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Exploring how research skills are taught and assessed in medical imaging and radiation therapy higher education: An international snapshot

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ABSTRACT

Introduction: Research competence is a core attribute of contemporary medical imaging and radiation therapy (MIRT), however, how research skills are taught and assessed across international radiography programs remains poorly understood. This study aims to explore research skills that are taught and assessed in different medical imaging and radiation therapy (MIRT) higher education institutions internationally, focusing on the curricula, experience of students and academics.
Methods: A two-phase design study was employed. Phase one involved an analysis of undergraduate MIRT curricula from nine international higher education institutions, examining programme structure, research credit allocation, research-related subjects, and teaching strategies. Phase two consisted of semi-structured focus groups with students and academic staff. All sessions were audio-recorded and transcribed using Zoom, with the transcripts checked for accuracy, and analysed using reflexive thematic analysis supported by NVivo software.
Results: Data were collected from nine institutions across three continents. Curriculum analysis revealed international variability in the scope, timing, and depth of research integration, with research-related content embedded at differing stages of training. Reflexive thematic analysis identified three overarching themes: 1. research skills in curriculum, 2. Navigating the research learning experience, and 3. Professional identity and practice.
Conclusion: This study demonstrates substantial international variability in research education for medical imaging and radiation therapy students, leading to differences in research capability among graduates. Importantly, research education also shapes how practitioners value and engage with research, influencing professional culture within the field.
Impacts on practice: Systematically scaffolding research skills across undergraduate radiography programs can support progressive learning and promote sustained engagement with research throughout the curriculum. Embedding clinically relevant research throughout education can sustain engagement

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with research, strengthening evidence-based practice and supporting a professional culture that values research in MIRT practice.

Introduction

In recent years, rapid advancements in medical imaging and radiotherapy, have increased the complexity of the professional role of radiographers.[1] Health professional education must evolve in order to ensure students are equipped to act with competence, uphold ethical standards, prioritise patient safety, as well as help to translate research into clinical practice. The European Federation of Radiographer Societies' (EFRS) White Paper on the Future of the Profession highlights this idea, recommending that radiographers must be prepared to serve as the link between the patient and technology, integrating technical knowledge, critical thinking, effective communication, and evidence-based practices to meet emerging professional expectations.[1]

The EFRS emphasises that programmes should be designed to produce graduates capable of delivering optimal, patient-centred care that meets local, national, and international healthcare needs.[1] Despite these expectations, recent studies reveal considerable variability in curriculum structure, clinical placement, and teaching and assessment strategies.[2] While historically, radiography has been more of a consumer than a producer of research, dedicated research education has the potential to aid in the cultural shift required in the profession.[3,4]

Radiography research has led to significant advancements, such as the development of clinical protocols, improved imaging techniques, development of patient-centred care in radiographers' daily work. Establishing a robust research culture requires support in research literacy, methodologies, and active inquiry throughout the undergraduate (bachelor-level) curriculum, ensuring that future radiographers become not just consumers of knowledge, but active contributors to it.[5] Within radiography education internationally, there is a wide diversity in terms of duration, training and topics covered.[6]

It is important to understand how students experience the teaching of research methodologies and how they perceive their usefulness for clinical practice and their professional future. In a context where evidence-based practice (EBP) is increasingly valued, the ability to understand, apply and even produce research is a fundamental skill for radiographers.[7] However, several studies point to gaps in training and a low appreciation of research among students and in clinical settings.[2,3]

Therefore, understanding students and academics perspectives on research training is crucial to designing successful undergraduate educational programs that equip students with the skills required for professional practice both now and into the future. This study aims to explore how research skills are taught and assessed in different medical imaging and radiation therapy (MIRT) higher education institutions internationally, focusing on the curricula, experience of students and academics.

Methods

Qualitative approach and research paradigm

This study was grounded in social constructivism; Vygotskiĭ & Cole[8] assert that knowledge is inherently shaped by social and cultural norms. As the research explored how learning and teaching occur across varied institutions and international contexts, this lens is particularly appropriate.

Data collection

Data were collected at an international summer research school for MIRT students, OPTIMAX and was generated in two phases, including a curriculum analysis and focus group discussions.

