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Development and application of a mammographic teaching Software (RADIF): a didactic tool application

Desenvolvimento e aplicação de um software de ensino para mamografia (RADIF): aplicação de uma ferramenta didática

Desarrollo y aplicación de un software de enseñanza para mamografía (RADIF): aplicación de una herramienta didáctica

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Abstract
Introduction: The advances in medical technology play a significant role in the acquisition of knowledge and skills by healthcare professionals. Objective: The objective of this study was to apply and analyze the usability of the mammographic teaching software (RADIF) as a didactic tool for Radiologic Technology students. Materials and methods: This exploratory and descriptive study with a quantitative approach, was carried out in partnership with research groups from the Federal Institute of Education, Science, and Technology of Santa Catarina (IFSC) and the Federal Institute of Education, Science and Technology of Bahia (IFBA). The sample size was 31 Radiologic Technology students. Results: The sample obtained 85% of correct answers to all questions, the highest percentage of correct answers was in the modules on radiological breast anatomy, positioning techniques, and mammographic views. The highest error rate 61.2%, was related to the radiological aspects area. The sample showed a positive evaluation of more than 95% regarding the use of the software criteria. Conclusion: The results indicated a positive view regarding the use and applicability of the RADIF software for teaching and training in the radiological anatomy of the breast.
Keywords: Learning health system; Teaching materials; Anatomy; Software; Radiology.

Resumo

Introdução: os avanços tecnológicos da área médica desempenham um papel significativo na aquisição de conhecimentos e habilidades dos profissionais de saúde. Objetivo: o objetivo do estudo foi aplicar e analisar a usabilidade do software (RADIF) em graduandos do curso de Tecnólogo em Radiologia como ferramenta didática aplicada à mamografia. Materiais e métodos: a pesquisa é do tipo exploratória descritiva com abordagem quantitativa, foi realizada em parceria com grupos de pesquisa do Instituto Federal de Educação, Ciência e Tecnologia de Santa Catarina (IFSC) e do Instituto Federal de Educação, Ciência e Tecnologia da Bahia (IFBA). Resultados: a amostra obteve 85% de acertos na totalidade das questões, o maior percentual de acertos foi no módulo sobre anatomia radiológica da mama, técnicas de posicionamento e incidências mamográficas. O maior índice de erros, resultando em 61,2% foi no módulo de sinais radiológicos. A amostra demonstrou uma avalição positiva superior a 95% em relação ao uso do software em oito dos nove critérios. Conclusão: os resultados indicaram uma visão positiva em relação ao uso e aplicabilidade do software RADIF para o ensino e treinamento em anatomia radiológica da mama.

Palavras-chave: Sistema de aprendizagem em saúde; Materiais de ensino; Anatomia; Software; Radiologia.

Resumen

Introducción: los avances tecnológicos en el campo de la medicina desempeñan un papel importante en la adquisición de conocimientos y habilidades por parte de los profesionales de la salud. Objetivo: el objetivo del estudio fue aplicar y analizar la usabilidad del software (RADIF) en estudiantes de pregrado del curso de Tecnólogo en Radiología como herramienta didáctica aplicada a la mamografía. Materiales y métodos: esta investigación es un estudio exploratorio y descriptivo con un enfoque cuantitativo, se llevó a cabo en colaboración con grupos de investigación del Instituto Federal de Educación, Ciencia y Tecnología de Santa Catarina (IFSC) y el Instituto Federal de Educación, Ciencia y Tecnología de Bahía (IFBA). Resultados: la muestra obtuvo un 85% de respuestas correctas en la totalidad de las preguntas, el mayor porcentaje de respuestas correctas fue en el módulo sobre anatomía radiológica de la mama, técnicas de posicionamiento e incidencias mamográficas. El mayor índice de errores, que se tradujo en un 61,2%, se produjo en el módulo de signos radiológicos. La muestra demostró una evaluación positiva superior al 95% en relación con la utilización del software en ocho de los nueve criterios. Conclusión: los resultados indicaron una opinión positiva sobre el uso y la aplicabilidad del software RADIF para la enseñanza y la formación en anatomía mamaria radiológica.

