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Research Article

The American Society of Radiologic Technologists (ASRT) AI educator survey: A cross-sectional study to explore knowledge, experience, and use of AI within education

Nikolaos Stogiannos[a,b,*], Michael Jennings[c], Craig St George[d], John Culbertson[e], Hugh Salehi[f], Sandra Furterer[g], Melissa Pergola[h], Melissa P. Culp[i] and Christina Malamateniou[a,j,k]

[a] *Department of Midwifery & Radiography, School of Health and Psychological Sciences, City, University of London, UK*
[b] *Magnitiki Tomografia Kerkiras, Corfu, Greece*
[c] *Senior Research Analyst, American Society of Radiologic Technologists, New Mexico, USA*
[d] *Director of Education, American Society of Radiologic Technologists, New Mexico, USA*
[e] *Director of Research, American Society of Radiologic Technologists, New Mexico, USA*
[f] *Department of Biomedical Industrial & Human Factor Engineering, Wright State University, Ohio, USA*
[g] *Department of Integrated Systems Engineering, The Ohio State University, Ohio, USA*
[h] *Chief Executive Officer, American Society of Radiologic Technologists, New Mexico, USA*
[i] *Executive Vice President of Member Engagement, American Society of Radiologic Technologists, New Mexico, USA*
[j] *Discipline of Medical Imaging and Radiation Therapy, College of Medicine and Health, University College Cork, Ireland*
[k] *European Society of Medical Imaging Informatics, Vienna, Austria*

ABSTRACT

Introduction: Artificial Intelligence (AI) is revolutionizing medical imaging and radiation therapy. AI-powered applications are being deployed to aid Medical Radiation Technologists (MRTs) in clinical workflows, decision-making, dose optimisation, and a wide range of other tasks. Exploring the levels of AI education provided across the United States is crucial to prepare future graduates to deliver the digital future. This study aims to assess educators' levels of AI knowledge, the current state of AI educational provisions, the perceived challenges around AI education, and important factors for future advancements.

Methods: An online survey was electronically administered to all radiologic technologists in the American Society of Radiologic Technologists (ASRT) database who indicated that they had an educator role in the United States. This was distributed through the membership of the ASRT, from February to April 2023. All quantitative data was analysed using frequency and descriptive statistics. The survey's open-ended questions were analysed using a conceptual content analysis approach.

Results: Out of 5,066 educators in the ASRT database, 373 valid responses were received, resulting in a response rate of 7.4%. Despite 84.5% of educators expressing the importance of teaching AI, 23.7% currently included AI in academic curricula. Of the 76.3% that did not include AI in their curricula, lack of AI knowledge among educators was the top reason for not integrating AI in education (59.1%). Similarly, AI-enabled tools were utilised by only 11.1% of the programs to assist teaching. The levels of trust in AI varied among educators.

Conclusion: The study found that although US educators of MRTs have a good baseline knowledge of general concepts regarding AI, they could improve on the teaching and use of AI in their curricula. AI training and guidance, adequate time to develop educational resources, and funding and support from higher education institutions were key priorities as highlighted by educators.

RÉSUMÉ

Introduction: L'intelligence artificielle (IA) révolutionne l'imagerie médicale et la radiothérapie. Des applications alimentées par l'IA sont

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* Corresponding author.
E-mail addresses: nikos.stogiannos@city.ac.uk (N. Stogiannos), mculp@asrt.org (M.P. Culp).

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déployées pour aider les technologues en radiation médicale (TRM) dans les flux de travail cliniques, la prise de décision, l'optimisation des doses et un large éventail d'autres tâches. L'exploration des niveaux d'éducation à l'IA fournis à travers les États-Unis est cruciale pour préparer les futurs diplômés à offrir l'avenir numérique. Cette étude vise à évaluer les niveaux de connaissance des éducateurs en matière d'IA, l'état actuel des dispositions éducatives en matière d'IA, les défis perçus autour de l'éducation à l'IA et les facteurs importants pour les progrès futurs.

Méthodologie: Une enquête en ligne a été menée auprès de tous les technologues en radiologie figurant dans la base de données de l'American Society of Radiologic Technologists (ASRT) et ayant indiqué qu'ils jouaient un rôle d'éducateur aux États-Unis. L'enquête a été distribuée aux membres de l'ASRT de février à avril 2023. Toutes les données quantitatives ont été analysées à l'aide de statistiques de fréquence et de statistiques descriptives. Les questions ouvertes de l'enquête ont été analysées à l'aide d'une approche conceptuelle d'analyse de contenu.

