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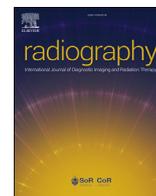
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Narrative Review

Harnessing the benefits of ChatGPT for radiography education: A discussion paper

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ABSTRACT

Objective: Radiography education is pivotal in training skilled radiographers for diagnostic imaging and therapeutic applications. With technological advancements, interest in innovative educational tools to enhance traditional teaching methods is growing. This discussion paper explores the possibility of the integration of ChatGPT, a cutting-edge conversational AI language model, into radiography education.

Key findings: We report that ChatGPT offers interactive learning opportunities that can facilitate learning. It also provides self-paced learning, revision platforms, and supports educators in scenario creation, assessment development, group collaboration, and professional and research activities. Despite these benefits, it is important to carefully consider issues related to academic integrity and privacy, along with the opportunities and challenges presented by this new technology in radiography education.

Conclusion: This paper highlights some of the prospects and limitations of the potential applications of ChatGPT in radiography education, underscoring the benefits for both students and educators. However, its implementation must be considered thoughtfully and ethically, taking into account its strengths and limitations.

Implications for practice: Integrating ChatGPT in radiography education has the potential to improve radiography education by improving digital literacy and graduate outcomes of students while streamlining the preparation process for educators. However, ethical implementation is vital for optimal outcomes.

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Introduction

ChatGPT, also known as Chat Generative Pretrained Transformer, is an Artificial Intelligence (AI) chatbot software produced by an AI company called OpenAI (<https://chat.openai.com>). It is a sophisticated natural language processing system which could have natural conversations while maintaining the context.¹

The introduction of Chat GPT in November 2022 caused great reactions in tertiary education training worldwide.^{1,2}

ChatGPT had over 1 million users within 5 days from its release³ and over 100 million subscribers within 2 months from its release.⁴ This level of impact shows how well it was received amongst the academic community.

However, there are some concerns about this AI tool. Particularly, some academics and professionals, including the radiography

workforce have expressed fears that the exposure of radiography and nuclear medicine students as well as some authors to ChatGPT could compromise academic integrity,⁵ and potentially affect the quality of the future workforce and healthcare. The concern stems from the already reported cases of contract cheating, and the use of the ghost-writing capabilities of ChatGPT by some students to commit academic fraud.⁶ The integration of AI-driven learning in healthcare education raises ethical considerations regarding patient privacy, data security, and the potential risk of over-reliance on AI systems.⁷

Consequently, many institutions have banned the use of ChatGPT by students for essay-based assignments, which is absolutely legitimate, due to academic misconduct and ethical issues. However, given the growing assimilation of AI tools into our everyday equipment and applications, this ban would be difficult to enforce, probably in the near future as change is the only constant in life. For example, Microsoft which we all use is integrating ChatGPT into their prevailing Office products under the brand name Microsoft 365 Copilot.⁴ When this is successfully incorporated, all

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institutions using Microsoft 365 will have the Software. This means that our policymakers would need to rethink our education systems in a way that would allow students and lecturers to use ChatGPT as a learning assistant while ensuring that they do not commit academic misconduct.⁴

In the meantime, we believe that the use of ChatGPT in education is not all that gloomy. We believe that the integration of AI technology in radiography education also has the potential to positively revolutionise the way radiography students learn and practice essential skills in medical imaging. Digital literacy continues to be a fundamental aspect of radiography training and should be a top priority for the graduate outcomes. This article, therefore, seeks to highlight some of the prospects and associated challenges or limitations of the potential applications of ChatGPT in radiography education through its beneficial impact on student learning outcomes and radiography lecturers.

Potential impact on radiography students

Interactive learning

ChatGPT can be utilised as a virtual radiography tutor,⁸ enabling students to engage in interactive learning sessions and receive immediate feedback on a wide range of radiography topics. While we are aware that ChatGPT 3.5 (which is a free version) cannot display images, it explores the impact of personalised learning experiences on students' ability to identify anatomical landmarks, identify features associated with different pathologies and measures to optimise image quality. Students can ask questions, and ChatGPT can provide immediate answers and explanations on various medical topics. It can also signpost students to the relevant learning materials. ChatGPT has the potential to support students in enhancing their reading comprehension abilities, particularly if English is not their first language. It can also simplify intricate subjects for those who are finding it challenging to grasp them through automated learning.⁹ Rahman and Watanobe¹⁰ mentioned the interactive nature of ChatGPT as one of its biggest advantages, where it allows students to ask questions as they would normally ask their tutor and receive immediate responses in natural language. While academics remain crucial to supporting students' learning in this regard, this feature of ChatGPT should be seen as a supportive tool to offer learners instant support and guidance, answering their questions, and offering feedback. Consequently, there are many positives to be gained by both the learner and lecturers when it is prudently embedded into the curricula and

the right ground rules and limitations of the AI tool are set and acknowledged by stakeholders.

