

## ORIGINAL ARTICLE

# Exploring Students' Feedback and Perception Towards an E-Learning Mobile Application for Radiation Protection

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## ABSTRACT

**Introduction:** Radiation protection awareness are crucial for minimizing the harmful effects of ionizing radiation. In line with the continuing growth of information and communication technology, this study aimed to explore the perception of medical imaging students towards the radiation protection mobile application as an approach to enhance student engagement in radiation protection courses. **Materials and methods:** Forty-one medical imaging students who enrolled in radiation protection courses in second semester were purposefully selected in this study. The mobile app known as the e-RadGo© app was introduced in radiation protection courses. A cross-sectional survey covering five aspects of student's satisfactions and one open-ended questions were conducted to gather initial feedback. Four weeks later, students completed a five-point Likert scale questionnaire to evaluate their perception of e-learning through the app. Descriptive statistics were utilised for data analysis. **Results:** This study revealed that the majority of students (> 80%) responded positively to the usefulness of the mobile app as an e-learning tool for radiation protection courses. More than 80% expressed satisfaction and maintained motivation throughout the e-learning process, with a mean score of  $4.07 \pm 0.69$ . Additionally, 51% of the students agreed that the e-learning facilitated the teaching and learning process, considering it as effective as traditional learning methods, reflected in a mean score of  $3.5 \pm 1.00$ . Students reported positive experiences and perceptions, highlighting the app's potential to enhance engagement and understanding in radiation protection courses. **Conclusion:** This study highlights the potential of integrating an e-learning mobile application in radiation protection courses which may improve teaching and learning process. *Malaysian Journal of Medicine and Health Sciences* (2025) 21(4): 15-23. doi:10.47836/mjmh.21.4.3

**Keywords:** Radiation protection, E-learning, Mobile application, Perception, Education

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## INTRODUCTION

The advancement of digital technology promotes new patterns in the teaching and learning environments at all levels of education settings. Young people nowadays are the 'technology generation' and possess diverse experiences and interactions with technology, influencing their behaviours, cognitive abilities, social connections, and adaptability in learning (1). According to studies, when teaching approaches align with students' learning preferences, they achieve statistically higher academic success (2,3). Technological advancement provides educators with new platforms to engage students and facilitate classroom discussions (4). The global coronavirus (COVID-19) pandemic in 2020 prompted a rapid transition to online and blended learning at universities around the world, elevating the

trends in electronic learning (E-learning) to facilitate the teaching and learning process at all educational levels (5–7). E-learning encompasses the use of electronic technologies and digital platforms, incorporating various principles, and learning-related technologies such as digital, electronic, online, distance, and mobile learning (8–10).

The integration of information and communication technology into education sectors has significantly impacted the educational process in higher education, leading to the introduction of blended learning models that combine traditional classroom sessions with online and e-learning activities. Blended learning offers students a more integrated and adaptable learning experience, with a balance between face-to-face and online components based on curriculum design and learner preferences (11–13). Mobile learning applications, particularly those with attractive features and incorporated gamified elements, have improved students' academic achievement while significantly increasing their learning motivation and engagement in

the subject (14,15). Incorporating mobile applications into a medical and health sciences program may provide substantial educational advantages and increase clinical competence and confidence (16). In a quasi-experimental study, Demir et al. discovered that using a mobile application in anatomy courses significantly improved academic achievement and reduced cognitive load among medical and dental students, with those who used the app together with traditional methods outperforming those who only received traditional lessons (14). Similarly, a study investigating the effect of health education delivered via a mobile application on the quality of life of asthmatic schoolchildren in metropolitan Malaysia discovered a significant increase in the mean quality of life score from pre- to post-intervention. In other words, adopting mobile technology in health education improved patients' quality of life compared to traditional learning methods (17).

Positive attitudes towards e-learning activities significantly contribute to successful learning, leading to productive learners and positive outcomes. In e-learning contexts, 'perception' refers to a person's feelings about using technology for educational reasons and their overall judgement of the value of learning based on their perceptions of what they receive and contribute in return (5,18). Students' perception and motivation for e-learning activities have shown a linear relationship with their academic performance and outcomes (19). A positive correlation was found between e-learning systems and student motivation, indicating that increased motivation significantly enhances student outcomes in terms of knowledge, skills, and attitudes (5). However, cohort research in Saudi Arabia found that dental students did not perceive the ease of utilizing internet resources for learning in the same manner as they did for personal use. The discrepancy in perceptions regarding the use of online tools for learning versus personal purposes could be influenced by several factors such as familiarity, task complexity and language barrier, particularly for non-native English speakers (20).