Résultats: Sur les 5066 éducateurs figurant dans la base de données de l'ASRT, 373 réponses valides ont été reçues, soit un taux de réponse de 7,4%. Bien que 84,5% des éducateurs répondants aient exprimé l'importance d'enseigner l'IA, 23,7% d'entre eux ont actuellement inclus l'IA dans leur programme d'études. Parmi les 76,3% qui n'ont pas inclus l'IA dans leurs programmes, le manque de connaissances des éducateurs en matière d'IA était la principale raison de ne pas intégrer l'IA dans l'enseignement (59,1%). De même, les outils basés sur l'IA n'ont été utilisés que par 11,1% des programmes pour faciliter l'enseignement. Les niveaux de confiance envers l'IA varient d'un éducateur à l'autre.

Conclusion: L'étude a révélé que, bien que les éducateurs américains de TRM aient une bonne connaissance de base des concepts généraux concernant l'IA, ils pourraient améliorer l'enseignement et l'utilisation de l'IA dans leurs programmes. La formation et l'orientation en matière d'IA, le temps nécessaire à l'élaboration de ressources pédagogiques, ainsi que le financement et le soutien des établissements d'enseignement supérieur sont les principales priorités mises de l'avant par les éducateurs.

Keywords: Artificial intelligence; Education; Medical radiation technology

Introduction

Artificial Intelligence (AI) is already starting to revolutionise many sectors of the workforce, and its use in healthcare is promising, since it can harness digital data to enhance patient experience and improve the existing clinical workflows [1,2]. There has been an exponential increase in the usage of AI, and in the diversity of accredited AI-enabled clinical applications in medical imaging and radiotherapy [3,4]. This has resulted, in most cases, in improved efficiency and efficacy [5]. The medical radiation technologists' (MRTs) profession, known as radiographers in most of Europe and other continents, is central to the rapid growth of AI in this field, since AI is transforming clinical workflows, and it augments certain operational tasks performed by MRTs. Currently, there are many AI-enabled tools which can provide automated patient positioning, protocol optimisation or slice prescription [6], more efficient image post-processing techniques [7], reduced image acquisition times, optimal radiation protection [8], image quality enhancement, and many more.

To achieve a safe, successful, and smooth implementation of AI in clinical practice, it is imperative to ensure optimal AI education and training for all clinical practitioners. Regarding MRTs, AI education is critical for the successful implementation of AI in clinical practice, as they can be key players in the evaluation, clinical use, and post-market monitoring of AI tools [9]. Professional societies have already embedded AI education and training in their career frameworks [10], while AI digital competences are now a requirement for radiographer registration in countries like the UK [11]. In the United States, the American Society of Radiologic Technologists (ASRT) was the first of all radiographer/MRT professional bodies globally to publish a white paper on the role of MRTs in the AI era, exploring the perspectives of MRTs, recognizing the upcoming changes for the profession and highlighting the need to optimally train the workforce to overcome any challenges associated with the use of AI technology in this space [12]. Other MRT societies followed and have now also published on this topic [13,14]. Some researchers have referenced ASRT's white paper and have used it as inspiration for research project planning in the MRT domain [15-17].

In the realm of AI in MRT practice, it has been suggested that blended-learning strategies, and a varied curriculum and customized AI education, are needed to adequately train MRTs to meet the demands of an AI-enabled present and future. Blended learning involves a combination of traditional face-to-face learning and synchronous or asynchronous e-learning, and it has been increasingly used in medical/clinical education, particularly so after the pandemic years [18]. The topics to be taught could include AI basics, governance and ethics, clinical applications of AI, evaluation frameworks, impact on professional identity and more [19]. However, an insufficient offering of AI education has been noted among MRT professionals in the literature until 2022, despite their excitement about AI technologies [20,21]. Recent research, however, has shown that MRTs have placed AI education and training within their top priorities for AI implementation in their workplace [1]. It has been noted that the majority of AI education and training opportunities currently offered are aimed at radiologists. Most of the available training for MRT professionals lacks a formalized, evidence-based format provided by universities or professional bodies, and it remains vastly industry-focused and discipline-specific [22].

Educational curricula for MRT professionals should aim to provide high-quality AI courses to ensure that future graduates are adequately educated to meet the demand for highly skilled professionals working in an AI-driven environment [23]. Therefore, it is vital for all educators teaching MRT students to integrate AI education and training in academic curricula, and to develop optimal learning and assessment strategies for their students.

To the best of our knowledge, there are no published studies exploring the MRT educators' perspectives on AI education and training in the United States. This study aims to explore the current state of AI education in the United States among MRT educators and academics, their use of AI-enabled tools to assist teaching, the perceived challenges around AI education, and to provide suggestions for future improvement of educational content and delivery.

Methods

Reporting

This is a cross-sectional study employing an online survey; thus, presentation of this work is aligned with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [24] and the Checklist for Reporting Results of Internet E-Surveys (CHERRIES) [25].

Instrument

An online survey was built in Checkbox, version 8.3.0 (Checkbox Technology, Inc., San Francisco). The survey questions were based on previously implemented surveys on AI usage [26,27], with input from AI experts in medical imaging and radiation therapy. The ASRT research department provided further guidance on survey questions and structure, with support from the ASRT senior executive and leadership team. The survey consisted of 37 total questions: 7 demographic questions, 26 closed-type questions related to AI, and 4 open-ended questions that allowed respondents to enter free-text responses. The approximate time needed to complete the survey was 15 minutes.

