ASSESSMENT OF THE USAGE OF MOBILE APPLICATIONS (APPS) IN MEDICAL IMAGING AMONG MEDICAL IMAGING STUDENTS

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ABSTRACT

Introduction: There are increasing numbers of medical imaging apps available on smart devices nowadays. However, knowledge about the usefulness of medical imaging apps among medical imaging students is rather limited. **Methods:** 38 medical imaging students of the International Islamic University Malaysia (IIUM) completed a validated online questionnaire that is formulated to investigate the awareness, usage and perception about medical imaging apps installed in the smart devices. The students' preference regarding the characteristics, features as well as areas and domains of medical imaging to be incorporated into future medical imaging apps were also dipped into. **Results:** The majority of the students, 24 (63.2%) were aware about the existence medical imaging apps nevertheless, only 14 (58.3%) among them had experienced using medical imaging apps. Most students reported positive responses towards the perceptions and usability of the apps. The students had also addressed a number of preferred characteristics, features as well as areas and domains of medical imaging to be integrated into medical imaging apps. **Conclusions:** There is low appreciation towards medical imaging apps among the students as depicted by the awareness, frequency and experience in its usage. However, they portrayed positive acceptance towards future usage of the apps evaluated from their opinion regarding the perception, usability and preferences towards the content of medical imaging apps. The preferences of the respondents have been identified as revealed by their opinions regarding the most preferred areas (MRI, CT, X-ray) and domains (imaging procedure, anatomy, image quality).

KEYWORDS: Apps, Medical Imaging, mHealth, mLearning, mobile learning

INTRODUCTION

Mobile device is a handheld computing device that is typically designed in a small form factor. A mobile operating system (mobile OS), is an operating system that is specifically designed to run on the mobile devices. Several mobile OS include Android by Google, iOS by Apple, Blackberry-OS by Research in Motion and Windows-Mobile by Microsoft. The major function of mobile OS is to be a platform for software application programs which are called apps. App is the abbreviation of the word 'application'. It is a computer program or software designed for a particular purpose that can be downloaded into the handheld device.

With the increase of mobile devices ownership among the medical personnel, there have been increasing discussions about the benefits of going mobile for knowledge and training. The advent of the usability of mobile apps has brought attention to their "usefulness". According to Merriam-Webster dictionary, usefulness means "the quality of having utility and especially practical worth or applicability". Whilst a number of usability evaluations of mobile apps have been done, very few

studies have been steered towards the appreciation of mobile apps in the field of healthcare (Harrison, Flood & Duce, 2013).

The term mHealth (mobile Health) has been predominantly relevant and universally accepted for the use of mobile devices in the health sector. The Foundation for the National Institutes of Health (FNIH), has demarcated mHealth as "the delivery of healthcare services via mobile communication devices". The IMS Institute for Healthcare Informatics (2015) has depicted that the number of mobile health apps has soared with more than 165,000 mHealth apps available in the Apple App Store and Google Play. Since there are growing number of smartphone ownership by the students, it is a good opportunity for them to utilize the apps in education. The application of mLearning (mobile learning) during the undergraduate studies will serve as a preparation for the future mHealth usability.

As a sub discipline in medicine, there is no exception for medical imaging field to utilize the use of mobile apps. In medical imaging, it involves the use of specific techniques and processes and imaging modalities for the visualization of internal structures of human anatomy for clinical analysis and medical intervention. Since there are various domains in medical imaging, it is largely anticipated that these domains have been incorporated into apps. In 2015, Kim et al. reported there were 381 radiology-related apps in the Apple Apps Store. Radiology apps fall under different categories including learning and teaching apps, reference apps, viewing apps, information systems apps and patient education apps. Despite the emergence of apps in the field, the knowledge about the usefulness of medical imaging apps especially among medical imaging students is rather limited. This study is conducted to explore the usage and appreciation of medical imaging apps among medical imaging students. The students' preferences of the apps content based on the domain of medical imaging are also investigated in this study.

METHODS

Study design

This is a qualitative study done by using questionnaire with the purpose to provide insight into the usefulness of medical imaging apps among medical imaging students and their preferences towards the content of the apps. The study was approved by the Kulliyyah Postgraduate and Research Committee (KPGRC) KAHS 202 and IIUM Research Ethics Committee (IREC) IREC 2017-076.