Initially curriculum information was collated from publicly available information for each institution participating in OPTIMAX. Data were extracted in relation to the areas of research education that were covered in each degree and the total number of credits dedicated to this learning and the where throughout curriculum this content was taught. The completeness and correctness were then checked by a member of staff at each participating institution.

Further data were collected via focus groups. A semi-structured, open ended interview guide was developed by the research team based on the objectives of the study and informed by existing literature on research training and research engagement in MIRT education. The topics were selected to ensure alignment with the study aims and to explore participants' experiences and perspectives regarding research training and engagement within radiography education. The interview guide is provided in the supplementary materials.

Participants were sorted into one of five focus groups after completing a short demographic questionnaire, three groups were student-based and two were academic groups. The groups were constructed in this way to ensure that students and academics were in separate focus groups. This measure ensured increased psychological safety of participants and aided in facilitating open discussion. Additionally, when allocating groups care was taken to ensure diversity in nationality in each group to garner rich discussion and comparison.

Each of these groups was facilitated by a junior researcher, with an experienced academic co-facilitator (LDM, SGH). Data were audio recorded and transcribed using Zoom recording and transcription and the transcripts were checked by the lead facilitator to ensure a complete and accurate record of the conversation.

Study participants

Data were collected across the nine institutions participating in OPTIMAX 2025 which represented a snapshot of curriculum across three continents for the curricular analysis. For the focus group element, a convenience sample of study participants were both students and academics that attended OPTIMAX in 2025. Participants that attended OPTIMAX were given a letter of invitation to attend a focus group session and those wishing to participate indicated their interest by completing the demographic survey and by giving their informed consent.

Students (n. 15) were included from their second year of study to a graduate level. Academics (n. 8) were academics who were involved in curriculum delivery at their home institution. Each focus group had 5–6 participants to ensure robust discussion whilst allowing for all voices to be heard.

Data analysis

Data from the curricular analysis were converted into the European Credit Transfer and Accumulation System (ECTS) as this a standard measure used in European higher education to quantify student workload. In this system, 1 ECTS is equal to 25–30 h of total student workload and 60 ECTS corresponds to the workload of one full-time academic year. Curriculum components were converted to their equivalent ECTS to enable comparison.

Data were analysed using reflexive thematic analysis as described by Braun and Clarke.[9] This process included an initial data familiarisation, coding, generating themes, reviewing, revising and naming themes, all of which were undertaken as an iterative process. The coding and thematic analysis were undertaken using NVivo 14. An inductive approach was taken to analysis, with latent meanings explored by the research team to draw meaning from the data in the context of radiography research education.

An initial codebook was developed through group consensus utilising the first focus group as an exemplar. The lead facilitator from each focus group then went on to code their own transcript with oversight from the lead author (LDM).

Each of the analysis team members kept a reflexive diary to monitor their own reflexivity and biases throughout the process and through this process, a team reflexivity statement was developed as a living document which prompted all authors to continually reflect on the assumptions and biases they brought to the study.[9] Throughout the analysis process, the team regularly debriefed regarding any assumptions that may be being brought to data analysis to enhance the trustworthiness of the results.[10]

Ethical considerations

This study received ethical approval from the faculty of Health Sciences, University of Ljubljana. Researchers adhered to the principles of the General Data Protection Regulations. Participation was on a voluntary basis, and participants were made aware that they could withdraw from the study if they wished. Participant details and any identifying information contained within their responses were de-identified.

Results

Curricular analysis

Nine institutions from nine different countries and three continents participated in this study. MIRT bachelor-level programmes across the participating institutions have durations ranging from 3 to 4 years, with a total number of credits between 180 and 240 ECTS (Fig. 1).

Research education in the medical imaging curricula of the institutions included in this study ranged from 4 to 40 ECTS credits (Fig. 1), demonstrating substantial variability in the extent to which research competencies were embedded in the programmes. While several institutions allocated more than 20 ECTS to research-related education, others included a more limited number of credits, indicating different curricular priorities regarding the development of research skills.

Research education was also integrated differently across the institutions. Our exemplar in the Netherlands, Switzerland and the United Kingdom adopted a longitudinal approach, with research-related content distributed across multiple years of the programme. In contrast, the remaining institutions tended to introduce research education at a later stage in the curriculum, typically beginning in the second or third year of the programme.