Conditional and branching questions were employed to automatically modify the order and appearance of survey questions according to the respondents' demographic characteristics and previous responses. This is an efficient strategy to reduce the number and complexity of questions and minimise the duration of the survey [25].

The first section of the survey gathered the respondents' key demographic data: age, gender, years of experience in education, current role, geographical location, and the type of educational program at which they work.

Respondents were then asked to report whether they included any educational content on AI in their curricula, and if so, to describe the format of delivery of the lessons, and the AI-specific topics taught. The respondents were then prompted to describe the most important factors required to support the development of AI-themed education, including any help that could be provided by the ASRT. In addition, they were asked if teaching MRTs about AI was a priority for them, and if their students enjoyed being trained on AI. This survey also assessed the use of AI-enabled tools for teaching purposes, and the educational content delivered with the use of AI technology. Finally, all respondents were encouraged to freely comment on anything else they felt was essential regarding AI training in MRT.

Participants

The survey was sent electronically to all United States-based educators in medical imaging and radiation therapy in the ASRT database, excluding those who had opted out of receiving electronic communication from ASRT. Hence, this survey was electronically sent to 5,066 educators working in all imaging and radiation therapy disciplines in both clinical and didactic settings.

Data collection

This survey was launched on February 24, 2023, and the data collection process lasted until April 19, 2023. A survey link was distributed to selected participants via personalized email. During the data collection period, email reminders were sent (n=3) to maximise participation. Because no items on the survey were mandatory, any respondent who reached the completion page of the survey was considered a "completed response", even if they did not answer every item. For purposes of analysis, any response to a given item was treated as valid; if a respondent skipped an item, their response was considered invalid. All answers were checked by a person of the ASRT research team to ensure completeness.

Data analysis

All quantitative data were analysed using descriptive and frequency statistics. Graphs and tables were also created to better visualise findings. Regarding the responses received for the open-ended questions of the survey, a conceptual content analysis strategy was employed to analyse qualitative data. This is a well-established data analysis approach used in qualitative research to transform text into a concise and organised summary of key results [28]. Content analysis was performed using the inductive approach, hence all themes and respective categories derived from the raw data after iterative coding.

Ethics

The mission of the ASRT is to advance and elevate the medical imaging and radiation therapy profession and to enhance the quality and safety of patient care [29]. The ASRT, therefore, surveys its membership as part of routine internal audit and evaluation to better support its members and mission.

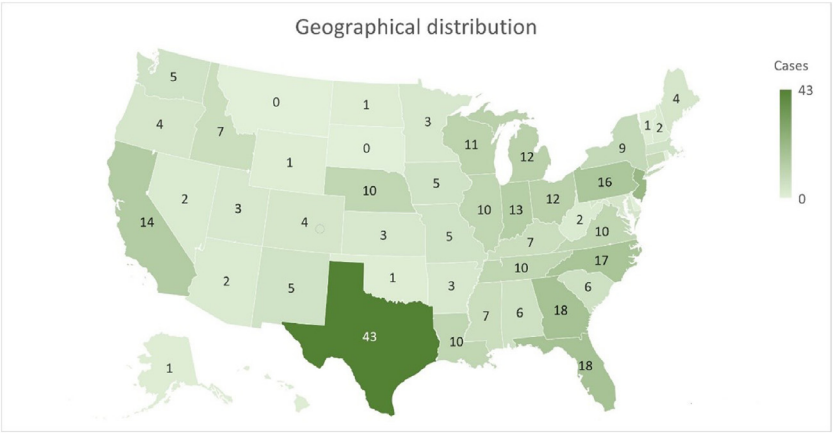

Fig. 1. Geographical distribution of responses across the States.

The survey and analysis within this manuscript was conducted by the ASRT as part of this routine internal audit and evaluation practices; hence, this survey did not need approval by an ethics review board. The research team observed all key principles of research governance, like informed consent, anonymity, and confidentiality [30,31].

This survey was completed within all terms of agreement with members. Only members who have opted-in to receive communications and elected to participate in ASRT research surveys were included in the sample. Survey completion was totally voluntary and did not result in any rewards (if completed) or disadvantage (if not completed) for ASRT members. In addition, all responses were automatically anonymised, therefore, no personal identifiable information of the respondents was released to the research team.

The ASRT releases all data and analysis associated with this member survey to the authors for publication, as these insights are important for advancing the profession longitudinally and globally.

Results

Out of 5,066 educators, a total of 373 valid responses were received, which yielded a response rate of 7.4%.