In diagnostic imaging, modalities such as computed tomography, mammography, and nuclear imaging are essential for diagnosing and treating medical conditions. However, ionizing radiation from these modalities poses a risk to healthcare personnel, requiring effective radiation protection practices. It is crucial for healthcare personnel who work with ionizing radiation to apply good radiation protection practices to protect themselves and minimize radiation hazards. In the medical imaging program, the radiation protection course is fundamental, typically taught during the first year of study. This course covers a variety of topics, including radiation protection principles, types, effects, and radiation measurement. However, students often perceive this course as being merely exam-focused, neglecting the long-term application of this critical knowledge throughout their studies and future careers. Lifelong learning is important

for radiation workers to equip themselves with the tools and adaptability needed with the need to keep up with the pace of changes particularly in the advancement of imaging modalities and technology development.

Hence, a new pedagogical approach such as the introduction mobile, robust and flexible e-learning app tool for sustainable radiation protection knowledge in radiation protection for clinical practice must be implemented to enhance student engagement and ensure the practical application of radiation safety principles beyond the classroom. The educational apps on mobile devices such as smartphones or tablets, are currently preferred by the younger generation as they are more engaging, easy to navigate and able to cater diverse learning style (11,21). This study introduces e-RadGo© app, an e-learning module adapted from the curriculum of the radiation protection course, evaluated by a group of lecturers with more than ten years of teaching experience in the related field. This comprehensive evaluation approach provided valuable insight into the application's effectiveness as an educational tool. Overall, the study aims to assess the usability of e-RadGo© app and students' perception of technology-enhanced learning tools. This information may assist future development initiatives, instructional techniques, and strategies for incorporating mobile technology into radiation protection courses.

## MATERIALS AND METHODS

### Study Design

This research explores the feedback and perceptions of medical imaging students following the application of mobile app combined with traditional learning to improve the learning process in radiation protection courses. The data collection was performed using a purposive sampling method. The research employed a cross-sectional design, with the subjects receiving alternative learning tool using a mobile app named e-RadGo© in combination of traditional lecture.

### Radiation Protection Mobile Application, e-RadGo©

The mobile application, e-RadGo© was an e-learning module adapted from the curriculum of the radiation protection course offered for the Bachelor of Medical Imaging (Hons) Program at the Faculty of Health Sciences, Universiti Sultan Zainal Abidin. Three subject experts in the medical physics field with teaching experiences over ten years reviewed the e-learning module, taking into account content and appearance validity, and relevant changes were made based on their feedback. After a thorough content evaluation by the subject experts, e-RadGo© was developed by an Android developer. As shown in Fig. 1, this mobile app enables students to learn about various topics of radiation protection, including biological effects, radiation protection principles, and monitoring methods. In addition, this app consists of quizzes in interactive

format, such as word searches, letter arrangement games, and crossword puzzles for self-assessment and evaluation. The e-RadGo© also incorporated additional tutorial videos regarding the application of radiation dosimeters for accurate measurement and monitoring of radiation exposure for better exposure to the students. Moreover, e-RadGo© is personalized specifically for educational purposes, to meet the curriculum standards and course learning outcomes. This e-RadGo© has been registered for copyright under Intellectual Property Corporation of Malaysia (MyIPO) (Application number: LY2023C03559).