Questionnaire Development

The development of the questionnaire was made by deriving relevant discussions from previous literatures. The questionnaire was divided into three parts consisted of open-ended and Likert scale questions. The first part was intended to record sociodemographic information of the respondents. The second part was to assess the students' knowledge and usage of medical imaging apps. The third part was designed to unfold the students' preferences regarding the content of medical imaging apps. The open ended questions was formulated to explore their preferred characteristics, features and functions of a typical medical imaging apps, to evaluate the impact of apps usage on their clinical practice and to determine the respondent's consideration between cost and the value of information before installing an apps.

The questionnaire was reviewed by four academicians for content validity. The questionnaire was improved post-validation by adding the System Usability Scale (SUS) developed by John Brooke (Usability.gov, 2018) to provide more information regarding the usefulness of medical imaging apps.

Questionnaire Distribution

The questionnaire was piloted by 15 students of the Department of Radiography and Diagnostic Imaging and Radiotherapy (DDIR), IIUM. They were randomly selected from the second to fourth year students. After piloting, the questionnaire was sent to the respondents by Google Form. The survey involved 38 medical imaging students from the same department, DDIR, IIUM. Purposive sampling was chosen where students in their third and fourth academic year only were selected to participate. They were selected as they have completed the basic medical imaging courses and have experienced clinical training. It is felt that they would have a greater need for using various clinical applications developed for smartphones that aid for the learning and practical use. The information, objectives and purposes of the research were explained briefly in the introduction of questionnaire. The research information sheet and the consent form was attached with the questionnaire to denote the voluntary agreement of the respondent to participate in research.

Statistical Analysis

For descriptive analysis, the results were presented as frequency and percentages which present the close-ended questions. The statistical significance of Likert scale responses was calculated by using the Weighted Mean in the Microsoft Excel 2013 software for Windows 8. Each of the Likert rating scale was devised with their own weightings (Strongly disagree – 1, Disagree – 2, Uncertain – 3, Agree – 4, Strongly agree – 5). By using the weighted mean formula, an average weighted score was obtained from the five qualities. The open-ended questions in the survey were analyzed by using thematic analysis to determine the pattern in the qualitative research.

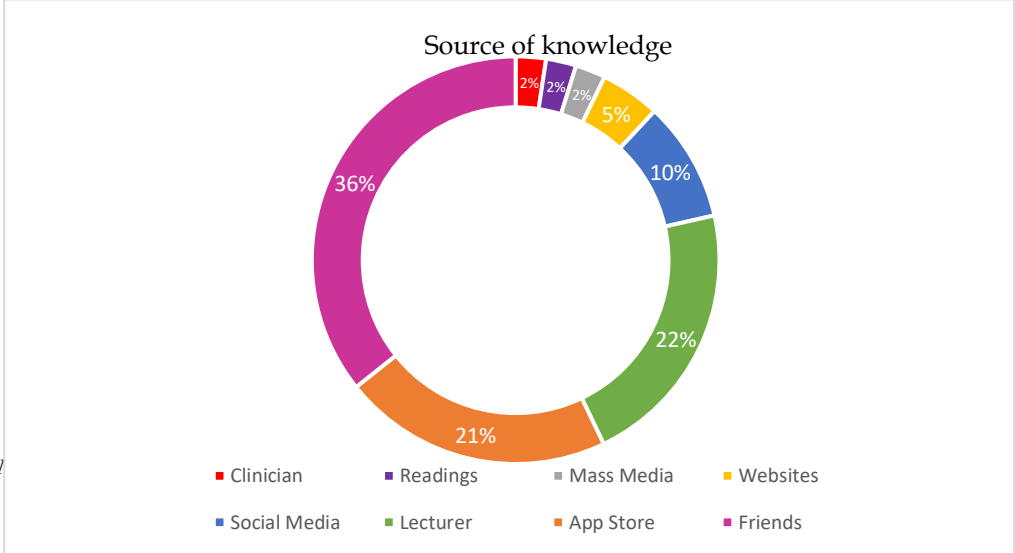
RESULTS

Sociodemographic Details

38 students took part in the study. 84.2% were females and 15.8% were males. 44.7% were rom Year 3 while 55.3% were Year 4 students.

Awareness of medical imaging apps

The majority of the students, 24 (63.2%) were aware about the existence medical imaging apps. Source of knowledge regarding the apps are portrayed in Figure 1.