There were no required answers to any of the questions in the survey. Respondents were free to answer (or not answer) each question. Consequently, the actual number of responses given for each survey question was not the same across the survey. The following results include both the number of responses (frequencies) received for each question and the corresponding percentages.

Demographics

The first section of this survey asked respondents to provide demographic data (see Table 1).

See Fig. 1 for the detailed geographical distribution of responses by state.

The respondents were asked to report their highest level of education that was offered by their program. Nearly a third (120/373, 32.2%) indicated that master's degree was the highest qualification offered, followed by Associate Degree (108/373, 29%), Bachelor's Degree (87/373, 23.3%), and Doctoral Degree (33/373, 8.8%). Other responses (25/373, 6.7%) included certificates or education in applications training.

Table 1
Basic demographic data of the respondents.

Gender	Female	74.5%
	Male	24.5%
	Prefer not to say	1%
Age	20-29 years	1.4%
	30-39 years	12.6%
	40-49 years	29.6%
	50-59 years	28.5%
	>60 years	27.9%
Experience in education	0-5 years	17.9%
	6-9 years	18.7%
	10-19 years	33.3%
	20-29 years	20.1%
	>30 years	10%
Setting where educator was primarily based	University/College	69.5%
	Clinical setting	12.9%
	Equipment vendor	8.5%
	Other	9.1%
Disciplines of MRT primarily taught	Radiography	78.3%
	CT	15.8%
	MRI	11.8%
	Interventional (CV, CI, VI)	8.6%
	Radiation Therapy	6.7%
	Mammography	6.4%
	Sonography	5.6%
	Nuclear Medicine	3.8%
	Quality Management	1.9%
	Dosimetry	1.6%
	Bone densitometry	1.6%
	Radiologic Assistant	1.1%
	Other	6.7%

Knowledge of AI among educators

The survey provided all respondents with conventional definitions of AI and Machine Learning (ML), as follows: for AI:

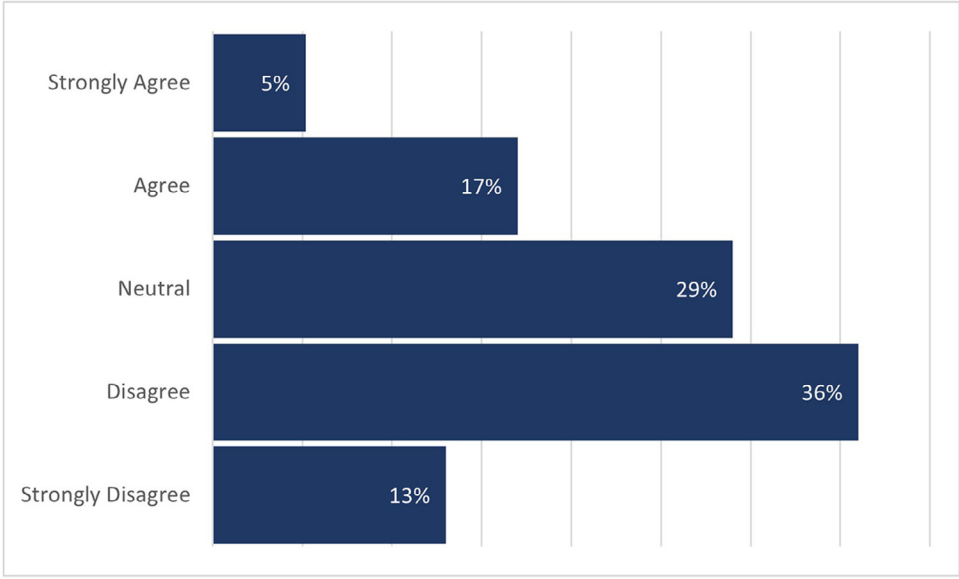

Fig. 2. Level of agreement for ''I have appropriate training to learn and apply new technology, including AI/ML automation".

"Human intelligence exhibited by machines; the science of designing computer systems to perform tasks that require human intelligence, including visual perception, speech recognition and decision-making", and for ML :"Approach to achieve artificial intelligence; a type of artificial intelligence that provides computers with the ability to learn without being programmed. Using a set of algorithms, the computer reviews large data sets, looks for patterns and makes predictions that improve with increased exposure to data" [32]. They were then asked to indicate their level of familiarity with these concepts. Out of 372 responses received for this question, 358 (96.2%) reported being familiar with AI, as defined, and 14 (3.8%) did not. Similarly, 295 (79.3%) were familiar with ML, as defined. Importantly, most of the respondents (361/371, 97.3%) said that these definitions of AI and ML were in line with their understanding of these concepts.

Respondents were also asked to indicate their level of agreement with the statement, ''I have appropriate training to learn and apply new technology, including AI/ML automation". The responses are summarised below (see Fig. 2). A 22% of the respondents answered this question favourably (strongly agree and agree), while 49% answered the question unfavourably (strongly disagree and disagree).