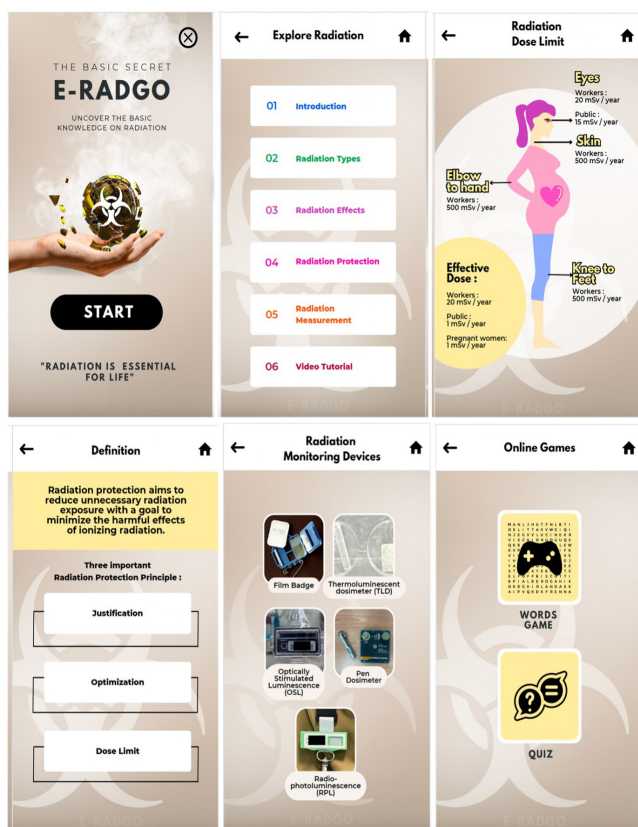


Fig. 1: Screenshot of radiation protection mobile app, e-RadGo©.

### Sample

The target population for this study consisted of medical imaging students who enrolled in a radiation protection course during the second semester at the Faculty of Health Sciences. A total of 41 students participated in the course and answered the questionnaires. Inclusion criteria encompassed all medical imaging students registered for the radiation protection course in that semester. The exclusion criteria were repeated students and students who do not possess an Android smartphone or tablet. Data was collected from November 2023 to March 2024.

### Research Instruments

Prior to the implementation of the mobile app, a survey was conducted using an electronic self-administered questionnaire adapted from Gashi et al. (22) to gain feedback regarding this application. The feedback survey

evaluated five attributes based on the previous research model to assess student's satisfaction with e-learning using mobile application, including perceived ease of use (PEU), self-efficacy (SE), perceived usefulness (PU), perceived interaction (PI), system accessibility (SA) and overall user experience. After the application of the app, students were required to complete a questionnaire about their knowledge, attitude, and experiences of e-learning using the mobile app. The questionnaire developed by Bhargava et al. (23) was adapted for this evaluation. The questionnaire comprised 14 items and was divided into 3 sections: knowledge, attitude, and experiences of e-learning using mobile app as an alternative learning platform in radiation protection subjects. All the questionnaires were in English and comprised a 5-point Likert scale ranging from 'strongly disagree' to 'strongly agree' and one open-ended question. The questionnaire has been validated by the expert panels to verify content and face validity (23). The internal consistency of the instrument is appropriate with Cronbach's alpha value 0.82, indicating internal reliability.

### Data Collection

Data collection started with gathering feedback from the students after the introduction of e-RadGo© app as an additional learning tool for radiation protection courses. Students were informed about its contents and functionalities to familiarise them with the features of the application. The steps required to use the app were demonstrated to the students to ensure that they understood the interactive features of this application. They were allowed to experience the application by exploring and discovering the content and features of the mobile application. An electronic survey using a self-administered questionnaire was conducted to gather their initial feedback. Four weeks post-implementation, students were requested to complete a questionnaire evaluating their knowledge, attitude, and experiences of e-learning using the mobile app.

### Data Analysis

The responses were analysed using IBM Statistical Package for Social Sciences (SPSS) Version 26.0. Graphs for responses were created using Microsoft Office Excel 2016 (Microsoft Corporation, CA, USA). The quantitative data from the questionnaires were analysed using descriptive analysis, while the qualitative data were subjected to narrative analysis. The descriptive data are presented as frequencies, percentages, mean score and standard deviation (SD).

### Ethical Clearance

This study was approved by the Centre for Management of Academic Excellence and Innovation (COMAE-I) and Human Research Ethics (UHREC) at Universiti Sultan Zainal Abidin (UniSZA/UHREC/2022/416). A briefing was held before the study to describe the purpose of the study, what it will involve, the benefits, confidentiality, and the duration. They were informed that the data

will be securely stored, and only researchers will have access to it.

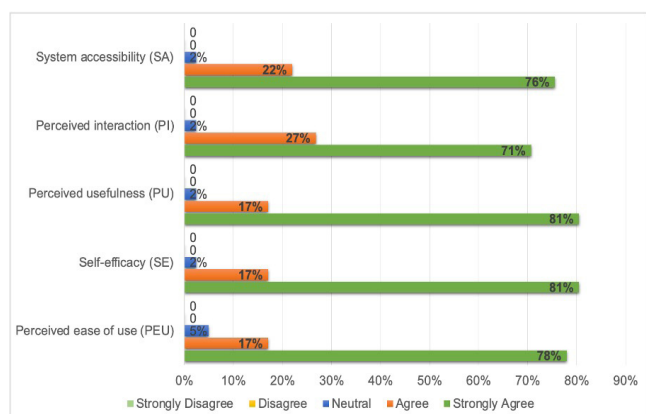
**RESULTS**

**Demographic Data**

A total of 41 medical imaging students participated in this study. Among them, 6 students were males (14.6%), and 35 students were females (85.4%). The respondents' ages ranged from 19 to 22 years old.