While authors like Ray¹¹ suggest that ChatGPT often struggles to maintain context during extended conversations, it is believed that one reason for this is the presence of unclear or ambiguous questions. When users ask well-defined questions, ChatGPT can significantly enhance the overall user experience.¹² Despite the fact that ChatGPT offers valuable learning support to students, it is crucial to refrain from using it to generate responses for essay assignments and other school submissions due to ethical concerns related to academic misconduct. Such practices undermine the integrity of educational institutions. Another challenge of ChatGPT which needs to be taken note of when using it as an interactive learning tool is that it may not fully understand the context or the specific learning needs of the user, leading to inaccurate or irrelevant responses. Moreover, its responses can vary, and they may not always provide accurate or up-to-date information, which can be misleading for learners. To address these challenges, it is important to use ChatGPT as a complementary learning tool rather than a primary source of instruction. Furthermore, critical thinking, fact-checking, and human oversight are essential to ensure that students receive accurate and reliable information at all times.¹¹

Justification of imaging examinations

ChatGPT can be used as a clinical decision support tool for radiography students. A test was performed on ChatGPT to assess its effectiveness in justifying radiographic examination requests in different scenarios and the response was amazing.

It is important to note here that ChatGPT is not an authorised referral guideline and does not have access to all the referral guidelines used for justification, but details provided by almost all the referral guidelines seem to be evident in the responses provided by ChatGPT. A sample of such justification can be found in Fig. 1.

From ChatGPT's response in Fig. 1, a thorough investigation of all responses should be done. While RCR *iRefer* Guidelines,¹³ ECR *iGuide*,¹⁴ ACR appropriateness criteria¹⁵ and Diagnostic Imaging Pathways,¹⁶ do not recommend a chest x-ray just for suspected rib fracture, they do recommend when there is a suspicion of lung perforation due to rib fracture causing symptoms like difficulty breathing and severe chest pain. A similar approach using virtual patient educational tools has been shown to improve clinical reasoning skills.¹⁷ Liu et al.¹⁸ undertook a study to compare AI-generated suggestions with human-generated suggestions for optimising clinical decision support and found that 45 % (9 out of 20) of the highest-scoring (scores >75 %) suggestions were

Q: Chest x-ray for rib fracture. Is this a valid examination?

ChatGPT

“Yes, a chest X-ray can be a valid examination for assessing rib fractures. While a chest X-ray primarily focuses on imaging the lungs and heart, it can also capture the ribs and the bony structures of the chest. Rib fractures can often be seen on a standard chest X-ray, especially if the fracture is displaced or significant. However, it's important to note that not all rib fractures may be visible on a chest X-ray, particularly if they are minor or non-displaced. In some cases, additional imaging studies like a CT scan may be required to get a more detailed view of the ribs and to confirm the diagnosis.

If someone has sustained a significant injury to the chest or if there is a suspicion of rib fractures due to symptoms like chest pain, difficulty breathing, or tenderness over the ribs, a chest X-ray is usually one of the initial diagnostic tests performed by healthcare professionals. The results of the X-ray, along with the clinical assessment, can help determine the presence and extent of rib fractures and guide the appropriate treatment plan.”

Figure 1. ChatGPT's response to the validity of a chest x-ray for rib fracture request.