Across the nine institutions, the most commonly covered topics include literature searching and critical review of scientific literature, research methodology, data analysis, scientific writing, research ethics, and how to apply evidence in practice. These topics aim to support students in developing fundamental competencies required to understand, conduct, and communicate research within clinical practice.

A variety of teaching methods were used to support the development of these competencies. The most frequently reported approaches included lectures, seminars, workshops and tutorials, complemented by more active learning strategies such as project-based learning and case-based learning (Table 1).

Similarly, assessment strategies varied across institutions. Research skills were most commonly evaluated through written examinations, individual or group reports, portfolios, oral presentations, and the preparation of a scientific article. While several programmes included a thesis or final research project as a capstone assessment, this requirement was not universal across the institutions included in this study (Table 1).

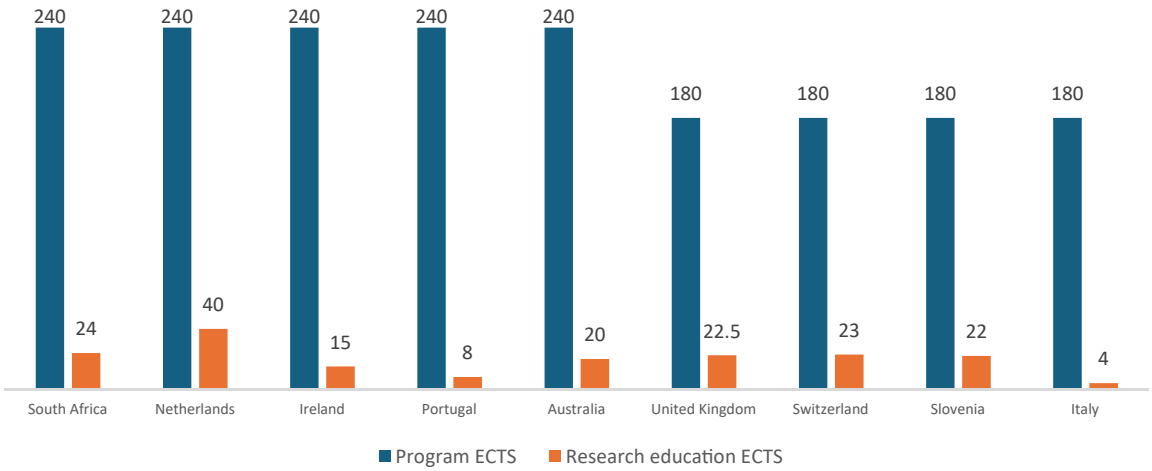

Figure 1. Included institutions' total European Credit Transfer and Accumulation System (ECTS) and research education dedicated ECTS.

Table 1
Summary of the main subjects, teaching and assessment methods included in the curriculum of the investigated institution.

	Subjects	Teaching Methods	Assessment Methods
Year 1	Introduction to research principles Introduction to evidence-based practice Introduction to fundamental concepts of science Introduction to basic statistics Introduction to research ethics Literature research Academic writing	Lectures Workshops Seminars Labs/digital environments integration sessions Personal worktime	Written test Portfolio Case study and report oral presentation/ communication
Year 2	Applied statistics Research questions & study design Data collection & analysis methods EBP implementation Legal & ethical issues Early project development Bachelor/Project thesis initiation	Lectures Practical/statistical labs Seminars Tutorial support Group supervision Guided independent study Personal worktime	Written exams Portfolio Project proposal Literature review assignments
Year 3–4	Full independent research project Data processing & interpretation Scientific writing Thesis/article development Research presentations/posters Participation in research events Peer review and dissemination Clinical/field research integration	Research supervision Workshops Seminars Independent project work Symposium/oral defence Clinical or research placement Personal worktime	Full research thesis or article Oral exam Poster/infographic Research portfolio Written report Final project/thesis evaluation

Thematic analysis

During thematic analysis, three primary themes were identified from the data. *Research skills in curriculum* covered concepts that related to curriculum content and delivery, exploring student and academic experiences throughout the learning process. *Navigating the research learning experience* explores the complex experiences that shape how students and academics engage with research learning. Finally, *professional identity and practice* encompassed how research education contributes to shaping professional identity and concepts around how radiographers view themselves professionally.

Research skills in curriculum

Participants explored what research skills are taught within their current programs and how this teaching occurs. Both student and academic participants discussed their experiences and perspectives on the development of research skills. This theme was further broken down into three subthemes.