**Students' Feedback on e-RadGo© Mobile App**

Fig. 2 illustrates the percentages of students' responses regarding feedback and satisfaction with e-learning using e-RadGo© mobile app. According to the Fig. 2, the majority (78%) expressed the ease of use of the mobile app in assisting the learning process in the radiation protection course. In terms of self-efficacy, a significant majority of respondents (80%) strongly believed that this mobile app was able to assist them in completing their task of learning the radiation protection course. More than 80% of respondents felt that this mobile app was useful and could support users in achieving their learning objectives. A notable percentage of respondents (70%) strongly agreed that this mobile app has an interactive design, a clear interface and user-friendly instructions, contributing to its high learnability. Furthermore, 75% of the respondents found that the structure of the mobile app was well-organized and well-designed, enhancing system accessibility by allowing users to access it easily and tailor settings to their preferences. According to supplementary feedback on the mobile app, respondents stated that they believed that additional learning through this app would be beneficial and boost their engagement with the course. Narrative feedback was categorized into three parts, with most respondents providing overall positive remarks on the perceived usefulness. A summary of these positive comments is presented in Table I.



**Fig. 2: Percentage of students' feedback regarding e-RadGo© mobile app.**

**Table I: A summary of feedback received from the students.**

Part	Examples of Positive Comments from the Users
Figures/Diagrams	'The interactive figures, diagrams, and short videos help to understand the subject better.'
Gamified Quizzes	'The interactive features of this application such as gamified e-quizzes fun and enjoyable', 'The game prepared in this module was fun'
Overall Contents and Features	'The mobile application design was attractive, interesting and improve students' engagement with the subject'. 'Very good content and easy to understand'. 'Help to understand better with outlines and mind map.' 'The module design is very interesting and easy to understand.'

**Perception of Students Regarding Radiation Protection Learning Using Mobile App**

The perception of students regarding e-learning in radiation protection courses using the mobile application was carried out on three main domains: knowledge, attitude, and experiences, as shown in Table II – IV. In the knowledge domain (Table II), of the respondents, 97% (n = 40) agreed on the importance of the e-learning concept, resulting a mean score of 4.66 ± 0.53. Additionally, they acknowledged that proficiency in information and communication technology skills and student feedback are essential for achieving an effective e-learning session. 88% (n = 36) of the respondents agreed on the adequacy and fairness of assessing their academic performance through online assessment. Nevertheless, only 61% (n = 25) agreed on the independence of students on e-learning platforms in comparison to traditional learning settings.

**Table II: Knowledge among students regarding the effectiveness and usefulness of e-learning mobile app.**

Question	Responses, n (%)					Mean ± SD
	Strongly Disagree	Dis-agree	Neu-tral	Agree	Strongly Agree	
E-learning is a comprehensive concept that involves using all forms of electronic media, information, and communication technology in education.	0 (0.0)	0 (0.0)	1 (2.4)	12 (29.3)	28 (68.3)	4.66 ± 0.53

CONTINUE

**Table II: Knowledge among students regarding the effectiveness and usefulness of e-learning mobile app. (CONT.)**

Question	Responses, n (%)					Mean ± SD
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
For a successful online session, both e-teachers and e-learners need special information and communication technology skills.	0 (0.0)	0 (0.0)	1 (2.4)	13 (31.7)	27 (65.9)	4.63 ± 0.54
E-learners' performance can be adequately and fairly assessed via online assessment.	0 (0.0)	0 (0.0)	5 (12.2)	19 (46.3)	17 (41.5)	4.29 ± 0.68
The e-learner is more independent than the traditional face-to-face student.	0 (0.0)	1 (2.4)	15 (36.6)	13 (31.7)	12 (29.3)	3.88 ± 0.87
E-learners' feedback is important to create a more effective and engaging online learning experience.	0 (0.0)	1 (2.4)	2 (4.9)	14 (34.1)	24 (58.5)	4.49 ± 0.71

In terms of attitude towards e-learning using mobile application (Table III), 80% (n = 33) of respondents could sustain their motivation in e-learning, and 95% (n = 39) of them also felt that university support in the e-learning medium was adequate with mean scores of 4.07 ± 0.69 and 4.32 ± 0.57, respectively. In addition, most respondents also expressed their confidence in applying what they have learned through the e-learning platform to real-life situations, such as the workplace. Approximately 51% (n = 21) expressed agreement regarding the effectiveness of online learning compared to traditional learning methods with a mean score of 3.5 ± 1.00. Furthermore, the majority of respondents agreed that online activities or feedback could assist them in reflecting on their comprehension of the subject.