Usage of medical imaging apps

Figure 1 Source of knowledge regarding medical imaging apps

Based on the 24 respondents who were aware of the existence of medical imaging apps, 14 (58.3%) had experienced using medical imaging apps. 10 (41.7%) respondents stated the reasons of not using any medical imaging apps. The main factor was because they had never installed any medical imaging apps 3(27.27%). The other reason was due to the low internal phone storage to accommodate the apps 3(27.27%). 2(18.18%) students also mentioned that they prefer the traditional way of referring to books rather than using the apps. The details of the medical imaging apps downloaded by the students are depicted in Figure 2.

Frequency and purpose of usage medical imaging apps

The frequency and purpose of the use of the installed medical imaging apps among the 14 respondents who had used the apps are shown in Table 1.

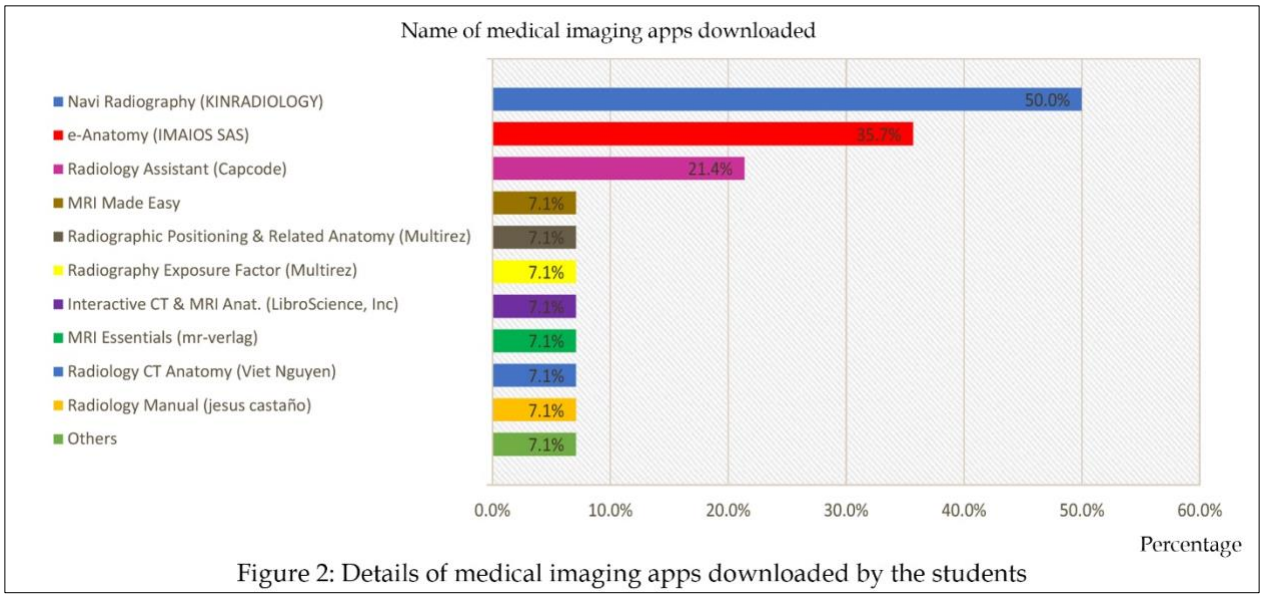


Figure 2: Details of medical imaging apps downloaded by the students

Table 1: Frequency and purpose of usage medical imaging apps

Parameters	Frequency	Percentage
Frequency of apps usage medical imaging apps		
• At least once a week	1	7.1%
• More than twice a week	1	7.1%
• Only when needed	12	85.7%
Purpose of using medical imaging apps		
• To prepare for presentations	4	28.6%
• To search for information	7	50.0%

• To guide in clinical practice	10	71.4%
• To revise the knowledge	11	78.6%

Usability, perceptions and benefits of medical imaging apps

For the analysis of Likert scale questions regarding the usability, perceptions and benefits of medical imaging apps by using weighted mean, the results are portrayed in Table 2.

Problems of using medical imaging apps

Several limitations were highlighted by the students when using medical imaging apps. The problems include the slow Wi-Fi/Internet connection when using the apps 8(57.1%). Same percentages were recorded among those who encountered problems related to the small screen size and unreliable or backdated information 6(42.9%). Other limitations in using the apps includes the expensive cost of apps for installation 5(35.7%).