Palabras clave: Aprendizaje del sistema de salud; Materiales de enseñanza; Anatomía; Programas Informáticos; Radiología.

1. Introduction

The advances in medical technology play a significant role in the acquisition of knowledge and skills by healthcare professionals (Terashita et al., 2016), who practice in dynamic disciplines owing to technological advancements (Herring, Mishra, Koehler & Firm, 2016). One of the practice areas that has experienced significant improvements aligned with these advances is mammography (Marshall et al., 2008; Strøm et al., 2018). Mammographers are responsible for the operation of mammographic equipment and are expected to have current knowledge in radiation dosimetry, patient positioning, patient care, cross-sectional anatomy; physiology; and pathology of the breast, the latter being aligned to the anatomy-physio-pathological criteria (Ministry of Health, 2019).

The upskilling of mammographers must therefore be aligned with technological evolution. However, the provision of training is considered challenging since it must be procedural, focused, and of short duration to avoid interruption of service provision (Terashita et al., 2016). Innovative tools that effectively and efficiently facilitate the teaching, learning, and assessment (TLA) process are therefore essential (Oliveira & Silva, 2015). Such tools are most suitable for virtual or simulated environments, which has led to the increased use of computer-based teaching as reported by Mdletshe and Oliveira (2020), and Moreira, Ramos, Ventura & Pereira Rodrigues (2019). Further, the use of information and communication technologies (ICT) which led to the development of teaching platforms such as e-learning, computer-assisted teaching, and synchronous and asynchronous environments, was already discussed in the 1990s (Elves et al., 1997; Vallée et al., 2020). In addition, the use of these platforms has become more common and a necessity due to the COVID-19 pandemic impact.

It is on this basis that context-constructed computer-based teaching, supported by relevant pedagogical approaches, needs to be developed to enhance the upskilling of mammographers. This will also strengthen safe practice and service delivery (Henderson et al., 2015). Further, the use of such tools allows TLA to be delivered outside of the clinical environment

thus reducing the training burden that could exist within resource-stretched clinical facilities while playing a significant role in radiation protection (for both professionals and patients) as the mammographers would be trained in a risk-free environment (Mdletshe & Oliveira, 2020). Thus, online educational tools can effectively and efficiently contribute to TLA, creating dynamic modes of interaction with radiological images while allowing a quantitative assessment and feedback about student learning (Kelahan et al., 2020).

This study contributes to the development of such online tools that are needed for the training of mammographers. This exploratory and descriptive (using design principles) study presents the findings of the development of the mammographic teaching software (RADIF) that was developed for the anatomical study of the breast and the technique of operating the mammographic equipment. The objective of the study was to apply and analyze the usability of the RADIF software as a didactic tool for Radiologic Technology students

2. Materials and Method

An exploratory and descriptive design (Vieira, 2020) with a quantitative approach (Lakatos, Marconi, 2021) was used. The study was a partnership of the research groups from the Federal Institute of Education, Science, and Technology of Santa Catarina (IFSC) and the Federal Institute of Education, Science and Technology of Bahia (IFBA). The study was approved by the Research Ethics Committee of the Federal Institute of Education, Science, and Technology of Bahia (protocol number 3,941,172).

The first stage of the study was the development of a questionnaire with multiple choice questions that composed a new interface of the interactive digital system - RADIF (Oliveira et al., 2020). The questions were divided into two sets, the first set (modules 1-3) related to the teaching of mammography. The second set (modules 4-5) focused on the characterization of participants and the applicability of the tool. In summary, the modules were as follows:

- **Module 1**: visualization of recommended anatomical landmarks in basic mammography views (CC/MLO) and a special view.
- **Module 2**: recognition of radiological aspects in the practice of the radiographer.
- **Module 3**: technical criteria for mammographic patient positioning.
- **Module 4**: sample features.
- **Module 5**: assessment of the didactic device.