Q: Discuss how to position a patient for a chest X-ray examination

ChatGPT

“Positioning a patient properly for a chest X-ray is essential to obtain accurate and clear images. Here's a step-by-step guide on how to position a patient for a chest X-ray:

- 1. Explanation: Start by explaining the procedure to the patient to ensure they understand what is going to happen. Inform them that they will need to remain still during the imaging process.*
- 2. Patient Preparation: Ask the patient to remove any clothing or jewellery that might interfere with the X-ray images. Provide them with a hospital gown or appropriate cover to wear during the examination.*
- 3. Upright or Supine Position: There are two common positions for a chest X-ray: upright and supine. The choice of position depends on the patient's condition and capabilities.*
 - a. Upright Position: In this position, the patient stands in front of the X-ray machine with their hands on their hips and their back straight against the image receptor (a flat panel or cassette). The technologist will adjust the height of the X-ray machine to the patient's chest level and ensure that the patient's chest is parallel to the image receptor.*
 - b. Supine Position: If the patient is unable to stand or it's not safe for them to do so, they can be positioned in a supine (lying down) position. In this case, the patient lies flat on their back on the examination table, and the X-ray machine is positioned above the chest.*
- 4. Proper Alignment: Ensure that the patient is correctly aligned with the X-ray machine and the image receptor. The patient's mid-sagittal plane (an imaginary vertical line dividing the body into left and right halves) should be centred to the midline of the image receptor.*
- 5. Chin and Shoulder Position: For both positions (upright and supine), instruct the patient to raise their chin slightly to open up the chest area. This action helps prevent the clavicles from overlapping important lung structures. In the upright position, ensure the patient's shoulders are rolled forward to avoid superimposition on the lung fields.*
- 6. Breath Hold: Instruct the patient to take a deep breath in and hold it at the end of inspiration (maximum inspiration) during the exposure. This helps expand the lungs, providing better visualization of lung structures and reduces motion artifacts.*
- 7. Shielding: If applicable and appropriate, use lead shielding to protect other parts of the body from unnecessary radiation exposure. Shielding should be placed over sensitive areas like the thyroid and reproductive organs.*
- 8. Image Acquisition: The X-ray technologist or radiographer will then take the X-ray image by activating the X-ray machine. During the exposure, the patient must remain completely still.*
- 9. Post-Examination: After the X-ray is taken, review the image for quality and ensure all necessary anatomical structures are visible. If any issues are identified, the X-ray may need to be retaken.*

Proper patient positioning is crucial for obtaining high-quality chest X-ray images, and the radiologic technologist or X-ray operator should be well-trained to perform the procedure accurately and efficiently. Additionally, ensuring patient comfort and cooperation is essential during the imaging process.”

Figure 2. ChatGPT's response to “Discuss how to position a patient for a chest X-ray examination.”

provided by ChatGPT, indicating great potential in this area. We recommend that radiography students familiarise themselves with the relevant referral guidelines in their respective countries of study while considering the responses provided by ChatGPT. It is important to note that while ChatGPT can assist in medical education and clinical decision-making,¹⁹ it should not be seen as a replacement for the carefully developed and disease-specific referral guidelines intended for human pathologies. A significant limitation is its inability to consistently offer in-depth and accurate explanations of complex radiology and referral guidelines.²⁰ Additionally, there is a potential for it to provide incorrect or biased information, especially in academic or critical learning contexts. Therefore, its use should be approached with caution.^{20,21}

Augmenting practical skills

ChatGPT can complement hands-on training by offering virtual clinical practice opportunities. Students can describe positioning techniques, and ChatGPT can provide feedback on correct positioning and image quality, enhancing students' technical skills.

ChatGPT could also describe patient positioning, although without touching on every core detail. ChatGPT's ability to describe patient positioning for projection radiography is quite satisfactory. A sample of such interaction is presented in Fig. 2.

The step-by-step description as shown in Fig. 2 could be easily understood by most students, and the more inquisitive students would quickly realise there are a few missing points that could add more marks when included. While ChatGPT can be a valuable tool to reinforce basic clinical concepts, students should be aware of potential inaccuracies and complement their knowledge by consulting professionally recognised texts or recommended resources. The OpenAI team acknowledged a limitation of the ChatGPT model, which lies in its ability to generate responses that, while sounding plausible, may be incorrect or nonsensical.²²

Self-paced learning and revision

Medical students generally often face a vast amount of information to learn and retain.²³ ChatGPT can serve as a personalised study aid, allowing students to revise specific medical topics at

Q: Draw a labelled diagram showing the layers of an artery

ChatGPT

“As an AI language model, I'm unable to directly draw images. However, I can provide you with a description of a labelled diagram showing the layers of an artery, and you can create the diagram based on the description.