AI education provisions

Regarding the importance of teaching AI in educational programs, 84.5% (315/373) of the respondents said that they felt it is important, in contrast to those who felt it is not important (58/373, 15.5%).

An open-ended follow-up question asked respondents to explain why they feel teaching AI is important or unimportant. A content analysis identified the most important themes in their respective rationales (see Table 2).

Most respondents stated that their educational programs (283/371, 76.3%) did not include AI in their curricula. Only a quarter (88/371, 23.7%) have integrated AI-related education into their programs.

Respondents who indicated that their programs did not include education on AI were asked to report the main reasons for not including it in their curricula (see Fig. 3).

Of those who answered that they provided courses on AI in their educational programs, almost half (41/87, 47.1%) said that they followed a didactic approach, followed by those who delivered short courses in-person (27/87, 31%), asynchronous (25/87, 28.7%) and synchronous online courses (24/87, 27.6%), simulation-based (20/87, 23%), hands-on training (17/87, 19.5%), scenario-based learning (13/87, 14.9%), role playing (9/87, 10.3%), use of virtual reality (9/87, 10.3%), and a flipped classroom approach (9/87, 10.3%). Workshops, series of seminars/webinars, masterclass sessions, and multidisciplinary approaches were used less. Other responses included AI being taught only as a small part of lectures and sessions, being part of discussions, or having the form of literature searching and article reading assignments.

Those who offered AI education in their educational programs were also asked to indicate the AI-related topics that were included in these curricula, and these have been summarised below (see Table 3).

Respondents were asked to discuss the factors they believe are important in enabling educators to effectively teach AI. The content analysis defined three major themes that are depicted below (see Fig. 4).

Teach not just "about" but "with" AI

Most of the respondents (327/368, 88.9%) said that their curriculum delivery did not use any AI-enabled tools. Of those

Table 2
Themes and categories around importance of teaching AI.

Reasons for believing teaching AI is important	**Benefits of AI** • Transformation of medical imaging • AI will improve patient care • AI will assist MRTs • AI will advance teaching **AI applications** • Increasing use in medical imaging • AI will be the future of healthcare • AI will be part of everyday life **Awareness and currency of knowledge** • Evolving technology • Keep up with technology • Maintain social currency • Ensure graduates' understanding of AI
Reasons for believing teaching AI is NOT important	**Impact of AI** • Not affecting MRTs right now • Not relevant to practice yet • Not capable of providing the human touch **Personal preferences** • I do not like the concept of AI **Educational issues** • Not best for clinical education • Should be taught only as introduction • Only in Continuing Professional Development (CPD) format

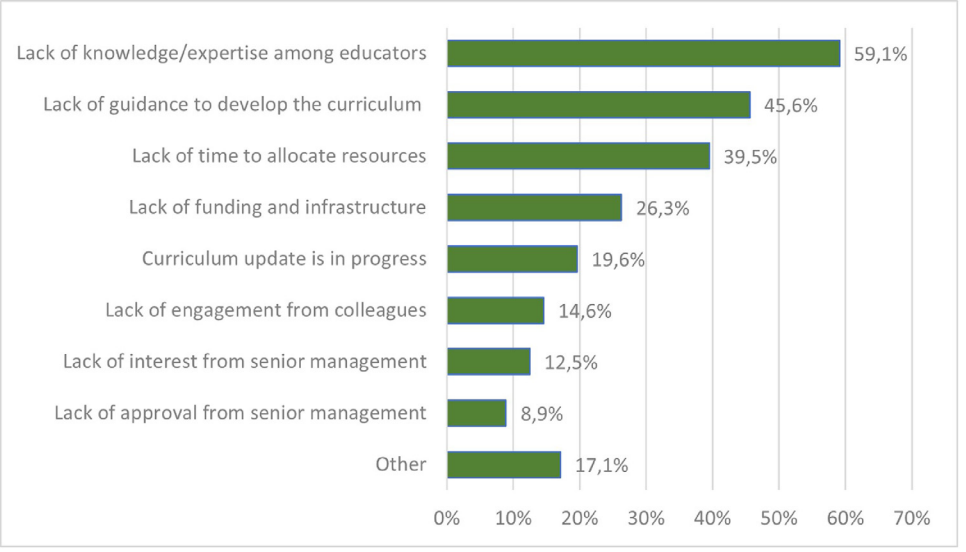

Fig. 3. Main reasons for not including education in AI in curricula.

few who used AI-enabled tools for teaching/learning, almost a third (13/41, 31.7%) said that their students often used (67-99% of the time) some AI-enabled feature on clinical equipment, a third (13/41, 31.7%) said they used them sometimes (34-66% of the time), a fifth (8/41, 19.5%) used them rarely (1-33% of the time), 12.2% (5/41) used them always, and 4.9% (2/41) never used them.