A non-probabilistic sampling technique was used and the sample was selected from the population of eligible students according to official records from the academic system. The total number of students regularly enrolled in the radiologic technologist course of the IFSC was considered, 63 students (N=63) were eligible to participate and 31 students (n=31) participated.

Software environment

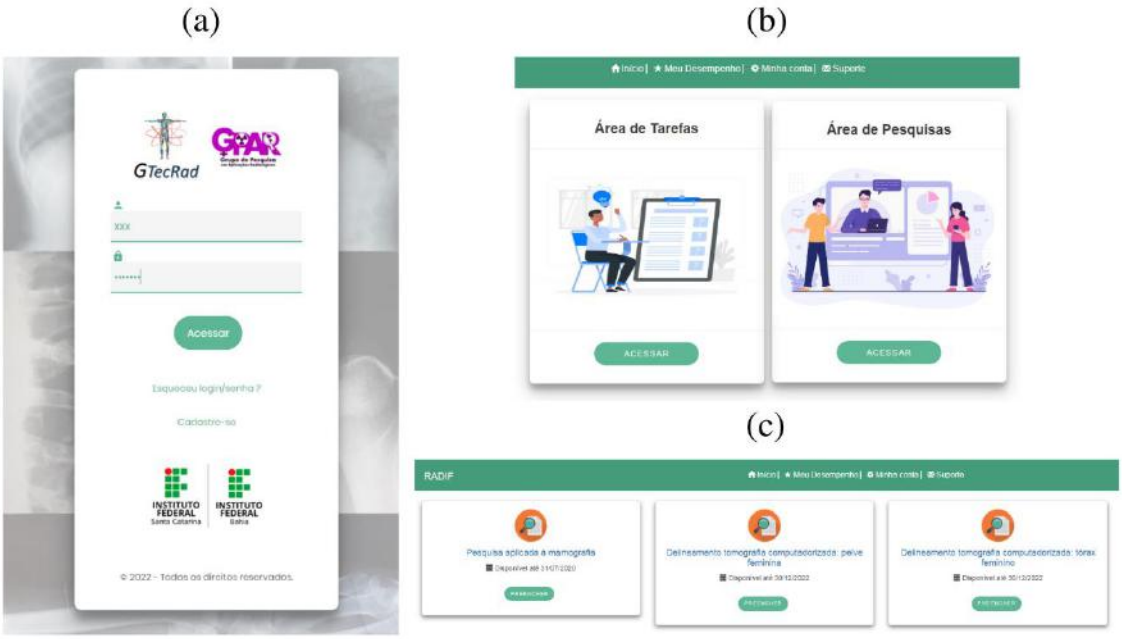
The software was developed using the .NET framework to deal with a consolidated development environment and to have good reuse of code structures, libraries (code library), and services that facilitate the development of Web systems. The software was created using an architectural pattern called MVC, which enhances the software architecture such as data settings, business logic, and data integration.

Through its division into three components, the programming process becomes simpler and more dynamic, which made it easier to implement the idealized features to be included in the application. Also, ADO.net was defined in the data modeling layer because it provides a full set of components to create distributed applications, and data sharing to facilitate

communication with the database management system for storing data from the application, PostgreSQL. For the development of the interfaces, HTML, CSS, and JavaScript were used to deal with well-established languages that are already used in several consolidated Web systems.

Figure 1 shows the RADIF software interface (https://radifapp.com.br), where (a) the login screen, (b) the initial screen, and (c) the teaching area.

Figure 1: RADIF software.



Source: Authors

Statistical analysis

An exploratory descriptive analysis of all investigated variables on the questionnaire was carried out, as well as the use of the theorems of central tendency. For data analysis, the statistical package R version 3 (R Foundation for Statistical Computing) was used. Usability was defined as follows: the ability of the software to be understood, learned, used, and appreciated by the user when used under the specified conditions (ISO/EIC 9126-1, 2003).