**Table III: Attitude among students regarding the effectiveness and usefulness of e-learning mobile app.**

Question	Responses, n (%)					Mean ± SD
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
I can sustain my motivation for learning online.	0 (0.0)	0 (0.0)	8 (19.5)	22 (53.7)	11 (26.8)	4.07 ± 0.69
I feel adequately supported by the University in adapting to this medium of learning	0 (0.0)	0 (0.0)	2 (4.9)	24 (58.5)	15 (36.6)	4.32 ± 0.57
I am confident that I will be able to apply what I learned online to the workplace.	0 (0.0)	3 (7.3)	10 (24.4)	16 (39)	12 (29.3)	3.90 ± 0.92
I feel that online activities and online feedback help me to reflect in depth on the subject I learned.	0 (0.0)	0 (0.0)	6 (14.6)	20 (48.8)	15 (36.6)	4.22 ± 0.69
I feel that discussion using an online learning platform is as effective as face-to-face.	1 (2.4)	4 (9.8)	15 (36.6)	13 (31.7)	8 (19.5)	3.5 ± 1.00

Regarding participant experiences in e-learning (Table IV), most respondents agreed that internet connectivity was their main concern during e-learning sessions. However, most respondents had access to the appropriate devices and hardware, such as computers and other electronic devices, as well as the appropriate e-learning resources required for online learning sessions. Over 53.4% (n = 22) reported that anxiety brought about by the pandemic had a detrimental impact on their ability to engage in online teaching and learning.

**Table IV: Experiences among students regarding the effectiveness and usefulness of e-learning mobile app.**

Question	Responses, n (%)					Mean ± SD
	Strongly Disagree	Dis-agree	Neu-tral	Agree	Strongly Agree	
I feel that internet connectivity was a major concern.	0 (0.0)	0 (0.0)	3 (7.3)	15 (36.6)	23 (56.1)	4.49 ± 0.64
I feel that I have access to appropriate devices/hardware.	0 (0.0)	0 (0.0)	3 (7.3)	21 (51.2)	17 (41.5)	4.34 ± 0.62
I feel that I have access to appropriate e-resources.	0 (0.0)	0 (0.0)	4 (9.8)	21 (51.2)	16 (39.0)	4.29 ± 0.64
I feel that pandemic-induced anxiety hampered my online learning.	0 (0.0)	2 (4.9)	17 (41.5)	15 (36.6)	7 (17.1)	3.66 ± 0.83

## DISCUSSION

Based on the findings of the study, the integration of the mobile application as an e-learning tool in radiation protection courses had a positive impact on the academic achievement of the students. This finding suggests that the use of mobile app for e-learning is useful, interactive and able to enhance the interest of students in learning radiation protection. This application embedded with various knowledge resources, offers interactive features, allowing for easy and quick access to information. Several studies have reported that the appropriate utilization of mobile applications can enhance academic achievement among students (3,11,24). For instance, the academic achievement levels among medical and dental students were significantly higher after applying mobile apps in the anatomy course (3,25). In the e-learning format for radiation protection and safety training organized by the Belgian Nuclear Research Centre, respondents demonstrated a higher overall knowledge gain than face-to-face respondents (26). Furthermore, e-learning by mobile app has been demonstrated to encourage and motivate students to learn by reducing cognitive load during the learning process and enhancing academic performance (5,14). Learning environments supported by mobile applications were thought to improve students' preparedness for professional careers by increasing their confidence in their knowledge and skills (3,4).