When AI-enabled tools are used, it is to teach general curriculum concepts (21/39, 53.8%), for exam practice (20/39, 51.3%), or to allow students to test their knowledge on a topic (15/39, 38.5%). About a quarter (10/39, 25.6%) used AI-enabled tools to teach AI concepts, and to deliver formative feedback (8/39, 20.5%), during final assessments (7/39, 17.9%), or as a way of adaptive learning (4/39, 10.3%).

Patient positioning was the topic most commonly taught using AI-enabled tools (19/38, 50%), followed by image quality assessment (16/38, 42.1%), radiation physics (16/38, 42.1%), pathology (14/38, 36.8%), anatomy (13/38, 34.2%), radiographic anatomy (12/38, 31.6%), radiation protection (11/38, 28.9%), patient care (9/38, 23.7%), communication skills

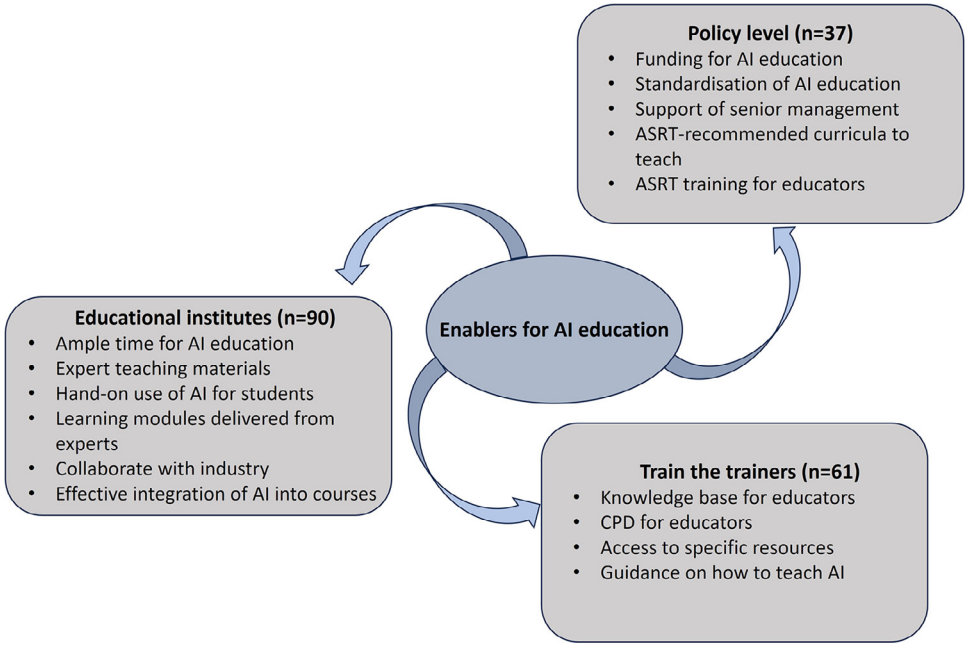

Fig. 4. Themes (with respective frequencies) and categories derived from content analysis regarding factors of AI education, according to educators.

Table 3
AI-related topics included in educational programs.

AI clinical applications	64%
AI basic principles	58.1%
AI terminology and concepts	50%
AI in different modalities	50%
Impact of AI on workflows	34.9%
AI ethics	20.9%
Acceptability of AI technology	14%
AI in different pathologies	11.6%
AI governance and regulation	11.6%
AI evaluation and validation	11.6%
Manufacturer roadshows for specific products	7%
Other	7%

(6/38, 15.8%), and professionalism classes (4/38, 10.5%). Additionally, 13.2% (5/38) reported using AI-enabled tools for all aspects of teaching/learning.

MRT educators said that their institutions used AI-based software for treatment planning, simulation of MRI scanning environments, as a training software for ultrasound scanning, as part of video-based training to prepare for registry examinations, while some of them used writing correction software to assist in the preparation of assignments, AI-based software to identify potential plagiarism, or generative AI tools to allow interaction and dialogue between users and AI for various tasks.

Trust in AI

Educators were asked whether they considered AI reliable and almost failure free. Most (243/361, 67.3%) said no, compared to those who considered AI technologies reliable (118/361, 32.7%). Following that, they were asked to report how frequently they think that AI can produce consistent outcomes. However, most (255/363, 70.2%) thought that AI can often generate consistent outcomes. Regarding medical image processing, about half (180/366, 49.2%) believed that bias can occur when this is performed by AI tools, while almost half (169/366, 46.2%) were unsure about any type of potential bias.

Work culture

When asked about the support they received from department leaders or management for implementing new processes or procedures related to new technologies such as AI/ML, many respondents (158/368, 42.9%) were neutral, indicating neither strong support nor lack of support. Roughly equal numbers felt they received appropriate support (88/368, 23.9%) as felt they did not receive sufficient support (82/368, 22.3%).