3. Results

The research participants were first enrolled between 2016 - 2018, with 83.86% (26) females and 16.12% (5) males, ages ranging from 20 to 47 years. In terms of the mammography area approach, 22.57% (7) performed the mammography internship and 70.97% (22) participated in mammography monitoring (Table 1).

Table 1: Sample features.

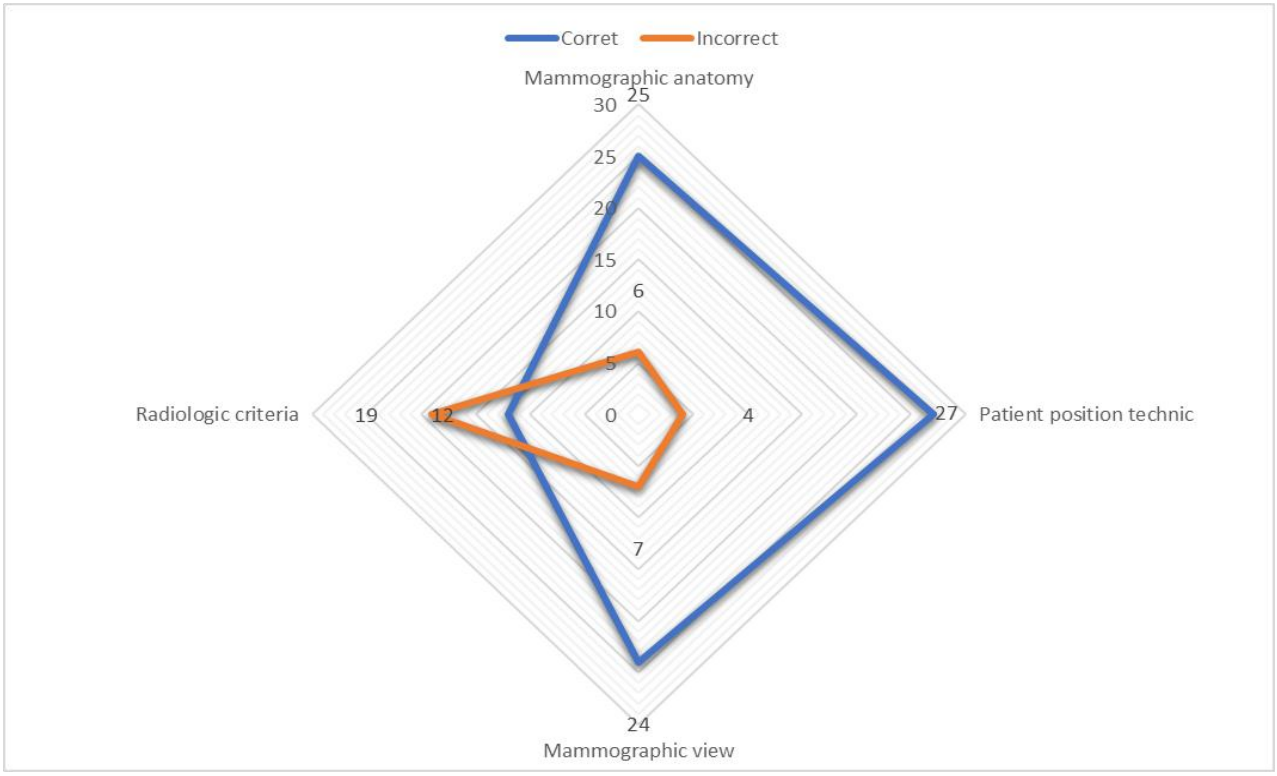
Continuous Variables	**Md**	**min.**	**max.**
Age	22	20	47
Gender		**Fem** **%(n)**	**Male** **%(n)**
Year of enrolment			
2016		0,00% (0)	3,22% (1)
2017		45,16% (14)	0,00% (0)
2018		38,70% (12)	12,90% (4)
	2016 **% (n)**	**2017** **% (n)**	**2018** **%(n)**
Mammography Internship			
Yes	0,00% (0)	19,35% (6)	3,22% (1)
No	3,22% (1)	25,81% (8)	48,39% (15)
Attendance as Teacher´s assistant			
Yes	0,00% (0)	22,58% (7)	48,39% (15)
No	3,22% (1)	22,58% (7)	3,22% (1)

Source: Authors.