Table 2: Usability, perceptions and benefits of medical imaging apps

Parameters	Weighted Mean Analysis
Usability of medical imaging apps	
• I thought the app was easy to use.	4.00
• I would imagine that most people would learn to use the app very quickly.	3.93
• I felt very confident using the app.	3.79
• I think that I would like to use the app frequently.	3.64
Perceptions towards medical imaging apps	
• Medical imaging apps are important tools for medical imaging studies.	4.27
• Medical imaging students should use medical imaging apps on their mobile devices.	4.00
• The use of medical imaging apps can complement medical imaging books.	3.93
• The content of medical imaging apps are more simple and concise than medical imaging books.	3.80
• The interface of medical imaging apps makes the delivery of contents effective.	3.80
Benefits of medical imaging apps	
• Information is easy to access anywhere/anytime.	4.33
• Reduce time to look for information.	4.33
• Ease of learning and understanding of information	4.13
• Provide concise information.	4.07

Preferred medical imaging areas

The respondents were of the opinion that aspects involving modalities that could be incorporated into apps were Magnetic Resonance Imaging (MRI) 37(97.4%), followed by Computed Tomography (CT) 33(86.8%) and Plain Radiography 18(47.4%). Other modalities of interest include Fluoroscopy 11(28.9%), Ultrasound 9(23.7%) and Nuclear Medicine 5(13.2%). The least preferred medical imaging area was Mammography, 1(2.6%). The details of the preferred domains for the content of medical imaging apps are shown in Figure 3.

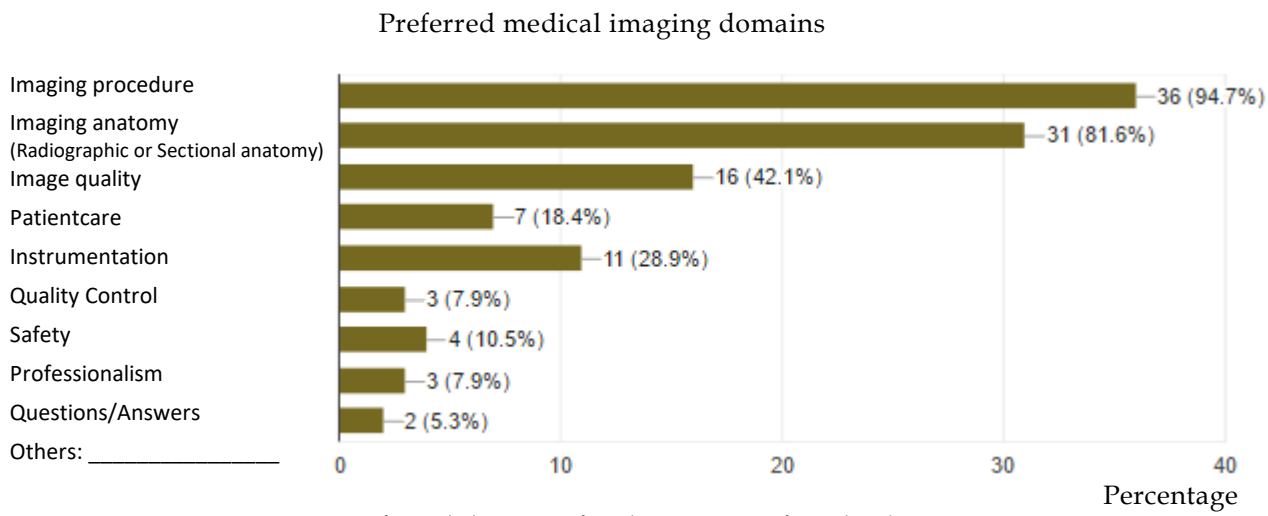


Figure 3: Preferred domains for the content of medical imaging apps

Preferred characteristics of an ideal medical imaging apps

The majority of the respondents felt that the ideal characteristics of medical imaging apps, is the information must be regularly updated (4.68); the apps' contents should be reviewed by medical imaging professionals (4.61), the information in the apps must be properly referenced (4.58) and the app should be recommended by clinician, academician or professionals (4.58). The students have also addressed some features or functions to be included in medical imaging apps as depicted in Table 3.