Regarding work culture in their environments, almost half of the respondents agreed (122/367, 33.2%) or strongly agreed (48/367, 13.1%) that their work culture was supportive of implementing new technologies, and 43.6% (160/367) were neutral. Approximately one out of ten disagreed (28/367, 7.6%) or strongly disagreed (9/367, 2.5%) with that.

AI development

The vast majority (360/367, 98.1%) of the respondents believed that technology companies and medical imaging equipment vendors should seek guidance from practicing MRT professionals when developing AI tools to create useful algorithms. Similarly, most (316/362, 87.3%) said that the above professionals would be interested in being involved in helping AI developers.

Table 4
Respondents' comments on AI training of MRTs.

Challenges of AI education (n=17)	• Current teaching may become obsolete • Not enough time for AI education • Potential risks of AI-assisted writing in education • Potential misuse of AI from students • Lack of funding at universities • Lack of educational resources
Priorities for AI education (n=16)	• Educators must be educated first • AI training must be standardised • AI must be integrated to all academic curricula • ASRT training/resources needed • Peer teaching/collaboration needed • Educators should embrace AI and adapt to technology
Professional issues (n=14)	• MRTs must embrace AI • Need to build trust on AI technology • Fears of staff becoming deskilled • Potential risk of over-reliance on AI
Patient care (n=11)	• MRTs must focus on patients • Fears of MRTs not interacting with patients • We must maintain human touch • Ensure care and safety • Fears of AI affecting care

Future of the profession

Respondents were asked to indicate whether they felt that AI threatens their job or not. A large percentage (313/369, 84.8%) did not believe that AI threatens their job, compared to 15.2% (56/369) who said the opposite. However, over half (248/364, 68.1%) believed that AI can deskill professionals, when used too frequently. Working with AI was not thought to be a stressful concept for over two thirds (252/367, 68.7%) of the respondents.

Slightly over half (198/362, 54.7%) of the respondents believed that MRT professionals will leave patient-centred clinical work in favour of working for technology companies developing AI tools, compared to those who did not believe this (164/362, 45.3%).

The future of the medical imaging and radiation therapy profession is viewed to be more positive with the implementation of AI for many of the respondents (295/358, 82.4%).

Finally, the respondents were asked to freely express any other comments related to AI training of MRTs. The content analysis identified four themes and their respective categories (see Table 4).

Discussion

Educators' AI knowledge

Although most MRT educators were familiar with the basic concepts and definitions around AI, 49% indicated that they do not have appropriate training to learn and apply new technology, including AI/ML/automation. This corroborates previous findings from different disciplines, where it has been argued that educators in health professions demonstrate a general lack of expertise on how to teach AI in their curricula [33], and that there is lack of learning theories, paedagogical tools and AI-specific educational textbooks [34]. Hence, it has been documented that providing optimal AI training to educators is one of the most important aspects of the operational dimension of AI education [35]. Collaboration between faculty members, multidisciplinary teams and AI industry experts within or outside the University could be a good starting point to acquire essential knowledge on teaching AI concepts, as this has been demonstrated to be a sustainable way for high quality, state-of the-art AI teaching for MRTs from previous successfully delivered AI programmes [19]. While Universities could certainly benefit from engaging with AI experts to bring their expertise to these institutions, it should be also noted that employing MRTs to teach AI will offer the advantage of providing profession-specific examples and guidance related to AI, since they are the only ones with knowledge of clinical practice and related technologies in the MRT context [36]. Currently, there is a paucity of studies assessing educators' level of AI knowledge, and this should be prioritised to allow the academic community to reflect on knowledge gaps and work towards building and sustaining academic expertise on AI education.

Teaching about AI

Securing adequate funding to develop and acquire resources to integrate AI education in academic curricula has also been highlighted from the findings of this study. This has been confirmed by previous research, where educators from different disciplines placed lack of funding as an important challenge for AI education delivery [37,38]. In addition, educators sought specific guidance on the development of teaching resources.

Providing AI education represents a vital aspect of AI implementation [9]. Recent research has shown that comprehensive AI policies should be implemented in higher education institutions, and that specific educational frameworks need to be developed [35]. Furthermore, professional bodies and educational societies should support educators by developing resources and providing expert knowledge to assist with the integration and standardisation of AI-related educational curricula.

With regards to the topics taught by educators, AI governance and ethics of AI were not referred to as often as one might have expected. Ethical and responsible use of AI in MRT has been highlighted as a requirement to ensure data privacy, patients' rights, optimal health outcomes, and informed decision-making [22]. Also, AI governance frameworks are needed to guide all professionals into the evaluation, clinical use, monitoring, and procurement of AI tools in MRT [9,19]. MRTs globally seem eager to adopt these technologies under an ethical framework [27]. Therefore, it is imperative that all MRT educators prioritise teaching of AI ethics and governance to ensure that future graduates are well-informed about these requirements. All the above AI topics could be effectively delivered by employing blended learning strategies, since it has been proved that this way of delivery can positively impact on the students' level of critical thinking [39], while also providing the advantage of self-paced learning [40].