Labelled Diagram of an Artery:

An artery is a blood vessel that carries oxygenated blood away from the heart to various parts of the body. It has three main layers, also known as tunics, which are (from outermost to innermost):

1. Tunica Adventitia (Outer Layer):

- *This is the outermost layer of the artery.*
- *It is composed of connective tissue that provides strength and support to the vessel.*
- *It contains collagen fibres, which help anchor the artery to surrounding tissues.*

2. Tunica Media (Middle Layer):

- *This is the middle layer of the artery.*
- *It is primarily composed of smooth muscle cells and elastic fibres.*
- *The smooth muscle allows the artery to constrict (narrow) and dilate (widen) to regulate blood flow and blood pressure.*
- *Elastic fibres enable the artery to stretch and recoil, maintaining continuous blood flow even during the heart's relaxation phase (diastole).*

3. Tunica Intima (Inner Layer):

- *This is the innermost layer of the artery.*
- *It is composed of a thin layer of endothelial cells that form a smooth, friction-reducing surface for blood flow.*
- *The tunica intima is in direct contact with the blood flowing through the artery.*

Again, it's essential to have a visual representation for better understanding, so feel free to create a labelled diagram of an artery based on this description. There are various drawing tools and software available online that can assist you in creating the diagram easily.”

Figure 3. ChatGPT's response to “Draw a labelled diagram showing the layers of an artery.”

their own pace. Azevedo et al.^{24,25} demonstrated the benefits of intelligent tutoring systems in supporting self-regulated learning.

Since the beginning of the COVID-19 pandemic, there has been a drastic implementation of blended learning in many higher educational institutions across the world.²⁶ Even with the outstanding benefits of this method, some authors have suggested that a lack of information technology skills²⁷ could hinder many from benefiting much from blended learning. However, ChatGPT presents a simple user interface and great potential that could make it a one-stop shop for blended learning in the future. In their 2023 study, Yilmaz and Yilmaz²⁸ identified the primary constraints associated with the use of ChatGPT in programming education. These included the challenges of acclimating students to a potential decline in productivity, difficulty in responding to certain queries, and the provision of incomplete or inaccurate answers, which could potentially lead to professional anxiety among students. This means students should be mindful of these limitations when using the ChatGPT tool.

Medical terminology and anatomy learning

ChatGPT can help students with the memorisation of medical terminology, anatomical structures, and their relationships. By engaging in natural language conversations, radiography students can reinforce their understanding and retention of complex medical terms commonly seen on request forms from clinicians. These terms could be seen under the patient history and clinical indication subsections of the forms.

Students could also learn complex anatomy by easily looking up the location and boundaries on ChatGPT. Even without the ability to display images, ChatGPT is very good at describing structures and boundaries as usually seen on images. When asked to provide a labelled diagram of an artery, ChatGPT gave a very good description that would aid anyone with achieving a good diagram. A sample of the conversation is shown in Fig. 3.

A study by Uttal et al.²⁹ emphasised the importance of active engagement in learning science subjects including anatomy. To support this, a recent study³⁰ conducted to evaluate the accuracy of ChatGPT in identifying anatomical terminology yielded positive results. All 18 anatomy-structured interview questions were answered accurately, including clinical relevance and related structures. While this potential of ChatGPT is undoubtedly a significant advantage for improving student learning, educators must reconsider their approach to assessments, emphasising the process over the outcome.¹⁹ Specifically, online assessments, which were traditionally conducted remotely, require significant modification to adopt an open-book format, thus promoting critical thinking and problem-solving skills unless they are held on-site under supervision.

Potential impact on radiography lecturers

Creating academic scenarios and examples

ChatGPT can offer valuable support to lecturers, even though there will be a need for such support to be critically assessed. One of the ways lecturers can benefit from ChatGPT is to use it to create academic scenarios and examples quickly and affordably to engage students in discussions. Here the tutors could also pull up some ChatGPT content and critically appraise it with students. Recent publications,^{31,32} for example, have suggested that with the assistance of ChatGPT and other AI-powered tools, there could be no longer a need for lecturers to search only the internet for clinical cases or align curriculum to pre-built texts, but they could have greater freedom and help to design the case, allocate roles, patient

observations, including mannequin, or actor responses. We believe radiography could also benefit in the same way in line with our unique situation. A sample of the conversation is shown in Fig. 4.