Foundational skill development explored how research education was introduced and structured across the curriculum, focusing on the timing of research skills within the curriculum. This scaffolded skill development was the preferred approach among both students and academics alike.

Participants had varied views about what constitutes research skills, with some identifying skills such as literature searching, critical analysis and referencing while others did not directly attribute these as research skills. Whilst some skills like critical thinking and statistics were deeply valued and often integrated through curriculum, qualitative research skill development was less represented across the board.

Interestingly, the timing of research integration in curriculum was discussed in both student and academic groups with all participants agreeing that scaffolded skills across the curriculum were preferable to one off modules taught in isolation. See Table 2 for quotes representing this subtheme.

Student led research projects captured the extent to which student-led research was encouraged, providing students with an

Table 2
Summary of quotes relating to foundational skill development subtheme.

Category and description	Participant quote
Defining research skills: Participants had varying views about what was considered foundational research skills. Some considered foundational skills such as searching and reviewing literature a research skill while others didn't.	*"We have a study skills module, and they teach you how to Harvard Reference, like how to find articles, use PUBMED, all that kind of thing, but like nothing about it like I wouldn't classify that as like a research course"* - Participant a (Student)
Critical thinking: Critical thinking is introduced early and reinforced continuously across the curriculum, encouraging reflection on decisions and analysis of methodologies.	*"I think for us critical thinking it's something that we start with at the beginning and keep on putting focus on throughout the whole studies. It's okay if you make a mistakes, it's okay if you do things wrong. You need to know why things are wrong or why you do actually the right thing. Why is the certain method better than the other method. Why is certain statistical analysis suitable and what you might propose is not. So that's something we focus on as well."* - Participant V (Tutor)
Quantitative research skills: Foundational quantitative skills were often taught early in programs.	*"We also have intensive courses on statistics, how to frame a research question, start a methodology – all in second year. So it's more concentrated earlier, and third year might be lighter."* - Participant M (Student)
Qualitative research skills: There was substantially less focus on qualitative skills, with some programs omitting them from curriculum.	*"none of our employees is very familiar with qualitative studies"* - Participant S (Tutor)
Timing of research integration in curriculum: By teaching foundational research skills in the early stages of the degree, the groundwork is laid for students to expand and develop these skills throughout the duration of their programme.	*"We sort of have like study skills and professionalism modules in like first year just to help us like understand like referencing and citation and just like avoid plagiarism and stuff and then in second year kind of get into professionalism and performing research and stuff and how to properly cite things and find things – without being biased or anything"* - Participant H (student)

Table 3
Summary of quotes relating to student led research projects subtheme.

Category and description	Participant quote
Collaboration and peer support: Group work within the dissertation context was perceived as a valuable opportunity to learn collaboration and mutual support.	*"But the last group work we did, it was part of the dissertation. And for that one, because it was part of the dissertation we had to all get involved in everything, so it taught me communication, teamwork, and supporting each other. Working with each other and not just doing your own thing, you know 'I have done my part, I'm not getting involved with the other things'. I had done my part but I had to help another member of the group to do her part because she was struggling with her part"* - Participant G (Student)
Reflective feedback and assessment practices: Participants appreciated thesis assessments that encouraged reflection and provided feedback aimed at improvement and deeper understanding.	*"I already wrote my thesis, so you have to present it and they are not only asking about results but also what you do differently, like the next time or write it to look like this and do like that. And I think it's a pretty good kind of assessment because they can really make it about that if you really understood what you were doing."* - Participant J (Student) *"The drop-in sessions were extremely useful for them. We carried out like every 2 weeks a drop-in session, especially if they have any question and do a data analysis and writing and they can just drop-in anytime they want or even zoom call. And for supervisors, we had a weekly supervisor meeting with them, and sometimes when we like kind of figure out there's another much of work will be done within 1 week so we can have a supervisor meeting within 2 weeks, but it's good actually to monitor their progress."* - Participant U (Tutor)
Multimodal evaluation of student led research projects: A variety of formats (written report, poster, oral presentation) were used to evaluate students' research, encouraging engagement and critical thinking.	*"For the thesis their reports are examined and they have to do an oral exam. So during the oral exam they do a poster presentation, so they make a poster, the poster is also examined and then their presentation skills and then how well they answered questions and I think, that's a very good method, we almost never see that people like "Shut down", or don't know anything anymore, cause they work (for) half (a) year on it, and then you go even see how critical were you and they do the oral exam alone."* - Participant T (Tutor)

opportunity to apply learned foundational skills in practice, particularly the opportunity to pursue a bachelor's thesis or similar research. Participants described small-scale research projects, such as a bachelor's thesis, as key moments in their programs for developing autonomy and collaboration.