Teaching with AI

Regarding the use of AI-enabled tools as assistance in MRT teaching, our sample of educators mainly used them to teach general curriculum concepts (e.g. patient positioning, pathology, anatomy), or to allow students to assess their knowledge. Future and further use of AI tools in education could have the form of virtual reality-based AI-enabled clinical scenarios to enhance the students' person-centred care skills, to deliver tailored educational content based on their needs and preferences [41], or monitor students' learning patterns and analyse their progress, reducing time needed for grading [42]. It should be noted that MRT educators could also benefit from the integration of the newly developed generative AI tools into their teaching practices. While some well-established large language models, like Chat Generative Pre-Trained Transformer (ChatGPT; OpenAI, San Francisco), have demonstrated a generally poor performance in most written assignments within radiography curricula [43], these tools can offer the benefits of self-paced and interactive learning, and they can support educators in assessment planning and group activities [44]. Their use in medical education has been widely recommended [45], and educators should be trained to support the use of such tools in education [46]. Furthermore, collaboration between educators, practitioners, and researchers is needed to ensure ethical integration of generative AI into education [47], and to mitigate the potential risks of plagiarism and student cheating. There is more to see in that space, as these technologies mature and governance is being formalised in different geographies around the world.

Confidence in AI

Educators expressed uncertainty and varied levels of trust in AI technologies, with many of them believing that AI may hold certain biases when used for medical image processing. Recent literature has stressed that building trust in AI in healthcare is a complex and multifactorial procedure, which requires sustained engagement with AI development [48]. The desire to innovate in AI and act as partners with industry has strongly featured in this group of respondents of the ASRT educators' membership, which is refreshing to read. Some of them went as far to say that contributing to healthcare innovation with AI might attract more MRTs than a clinically based job, where patient-centred care was central, perhaps because of the scalability of deliverable patient benefits. The way respondents answered those questions, respectively didn't always match up, at least intuitively; although they didn't consider AI reliable in the sense of being failure-free, they nonetheless thought it produced consistent outcomes most of the time. This might be due to the way the questions were originally worded, which left room for interpretation, since AI could produce consistently wrong outcomes, depending on the interpretation. In addition, the majority of US MRT educators expressed confidence that AI will not threaten their jobs, but many believed it could cause deskilling, if used too often. These responses felt more positive compared to clinically based MRTs, who reported varied levels of increased anxiety that AI may potentially threaten their jobs [21,49-51]. The fact that this study's sample demonstrated more confidence in the future of the profession could be attributed to a higher level of knowledge resulting from their prior academic/educational experience with AI, their advanced educational qualifications compared to the general population (with one third of them having a master's degree and one tenth having a PhD) and their more research-driven roles, but also might be due to more mature AI technologies in the United States, that have been tested for longer.

Limitations

The survey's response rate is a possible limitation that could potentially impact the generalisation of the results. Therefore, all findings should be interpreted with caution, since non-response bias may be present.

In addition, the online format of this survey might have inadvertently prevented those with limited or no access to digital resources or lack of digital competencies from responding to this study.

Finally, the fact that some survey questions might have inadvertently been negatively or positively skewed, might have resulted in survey response bias [52].

Recommendations for practice

The results of this study strengthen the argument for interprofessional collaboration to create successful, clinically relevant and technologically advanced AI educational provisions

Table 5
Suggested topics to be taught in AI curricula for MRTs.

AI terminology and principles
Clinical applications of AI within the specific MRT context
AI ethics, regulation, and governance
AI validation, evaluation, and post-market monitoring
Impact of AI on workflows, careers, and professional identity
Patient and professional acceptability of AI
AI innovation: from idea to commercialisation

for MRTs. In addition, adequate resourcing and funding is required to ensure curriculum design, variation in delivery format and up-to-date content, in line with research developments. Regarding the topics to be included in academic curricula, below are some suggestions (Table 5), based on the findings of this study (see Table 3), and reinforced by recent research evidence [19,36,53].

Conclusion

The general lack of AI education and training that has been noted in previous studies among MRTs in other studies globally is also observed in this survey among US educators in medical imaging and radiation therapy. The study respondents were optimistic about the use of AI and, although concerned about deskilling, they felt there was a lot of space and scope for role development and innovation where MRTs could have a central role. Educators requested adequate AI training, specific resources and guidance provided by AI experts and professional societies, in addition to ample time and funding to safely and effectively integrate AI into academic curricula in the United States. Lack of educators' training and guidance, and time and funding constraints were the key barriers to implementing AI into educational programs of future MRTs. AI-enabled tools used to assist education are already being used for certain educational topics and tasks, and these should be enhanced and expanded with the integration of generative AI to further support students and educators. Educators should ensure the ethical use of AI tools in education and provide students with the necessary knowledge on how to use these frameworks to improve patient experiences and outcomes.

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