ChatGPT could also be used as a tool to generate a sample-lesson plan from which educators can draw inspiration and develop their teaching in a way that aligns with best practices.

While authors such as Chrisinger³³ believe that ChatGPT is already coming for faculty members in terms of originality of content and laziness in lecture planning, we believe it could be a useful guide to meaningful suggestions about lesson plans and the creation of high-quality clinical scenarios that would streamline the preparation process and support the students' learning if used in

Q: Create a short scenario of poor infection control practices for radiography students to analyse and learn from. Give possible answers.

ChatGPT

“Scenario: Poor Infection Control Practices in a Radiology Department

Situation: As a radiography student on clinical rotation, you observe a scenario in a radiology department that raises concerns about infection control practices.

Scenario Description: You are observing a radiologic technologist performing a chest X-ray on a patient suspected of having tuberculosis (TB). During the procedure, you notice the following issues:

- 1. The technologist does not change gloves between interacting with the patient and adjusting the X-ray equipment.*
- 2. The patient is not wearing a surgical mask, and there is no protective barrier on the X-ray table.*
- 3. The technologist places the patient's personal items (jacket, bag) directly on the table where the patient lays for the X-ray.*
- 4. After the procedure, the technologist does not clean the X-ray equipment or the table before the next patient.*

Possible Questions for Analysis:

- 5. What specific infection control measures are being neglected in this scenario?*

- Changing gloves between patient contact and equipment handling.*
 - Ensuring proper respiratory hygiene, including having the patient wear a mask.*
 - Using protective barriers to prevent contamination of the X-ray table.*
 - Cleaning and disinfecting equipment and surfaces between patients.*
- 6. What are the potential consequences of these poor infection control practices?*
 - The technologist may inadvertently transfer pathogens from the patient to the equipment and surfaces, increasing the risk of cross-contamination.*
 - Patients and healthcare workers in the department may be exposed to infectious agents, including TB.*
 - Failure to use proper protective measures can contribute to the spread of infections within the healthcare facility.*
 - 7. How might this situation impact patient safety and healthcare worker health?*
 - Patients undergoing X-rays may contract infections due to contaminated equipment and surfaces.*
 - Healthcare workers, including the radiologic technologist, may be at risk of contracting infections from unprotected exposure.*
 - 8. What steps should be taken to address these issues and improve infection control practices in the radiology department?*
 - The technologist should change gloves between patient contact and equipment handling.*
 - Patients suspected of having TB should be provided with surgical masks to prevent the spread of infectious droplets.*
 - Protective barriers (e.g., disposable drapes) should be used on equipment surfaces.*
 - Proper cleaning and disinfection protocols should be followed between patients.*
 - 9. How can radiography students and healthcare staff be educated and trained to ensure better infection control practices?*
 - Provide comprehensive training on infection control protocols specific to radiology procedures.*
 - Emphasize the importance of consistent glove changes, protective barriers, and proper equipment cleaning.*
 - Conduct regular audits and evaluations to ensure compliance with infection control guidelines.*

By analyzing this scenario, radiography students can gain insights into the critical nature of infection control in radiology settings, understand the potential risks of poor practices, and learn how to implement effective measures to ensure patient and healthcare worker safety.”

Figure 4. ChatGPT's response to “Create a short scenario of poor infection control practices for radiography students to analyse and learn from. Give possible answers”.

proper alignment with best practices. Despite ChatGPT's value as an aid in the preparation process, it must be emphasised that it cannot replace real-time interactions between educators and students in a classroom setting.⁹

Supporting assessments creation

ChatGPT could also be used by radiography educators to create assessments, particularly formative assessments with answers to engage with their students. These could be *Objective Structured Clinical Examination (OSCE)*, *multiple-choice questions (MCQ)* or *written questions*. A sample of the conversation is in Fig. 5.

From Fig. 5, it can be seen that ChatGPT does not only provide a question and answer, but it also explains and justifies the decision for not selecting the other options as the right answer.

Moreover, it can be utilised to create a number of distractors that are plausible but incorrect answers to the MCQs. These distractors are needed in MCQs because they help test the depth and accuracy of the students' knowledge and understanding.³⁴ Here the lecturer could ask ChatGPT to generate possible distractors and iterate them till they are considered satisfactory. This would be important for educators in radiography as it is always a daunting task to produce fresh and equally good distractors, especially for higher-order thinking objectives.

