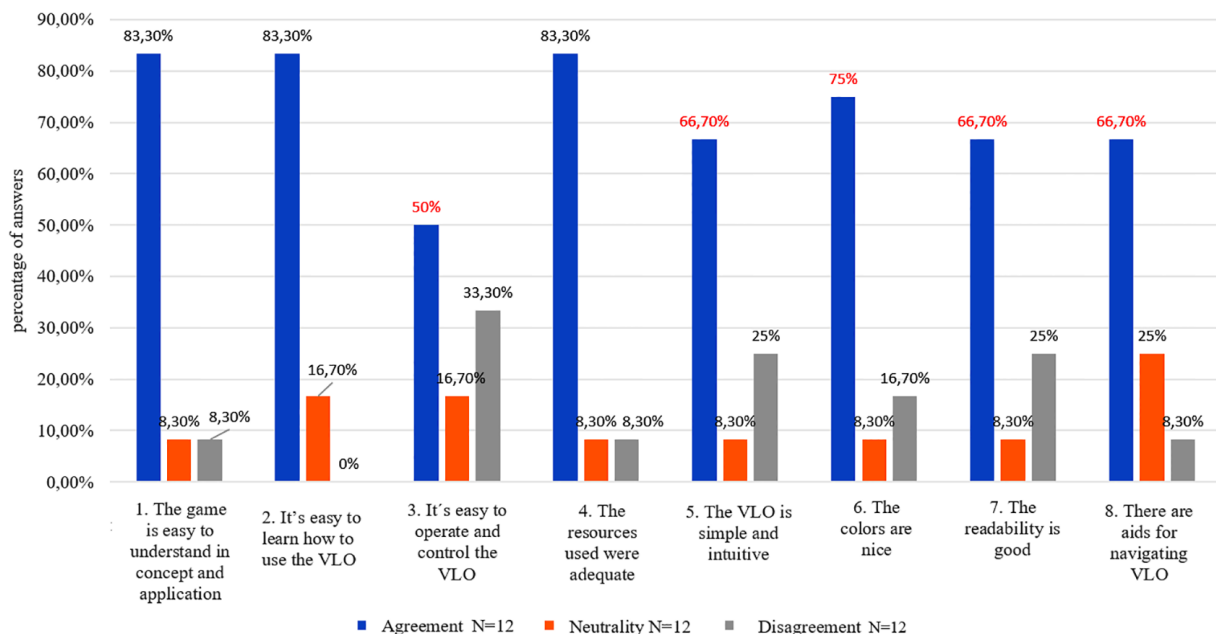
It is noteworthy that the three items of the knowledge domain were positively evaluated by the participants, demonstrating that they considered that the MedSafe game promotes retention of the contents addressed in the memory

and better understanding of the themes, enabling application outside the simulated environment.

As for the items with a negative highlight, those that stated the difficulty in achieving the game's objectives and the absence of feedback texts after the exercises stood out.

In addition to the aspects proposed by Savi *et al.*⁸ for the evaluation of the game, eight items related to the usability evaluation at the end of the two applied instruments were also included. The evaluated items refer to understanding the concept of the game, ease of access, use and operation of the game, adequacy of features, simplicity, colors, readability and help systems.

The evaluation questions were sent to both tutors and lecturers, totaling 12 completed instruments. Of the eight usability assessment items, three were approved by more than 80% of the participants; the other items had a low level of agreement, reinforcing the need for system improvements to improve the usability of the built game (Figure 3).

Figure 3 - Usability evaluation by lecturers and tutors – *Fortaleza-CE, Brazil, 2017.*

Among the items with poor agreement, items five and seven stand out. Lecturers and tutors did not find the VLO simple and intuitive and indicated that the game readability needed to be improved. This finding indicates the need to reassess the graphic quality of the images and texts used, seeking to make the virtual object more enjoyable.

A field was also included for the participants to express their opinion about the game, mentioning strengths, weaknesses and suggestions for the improvement of future versions.

Lecturers and students considered the VLO to be an appropriate, well-designed and stimulating learning strategy. According to them, the game can assist students in understanding the complexity of the process of preparation and administration of medications in a simulated environment.

As a weakness of the game, the poor readability which hindered understanding was reported. The main suggestion given by the participants was the inclusion of help buttons and complementary materials, providing not only the knowledge test, but also the learning.

DISCUSSION

Regarding the production process of MedSafe, it can be seen that the creation of digital games for health education is a modern methodological strategy that can provide more interactive learning. The prototype of the game was planned and designed to serve as an auxiliary tool for learning about the intravenous drug administration process for students in the Semiology, Semio-technic and Care Process discipline of a Northeastern public university.

Researchers reveal data that reinforce the importance of using games, especially simulation games, in undergraduate Nursing course. When using these technologies, it is possible to enhance the future nurse's technical and relational training and to address issues such as fear of making mistakes during care and communication difficulties.¹⁵

The evaluation of the judges revealed that the MedSafe VLO stimulates learning and facilitates the retention of content in the students' memory; this can also be confirmed in other studies on the use of digital technologies in teaching.^{2,16}

The minimum score obtained by the evaluation of the judges is necessary for validation; however, because it is exactly above the minimum value, it indicates weaknesses that should be addressed in future studies so that, in the next evaluations, more satisfactory validation scores will be reached, as in studies developed by other authors.¹⁷ The validation results are believed to reflect the prototyping stage of the game. In future research studies, the prototype will be improved and clinical validation will be performed.

From the game validation stages, the positive evaluation of the items by the tutors is related to the retention of the contents

covered after the use of MedSafe, similar to other studies that assessed students' knowledge before and after the use of educational technologies. It was found that the participants' cognitive learning improved after contact with the technology. The authors believe that the teaching tools used in support of classroom and online activities impact on students' learning.¹⁸

It is also important to emphasize that the use of technologies should not deter the teacher's role as a content mediator. In the use of games, the teacher's feedback during and after the game is fundamental not to generate a sense of frustration in the students. It is not enough to just propose the activity with games, it is also necessary to verify if the students are reaching the proposed objectives and to provide some kind of answer.⁸

The comments and suggestions of the participants suggested that the aspects considered to be flawed by the professor and the target audience corroborate the data presented by the questionnaires, which converge the items with low CVI in the content evaluation and with little agreement in the quality and usability evaluation.

It is then necessary to work on these specific points, such as readability, image quality, the inclusion of feedback and help options, to broaden the characters and to bring the graphic design closer to reality. And to make the information clearer to users, making it easier to access and use the game, making it more intuitive and understanding that it should be an activity not only of apprehension or testing of knowledge, but also something stimulating and enjoyable, so that, in fact, the student can immerse himself in the virtual world and enjoy all the benefits that a simulated experience can provide.

CONCLUSIONS

It was found that MedSafe showed potential to be used as a complementary tool in teaching the medication administration process and to assist the student to reinforce the learning points addressed, promoting learning stimulation and more security in the application of knowledge in practice. Students and teachers considered the content addressed in the game relevant and consistent with the literature, enabling the use of a dynamic methodology in the classroom.

This fact revealed that the game can contribute to the promotion of patient safety, since the student will feel more prepared to provide assistance from training in a virtual environment, simulating situations common to the daily work of Nursing.

The validation of content with a minimum recommended value indicates that some modifications need to be made in the game. This can be complemented by the quality assessment of the tutors, the usability analysis and the participants' suggestions that recognize the need to make the game more realistic, with images and sounds that are true to reality.

The next versions of the VLO will be developed through future research studies aimed at improving the game and to approximate it to the reality of the work of Nursing professionals.

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