There was differentiation between experiences at different institutions and countries with some of these projects being undertaken as individual projects, whilst others were undertaken in groups. Students who completed these projects in groups reported developing additional skills tangential to research such as teamwork and communication that mimic research requirements in real life settings.

Consistently among both academics and students who participated in student-led research projects reported the supervisory relationship and focused feedback as highly valuable and integral to their success. See Table 3 for quotes representing this subtheme.

Experiences of learning and teaching explored broad ideas about the ways in which teaching is taught and assessed in the curriculum and discussed the response of students and academics to the learning process, focusing, as well, in the individuals' experiences of learning and/or curriculum and how they draw meaning from it.

Applied learning and assessment styles were valued highly among all participants, as was the integration of research skills among other curriculum activities as this assisted in bringing meaning and application to the skills for students. Feedback was noted as integral to the development of research skills by both academics and students with this promoting success among those undertaking research skill development.

Students particularly enjoyed interactive teaching methods where they were able to problem solve collaboratively and found this helpful to learning. They further noted that when done well, learning about research provided a sense of achievement and pride, which then contributed to the motivation to continue to learn more. See Table 4 for quotes representing this subtheme.

Table 4
Summary of quotes relating to experiences of learning and teaching subtheme.

Category and description	Participant quote
Applied learning: Application of learning to real life examples was highly valued by participants, allowing them to consolidate their research skills.	*"When we had the seminars, we were actually applying the knowledge we learned from the lectures, that's what stuck with me the most."* - Participant G (Student) *"For me, it's a real case scenario when I [taught], skills labs for statistics … for example if you're doing [image] optimization"* - Participant Z (Tutor)
Integration of research skills: Participants described as being embedded within broader curricular activities, rather than taught in isolation. Through practice-based assignments and clinical scenarios, students are encouraged to apply research thinking in realistic contexts, linking academic knowledge to patient care.	*"We don't have a lot of set research modules but usually the research is woven into other subjects. So we offer what we call practical assignments or practice-oriented assignments …. ..And that's what we do generally throughout the first two years. There are some more focus classes."* - Participant V (Tutor)
Interactive teaching methods: Participants tended to value interactive teaching styles.	*"Because it was a classroom-based setting that you actually got to interact. (normally in) lecture halls, students aren't talkative, and the students aren't openly asking questions"* - Participant a (Student)
Feedback as part of the learning process: Feedback was seen as integral to the development of research skills and a range of methods for feedback were utilised.	*"What tends to work well is the group approached as well. for me, as a supervisor, getting the feedback to one student, it's really relevant for the other students to hear it as well, because their might be a problem they haven't approached yet, but it could be something that's really helped them, so they really do learn from each other as well."* - Participant X (tutor) *"We kind of took the feedback that we were given and we had a bit of better guidance of what the skills are, what we're looking for, how to build things. So that was a bit more applicable to us and the majority of people scored quite well"* - Participant C (Student)
Reflections on learning: Participants shared their reflections on learning research skills throughout the duration of their degrees.	*"I think it's a great experience. I enjoy it. It's exciting to contribute something new to the world through research."* - Participant L (Student)

Table 5
Summary of quotes relating to navigating the research learning experience theme.