In 2017, a new curriculum was implemented, providing opportunities for the teacher assistant role in practical classes of the discipline. It was observed that the practice of internship in mammography was predominant in the years 2017 and 2018, but there was no relationship with the curricular change.

Figure 2 shows the number of correct answers and mistakes regarding aspects of mammography practice. The sample obtained 85% of correct answers to all questions, the highest percentage of correct answers was in the module on radiological breast anatomy, positioning techniques, and mammographic views. In contrast, the highest error rate was 61.2%, related to the radiological aspects area.

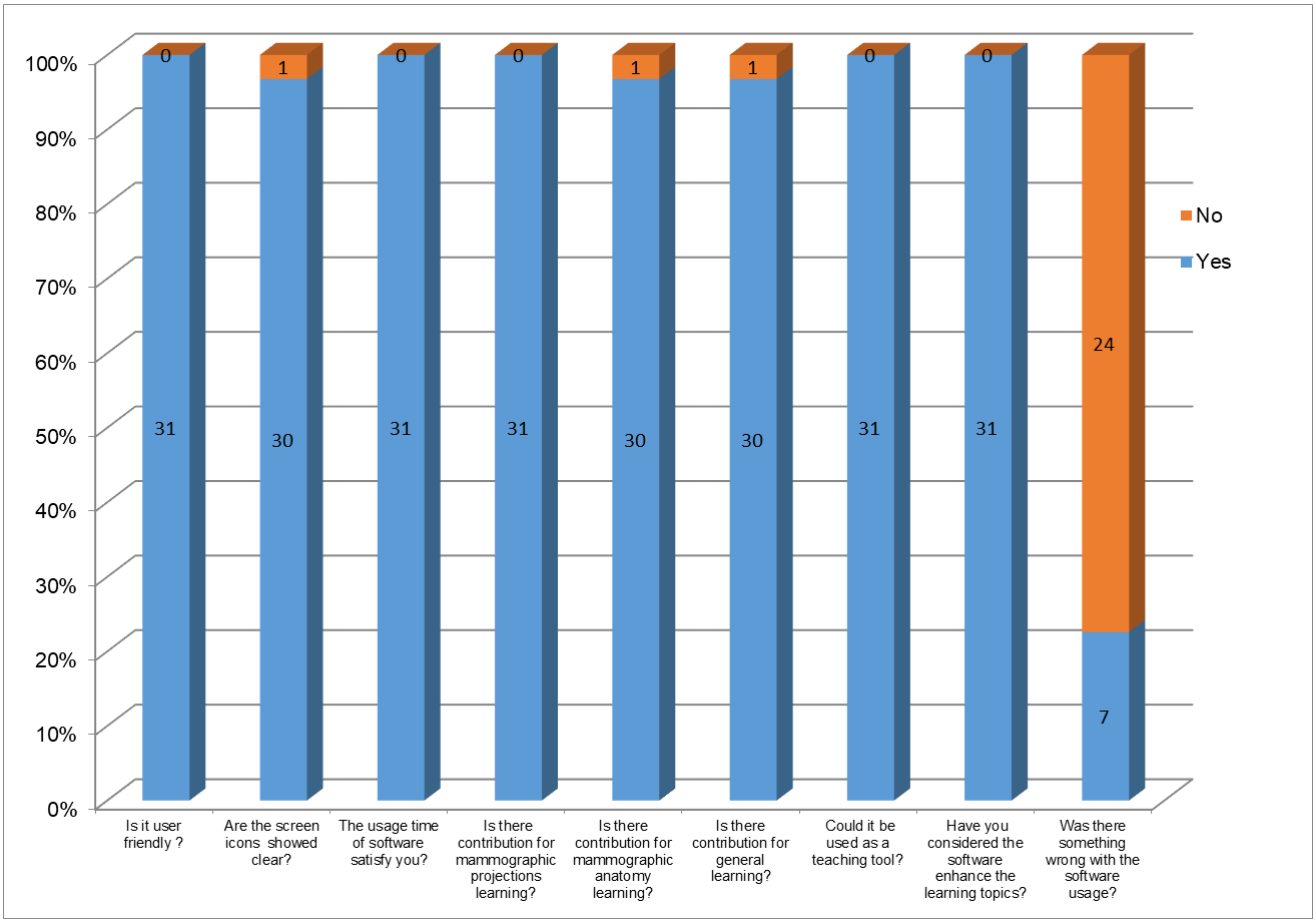
Figure 2: Descriptive data of mistakes and correct answers about the teaching of mammography praxis.