Table 3: Preferred feature or function of medical imaging apps

Parameters	Frequency	Percentage
User-friendly, good user interface design	13	28.26%
Provide instant feedback	11	23.91%
Social media connectivity	4	8.70%
Professional involvement	3	6.52%
Offline usage	3	6.52%
Questions/Quizzes	3	6.52%
Use low memory storage	2	4.35%
Provide discussion forum	1	2.17%
Comprehensive content	1	2.17%

Free access	1	2.17%
Able to insert notes	1	2.17%
Others	3	6.52%
Total	**46**	**100.00%**

Issues of the usage of medical imaging apps in the clinical settings

The result of thematic analysis from the respondents' comments had highlighted four common issues that may arise in relation with the use of medical imaging apps in the clinical settings as depicted in Figure 4.

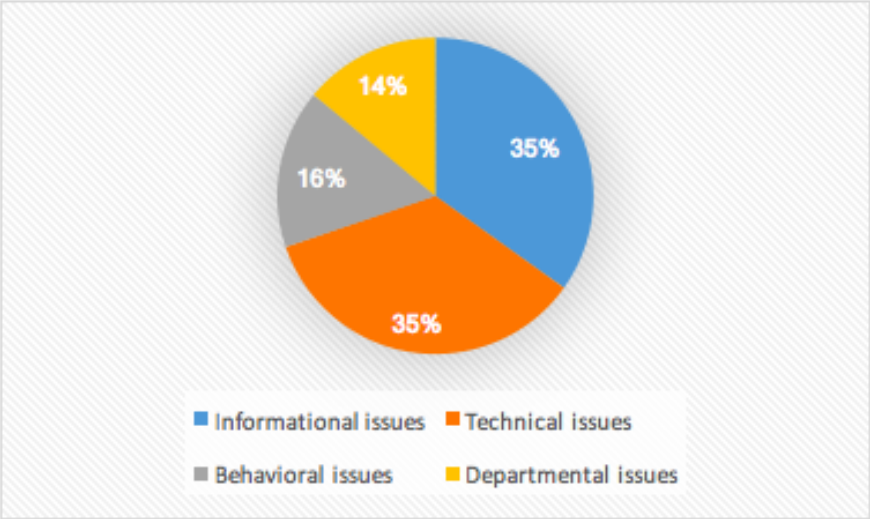


Figure 4: Issues of the usage of medical imaging apps in the clinical settings

Prioritization between cost and information when installing medical imaging apps

A number of respondents prioritized cost in such a way that they preferred free 7(16.67%) or low cost apps 6(14.29%). Some respondents feel that apps are just a secondary medium to obtain information in comparison with the book. They indicate that books were more preferred 7(16.67%) as books can be accessed readily from the library.

On the other hand, some of the respondents feel that they are willing to spend for paid app as long as the cost is appropriate with the information provided 8(19.05%). They are in agreement that information is more crucial than the cost as the apps usage would help them to provide better quality of service 5(11.90%). The students also feel that information provided by the apps is more valuable as it would serve as reference or guidelines 4(9.52%).

DISCUSSION

Awareness and usage of medical imaging apps

Only two-thirds of the respondents showing their awareness about the availability of medical imaging apps. This is along the study by Krebs & Duncan (2015) who found that the

majority of health applications on smartphones are still underutilized. These results in the present study indicate the need to reinforce the digital literacy among the students by introducing and promoting medical imaging apps to them. It also can be denoted from the results that the awareness primarily rely on social interactions such as friends, lecturers and social media platforms. Regardless of the awareness towards medical imaging apps, the respondents showed less acceptance in relation with its usage. Further study is warranted to unearth their reasons for not installing the apps even though they are aware of the existence of the apps.

With respect to their reasons of not using the apps due to better preference towards books, this finding is in line with the study done by Koh et al. (2014) who reported that books are still favored by the students in the study. Besides providing deeper comprehension, the printed texts are also proved to help better in the recall process as dealing with papers can enhance memorization (Singer & Alexander, 2016). It can be concluded that the use of apps was not the usual practice of the respondents in learning.

The reviewers of medical imaging apps (Navi Radiography, e-Anatomy, Radiology Assistant) expressed their positive feedbacks regarding the functionality of existing apps. These include in aiding patient positioning, human anatomy and image diagnosis. In order to create new apps attention should be given to the adaptation of more updated content and improvement of problems and gaps in previous apps.

Mobile apps were one of the medium for students to revise and obtain knowledge. A study by Sayedalamin et al., (2016) reported that the major reasons in using the medical apps are either for their course revision or for retrieving medical information. Compared to the traditional way of seeking information using books, the use of technology permits an easier avenue to acquire information when needed.