Category and description	Participant quote
Intrinsic motivation: There was a perception among participants that student engagement with research curriculum was widely variable	*"For us a challenge I think it's not the most favourite subject of most students … During the first two years, it's very difficult to get people to class. To motivate them about science."* - Participant W (Tutor)
Enhancing engagement: Participants discussed several strategies to enhance engagement with research curriculum, including agency in topic choice, and enhancing the relevance to clinical radiography practice.	*"For me too it's also encouraging, especially when you get to choose your own topic for the research because you can choose from something that you are passionate about and then you put more effort into it."* - Participant I (Student)
	"I feel like for us, while we do research elements, like they show us how to reference and they show us how to research in terms of the actual radiography related research we don't see any of that, like they never encourage us to do it." - Participant H (Student)
Language as a barrier to research: Participant with lower confidence in their English language skills noted this as a barrier to disseminating their research	*"But the problem with us with the conference is US, UK, Iran and US Ireland. You are native speakers with us. There is not a challenge when you say you are going to an international conference. No, I will not be talking. I know the [nationality] are really fluent also in English but with us usually it's hard. It's hard to motivate them in order to go and give the talk for example."* - Participant Z (Tutor)
Ethics as a barrier in research education: Participants noted the challenge of ethical approval, in relation to student research education and ethical use of data.	*"the problem is with ethics. We have the same problem in each institution because the patients are involved. We need to add ethical approval, which in our country, we need to have to pay for ethical approval for living research …"* - Participant Z (Tutor)
Credits for learning: Participants noted that often the credits associated with research learning require more work from students than other modules or subjects.	*"And the research is the very last thing on the back of their mind, because at the end of the day it has only 10 credits out of 60. So we started off great but then we need to work overtime, because then everything else takes priority, and I think that's the biggest problem we have"* - Participant X (Tutor)

Navigating the research learning experience

This theme explored notions around motivation, including what drives students to learn about research and how this motivation can vary across different student cohorts. Academics discussed the variability in student engagement and participation, describing the difficulty they often find in motivating students to learn about research. Student participants as a counterpoint discussed what made them more motivated to learn with key elements including explicitly linking research content to their future role as MIRT professionals and the intrinsic motivation associated with researching a topic that they were passionate about. Additionally, students discussed that when compared to other learning they were required to undertake as part of their degree, that subjects involving research often required more work comparatively which could both decrease motivation and act as a barrier for student uptake if that subject were elective and not core.

Furthermore, the theme explored the barriers and enablers encountered in the learning environment, as they relate to research training. Such barriers included timely research ethics approvals, language as a barrier to dissemination in countries in countries where English was not the native language. Together, these insights provide a deeper understanding of what supports or hinders research learning, and how it can be made more effective and meaningful. See Table 5 for quotes representing this theme.

Professional identity and practice

This theme was heavily centred around the views of student participants and explored the value placed on research skills not just during academic training but throughout one's career. It encompassed student reflections on the clinical relevance of research training, and integration into a broader evidence-based and research-oriented professional culture.

Student participants described a discontinuity between the importance placed on research skills in the academic environment and their experiences during clinical placements. Some students described the lack of research within the clinical environment and noted this as a factor that reduced their motivation to learn research skills.

Interestingly, this theme highlighted differences in professional culture and identity across international boundaries. This professional culture influenced students' engagement with research, whether they perceived that they would have continued engagement with research after graduation and into their professional practice. See Table 6 for quotes representing this theme.

Discussion

Curricular analysis

The comparative analysis conducted across nine international institutions offering education in MIRT at a bachelor level revealed significant diversity in how research education was integrated, taught, and assessed within their programmes. Although all institutions included curricular units dedicated to research, substantial differences were identified in the number of ECTS allocated, in the timing of their delivery throughout the academic pathway, and in the depth to which investigative skills are developed. These results, which highlight the heterogeneity of training in general and, more specifically, of research education within MIRT, are consistent with what has been reported in the literature.[6,11]

The presence of up to 40 ECTS dedicated to research in the institution in the Netherlands demonstrates a strong commitment to scientific literacy, in line with international recommendations asserting that MIRT professionals should be able to interpret, apply, and produce scientific knowledge in both clinical and academic contexts.[5]

The most striking difference between the institutions analysed relates to the model adopted for integrating research within the curriculum. Institutions in Switzerland and the United Kingdom employed a longitudinal approach, scaffolding the development of research competencies over several years, which aligns with evidence indicating that progressive models support competence consolidation and foster scientific autonomy.[12,13] The content addressed across the various institutions (including literature review, research methodology, data analysis, ethics, and evidence-based practice) is consistent with recommendations from international bodies, particularly the EFRS.[5]

Pedagogical aspects of research teaching

Regarding teaching methods, institutions combine traditional approaches (lectures, seminars) with active methodologies such as project-based and case-based learning. According to the literature,[14] these active pedagogical strategies facilitate the development of investigative competencies and promote autonomy, critical reasoning, and the ability to solve complex problems. Despite the presence of research-related content across the curricula examined, substantial differences persist that may

Table 6
Summary of quotes relating to professional identity and practice theme.