Although ChatGPT has been criticised for underperforming in generating correct answers to questions in radiography written exams,⁵ we believe that it is a useful tool in the creation of assessment questions and could be more accurate in tailoring questions to needs if fed with the right content from the specific teaching resources.

Group work and peer discussions

ChatGPT can also be used by lecturers to promote group work and peer discussions. One of the means of ensuring effective peer

discussion is through the provision of opportunities for participants to pair-share.³⁵ This is a handy tool that lecturers can use for a group of students to develop and discuss content in class or remotely. Lecturers could even ask students to criticise ChatGPT essays and learn through this.

The potential limitation of this application would be the general challenges of academic group learning, such as communication abilities impacting the students' confidence and enjoyment of the topic when working in groups,³⁶ but this is not directly linked to the process of topic or activity creation.

Professional development and research

ChatGPT can significantly support radiography lecturers in staying updated with current trends and best practices within the field by acting as personalised assistants. Xu et al.³⁷ did a comparative study of search performance and user experience between ChatGPT and Google search and concluded that there was no significant difference in the performance of both, but user experience gave better ratings to the ChatGPT user-group as they completed their tasks faster than the group which used Google search. In terms of research, ChatGPT can also be used to identify topical research areas in radiography and automate the process of identification of relevant information from a vast number of scientific publications which is often time-consuming and labour-intensive to do. However, the utilisation of ChatGPT in scientific papers gives rise to ethical dilemmas, methodological and copyright considerations, and, in certain instances, the risk of incorporating inaccurate content. While it can aid in composing papers using evidence from online search engines, it cannot fully conduct an exhaustive literature review or engage in critical analysis and discussion.¹⁹ It also needs to be emphasised that excessive reliance on ChatGPT for medical knowledge might discourage researchers or students from cultivating their critical thinking skills and conducting independent research.

Q: Provide a sample multiple-choice question (MCQ) on the principle of radiation protection in radiography.

ChatGPT

“Question: Which of the following best describes the primary goal of the ALARA principle in radiation protection?”

- A) Achieving the highest image quality in radiographic examinations.*
- B) Minimizing radiation exposure to patients and healthcare workers.*
- C) Using the maximum allowable radiation dose for optimal diagnostic outcomes.*
- D) Focusing on rapid image acquisition to reduce patient discomfort.*

Correct Answer: B) Minimizing radiation exposure to patients and healthcare workers.

Explanation: The ALARA principle (As Low As Reasonably Achievable) is a fundamental concept in radiation protection. Its primary goal is to minimize radiation exposure to patients, healthcare workers, and the general public while still obtaining diagnostic images of acceptable quality.

A) While image quality is important, the ALARA principle emphasizes dose reduction as the primary goal. C) The ALARA principle encourages minimizing radiation doses beyond merely using the maximum allowable dose. D) Rapid image acquisition can be a goal, but the ALARA principle specifically emphasizes dose reduction.

By choosing option B, radiographers prioritize the safety and well-being of patients and healthcare personnel while maintaining diagnostic accuracy.”

Figure 5. ChatGPT's response to “Provide a sample multiple-choice question (MCQ) on the principle of radiation protection in radiography.”

Conclusion

This paper highlighted some of the prospects and limitations or challenges of the potential applications of ChatGPT in radiography education, emphasising the means students and educators could utilise the AI tool to their advantage. ChatGPT holds the promise of transforming radiography education by simplifying the process. Radiography educators have a vital role in equipping radiography students for a career that embraces technology integration. The introduction of ChatGPT brings forth both possibilities and hurdles. It is important to acknowledge that while ChatGPT can be a valuable educational tool, it should not replace traditional teaching methods or the importance of real patient interactions and clinical experiences. Therefore, implementing or utilising ChatGPT in radiography education should be done thoughtfully and ethically, considering its strengths and limitations.

Definition of terms and abbreviations

Technologist is the same as Radiographer.
 ChatGPT is Chat Generative Pre-Trained Transformer.
 MCQs is Multiple-choice questions.
 OSCE is Objective Structured Clinical Examination.
 ACR is American College of Radiology.
 RCR is Royal College of Radiology.
 ECR is European College of Radiology.

Conflict of interest statement

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