Users' perception towards medical imaging apps

From the evaluation of System Usability Scale (SUS), it was found that the user-friendliness of the apps is the major contributor towards the increase usability of the apps. User-friendliness may indicate there is no need for guidance from other person to use the apps. As each user has different level of expertise, it is significant for the apps to have a user-friendly and intuitive interface. Apps should have intuitive functionality as this will reduce the cognitive burden of users (Kim et al. 2015).

It was also portrayed that the use of medical imaging apps is necessary as it can supplement the use of books due to its simple and interactive nature to convey its content. The use of technology in education by students can be regarded as part of blended learning. The utilisation of apps on smart mobile devices brings a new dimension into blended learning which is so called mobile learning or m-learning. Researchers stated that the ease of access to current information in any place or time was among the greatest advantages of mobile learning (Ibrahim, Salisu, Popoola & Ibrahim, 2014).

The ease in accessing and understanding of knowledge accompanied with minimum time to obtain the information were the major advantages in using medical imaging apps. On the contrary, several limitations were also highlighted by the students when using medical imaging apps. Slow connectivity and users' preference towards larger screen had limit the use of medical

imaging apps. Other barriers that contributes include the cost and reliability of information provided in the apps.

In relation with the use of medical imaging apps in the clinical settings, several issues have been highlighted by the students; informational issues, technical issues, behavioral issues and departmental issues. Among the informational issues identified concerning the use of medical imaging apps in the clinical settings were about the reliability of the information provided in the apps. There were also a concern among the respondents on whether the information provided in the apps is suitable to be applied on local patient.

Some of technical issues may also be encountered when using the apps such as the lagging of content, low internal storage of phone memory and slow Wi-Fi connectivity. However, the issues are rather relative as different users have different models of smartphones that possess varying specifications and capabilities to accommodate the apps. Professional concerns pertaining to the use of apps in clinical areas involves the institutional policy, rules and regulations. As such, there is a need to review the institutional policy related to the usage of mobile apps. This is to support the students' effort in utilizing mobile learning by referring to apps during clinical placement.

Users' preferences towards the content of medical imaging apps

The majority of respondents were of the opinion that aspects involving modalities that could be incorporated into apps were MRI, CT and X-Ray. Other preferred domains for the content were imaging procedure and imaging anatomy. Besides the interest on review and recommendation from professionals, updated and properly referenced information are the vital characteristics of an ideal medical imaging apps. This will highly convince the users to be more confidence in using the apps as the information has already been approved by professionals. As proposed by Lienhard & Legner (2017), it is believed that the integration of medical professionals' expertise along with the software developer is an essential criterion to design an effective medical apps.

In terms of the respondents' preference towards the features and functions of medical imaging apps, user-friendliness, instant feedback service and social networking were among the suggested ideas to be incorporated into the apps. By having certain functionality such as demonstration video and 3D images, it will contribute to the user-friendliness and interactivity of the apps interface. This will help the novice users to easily understand the apps within short period of time without the technical supervision. The instant feedback service feature is crucial in case the users need to voice out their reviews towards the apps in form of comment, opinion or suggestion. The integration of social media not only facilitate the sign up process but also allow the sharing of information across the social media platforms.

There is overwhelming preference of students towards free or low cost apps that suit with their financial situation. Less preference towards paid apps is attributed to the availability of books in the library. Different opinions have been uncovered from another group of students who are willing to pay for the apps. They affirmed that the value of information in the apps was more significant than its cost. This is because the apps have good quality of content to provide the reference or guidelines for the theory in medical imaging. Future research is warranted to evaluate the difference in characteristics as well as the content of free and paid apps and the comparison of its efficiency when used as an education tool.

CONCLUSION(S)

There is low appreciation towards medical imaging apps among the students as depicted by the awareness, frequency and experience in its usage. However, they portrayed positive acceptance towards future usage of the apps evaluated from their opinion regarding the perception, usability and benefit of medical imaging apps. There is need to introduce and promote medical imaging apps to them for the use in learning and education. The preferences of the respondents have been identified as revealed by their opinions regarding the most preferred areas (MRI, CT, X-ray) and domains (imaging procedure, anatomy, image quality). Therefore, these aspects should be given attention to be incorporated into future medical imaging apps. It is highly suggestive for the present study to be conducted among practicing radiographers to compare whether they have the same preferences of the areas or domains that can be incorporated in the apps compared to the students. The present study can also be used to investigate the lecturers' perceptions about web-based material including mobile apps to teach the various domains in medical imaging.

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