Incorporating illustrations, schematic diagrams, and game-based learning on radiation protection in a mobile app could be one of the factors that improve academic achievement among students. The combination of textual and visual material facilitates more significant

learning and academic success (9). A recent study exploring the experiences of healthcare students' learning radiation safety through virtual reality (VR) simulation-based discovered that VR learning had a greater impact on students' confidence levels in their grasp of radiation safety issues (6). Overall, graphic representations such as schematic diagrams and illustrations in e-learning can significantly improve the learning experience by simplifying complex concepts, reinforcing textual information, and providing a more comprehensive and engaging learning experience (27,28). In addition, gamified mobile learning, through elements such as e-quizzes, rewards, and feedback, can effectively engage students and make learning more enjoyable, thus influencing students' academic performance positively (21,29). Gamified e-quizzes create a game-like environment, enabling students to assess their understanding, compare progress, and use the quizzes as a revision tool for examinations (11,30). This study shows that e-RadGo© mobile app's interface design has achieved a substantial degree of user satisfaction and has positively impacted user excitement. According to user feedback, the app is described as well-structured and organized, offering users control over their experience. Integrating embedded tools enhances learnability, providing a dynamic and interactive learning environment. The current data indicated that the users could learn efficiently by referring to information in the mobile application. Previous studies that used mobile or digital applications together with face-to-face learning reported that students' enjoyment levels were relatively higher, and they could complete their tasks efficiently (4,31).

In general, the application of mobile app as an e-learning tool for radiation protection courses was well perceived, as most students reported having a positive impression in the survey. Additionally, students who utilized e-learning platforms were found to be more self-reliant compared to those who learned through conventional methods. Furthermore, the majority of students (>80%) acknowledged the value of online activities and feedback in assessing their comprehension of the subject matter. Apart from internet connectivity issues, most students had access to the necessary devices, hardware, and e-learning resources required for online learning sessions. The success of e-learning adoption in teaching and learning depends on technology accessibility and a good internet connection (20,25). In this study, most students reported that their ability to participate in online teaching or learning was restricted by pandemic-related anxiety. Although the pandemic may no longer be a current issue, its effects such as persisting anxiety and psychological impacts may still be present among individuals. Its effect on students' learning experiences, particularly in online learning, can have lasting implications.

Medical education in healthcare sectors across the globe

faced new challenges due to the spread of the COVID-19 pandemic (3). This pandemic has significantly impacted medical education, prompting educational institutions to adapt to novel technological solutions quickly. This adaptation has involved the use of digital technologies, online resources, and specialized applications to improve the delivery and effectiveness of medical education in the context of a current worldwide health crisis (32,33). Therefore, the utilization of e-learning or the use of mobile devices such as tablets or smartphones for training may be essential to adapt to the changing global conditions while still ensuring that health sciences students acquire the necessary hands-on technical skills for their future clinical practice.

Learners benefit from the flexibility of studying at any time and from any location, self-paced learning, enhanced engagement through interactivity and attractiveness, personal accountability for learning, and rapid access to knowledge (18,26). However, e-learning platforms may present challenges such as managing motivation, lacking a social learning environment, dealing with technology and network issues, and adapting certain communication and technology skills (8,26). This study has shown that most students felt that online assessment and discussion may not be as effective as traditional learning settings in assessing students' academic performance. Online assessment can be a beneficial tool in e-learning. Still, it must be carefully considered and implemented to ensure that evaluation approaches are congruent with online learning and successfully evaluate students' academic achievement (34). Effective two-way communication in e-learning is fundamental for creating an inclusive and supportive learning environment, enabling both students and lecturers to actively contribute to the educational process (35).

On the other hand, the application of e-learning was believed to improve students' critical thinking skills effectively (36). E-learning platforms indirectly promote students' critical thinking abilities to analyze, synthesize, and evaluate information. They encourage higher-order thinking, problem-solving skills, and the capacity to apply knowledge in real-life scenarios. Previous studies demonstrated that most students (80%) believed that using virtual learning in radiation safety helped them understand the subject better and enhanced their critical thinking (6). Integrated e-learning as an active learning strategy has been proven to enhance critical thinking skills among students (10). In today's fast-paced and complex environment, the ability to learn independently and critically has become essential for effective problem-solving (36).

The study identified several limitations. The findings of the research are hampered by the small sample size of medical imaging students, which reduces the ability to generalize the results. The students' responses were based on their opinions and might have been biased

due to subjectivity and personal interests. Additionally, there was no user manual available for this mobile app to assist or guide the user. Further studies on mobile app implementation in radiation protection should explore feedback, perception, and effectiveness on a larger scale involving multiple cohorts of students and relevant stakeholders.

## CONCLUSION

In conclusion, the students responded positively to the introduction of the mobile app, with the majority addressing the ability to sustain motivation throughout the learning process and expressing confidence in applying what they learnt through the e-learning platform to real-life situations. The outcome of this study emphasized the potential and feasibility of integrating mobile application e-learning with traditional learning methods, which potentially leading to greater success in enhancing students' understanding of radiation protection concepts and principles.

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