Source: Authors.

Regarding the evaluation of the teaching environment (RADIF software), the result showed user satisfaction (Figure 3), according to the established usability criteria. The sample showed a positive evaluation of more than 95% regarding the use of the software criteria.

Figure 3: Evaluation of the RADIF.



Source: Authors.

The results show that in some aspects there was total acceptance of the use of this software for teaching support. In contrast, 23% of the participants indicated challenges during the use of the RADIF software due to the temporary hosting of the tool online.

The RADIF software demonstrated positive applicability in undergraduate Radiologic Technology students, and consequently, it can also be used by Radiologic Technology professionals. In addition, the tool is free, and the proposed format for execution is online for computers (web). Another positive point is its intuitive and adaptive interface.

4. Discussion

Technological graduation courses, such as Radiologic Technology, demand a high number of practical classes (Oliveira, Geambastiani, Lopez, Cambui, Ubeda & Mdletshe, 2019). Despite this, the results indicated a good level of knowledge of the students about the contents related to mammography. This aspect is relevant when discussing the national recommendations that guide professionals in radiological techniques working in the mammography sector to have extensive knowledge of radiological anatomy of the breast, as well as pathologies, to perform the radiographic positioning technique and ensure that the examination is within the mammographic criteria (Ministry of Health, 2019).

In this way, educational tools are presented as an alternative to work practice. Since it relates the integration of theory with practice, directed toward the anatomical criteria of positioning, the radiological anatomy of the breast with mammography views (Filho, 2018). However, for an evaluation of a computational tool, the participation of users is necessary to assess the

relevance of using the software (Moreira et al., 2019).

There are challenges to be faced in the practice of mammography such as the application of theoretical and practical knowledge, the execution of the exam, clear communication with the patient, the patient positioning, and the assessment of image quality (Strom et al., 2018). All these aspects were considered in the development and application of the RADIF software. It is noteworthy that the use of virtual resources significantly improves students' academic performance (Kelahan et al., 2020).

Computer-based teaching tools aid the improvement of LTA. In addition, it stimulates autonomous student learning, creating an environment for the construction of knowledge (Mdletshe & Oliveira, 2020). These characteristics apply to RADIF software, which will be able to help teachers, students, and professionals in the teaching-learning process that is freely available as an online resource and provide education directed to the student's needs.

Electronic media is used as a tool to engage students both in and out of the classroom, allowing engagement and interaction in an asynchronous way of teaching (Awan, 2021). These technological advances allow the expansion of knowledge and experience in radiology to students around the world (Gupta, Johnson, Peacock, Jiang, McBee, Sneider & Krupinski, 2020). Other tools, with a similar goal, such as UBC, a free, mobile app, also provide the student with an accessible educational tool for teaching radiological anatomy (Spouge, 2017).

5. Conclusion

The results indicated a positive view regarding the use and applicability of the RADIF software for teaching and training in the radiological anatomy of the breast. The use of these educational resources based on computational tools contributes to safe praxis in the health environment. The application of RADIF software as a teaching support tool is shown as an alternative method to consolidate the knowledge taught in theoretical mammography classes, as well as for the training of professionals as an instrument of continuing education.

It is suggested for future studies, the usability of the RADIF software be carried out with a larger population that includes participants from other educational institutions.

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