Category and description	Participant quote
Applicability to clinical practice: There were varied perceptions among participants about the usefulness of research skills to daily practice as a radiographer.	*"For me, the theoretical part was more boring than the practical. The professor who taught it was an expert in methodology but didn't work in healthcare. So, he knew the theory in detail but not how to take measurements or apply it in practice. But the practical part was taught by professors from the department, and they had done research — so it felt more relevant to radiography."* - Participant N (Student) *"Technically, I'd say it's not relevant … the skills for doing research don't really benefit you on a day-to-day basis in your future career. But then again, I think it's so relevant to if you are carrying out research in the future if you go into that field, I just never really thought of it before this."* - Participant a (Student) *"I think it's important to know how to find and critique articles. You don't need to be a researcher, but you need to stay updated — technology changes fast. Like with AI and other advancements, you need to know what's new. If you don't know how to find good articles, you might keep using outdated protocols and expose patients unnecessarily."* - Participant L (Student)
Research culture: There was varying experiences when it came to encouragement for radiographers to pursue research.	*"Yeah, I think so like we are inside the medical department like doctors, nurses, doing a couple of research. But we (radiographers) are not. It's not promoted. From the top, it's not promoted."* *"Our major representative of the category has not really interested to leading our category."* - Participant E (Student) *"The difference between [university name] and some of the other universities is that our degree, it teaches you to be a radiographer going to clinical, but they do have a really heavy emphasis on encouraging you to go into research … They constantly give opportunities for leadership placements or research interns … They say it in first year, "if you don't like radiography (clinical), you can go into research or lecturing." so that's a difference, I think we've an emphasis on research."* - Participant C (Student)
Professional identity: Student participants viewed research as something that is predominantly done on-the-side rather than a full-time pursuit. This contributes to an idea that radiographers are first-and-foremost clinical workers and not solely research academics.	*"I want to work in clinical. Most of my jobs, but I also don't mind if I get into research, like as a part-time (role) and to.. because when we're going to research, you can also learn how to be a better professional."* - Participant D (Student) *"you have the option to just work (in a clinical/hospital setting). But a lot of our grads are research-active grads. So, they do research on the side. Like I know so many radiographers that just submit "bits and bobs" or like they'll lecture part-time.. And work. And you need to have the research skills to do that, to be able to teach things"* - Participant C (Student)

influence graduates' preparation for both evidence-based clinical practice and for engagement in research activities.

Among all participant groups, there was a clear preference for research skills to be well scaffolded and integrated into curriculum, which aligns well with the literature examining teaching research skills in health professional education.[15,16] This integration, when supported by evidence-based pedagogical techniques such as active teaching methods,[17] varied and authentic assessments,[15] and explicit and clear feedback,[18] has the potential to develop research skills among pre-registration MIRT students.

Interestingly, views about what constitutes research skills differed between contexts and countries, particularly among student participants with some viewing the development of digital literacy skills, such as developing questions and searching for evidence as a research skill, while others did not. This highlights the importance of drawing explicit links while teaching to research, signalling learning for novice students.[19]

There was a strong tendency acknowledged among both student and academic participants that quantitative research skills are more likely to be taught than qualitative. The reasons for this included a lack of staff to teach qualitative skills, and a sense that quantitative skills were more important for students to know and understand. There is a documented trend among radiographers to value quantitative research more highly than qualitative research.[20] It is imperative that to ensure that radiographers are appropriately versed in critical appraisal to ensure this imperative aspect of research skills training is not overlooked.

Additionally, commonly cited barriers to research transcended into research education. Challenges with timely ethical approval for research were magnified in educational settings where student-led projects often have shorter timeframes over which they must be completed, meaning that it was challenging to ensure that students' experience was both authentic and that research could be undertaken in the required time frame. Furthermore, language barriers among students for whom English was not their first language posed challenges to those looking to disseminate findings from honours research.

Research culture within the profession

Student participants' views were varied when it came to discussing the applicability of research skills to their roles as radiographers. Student participants who discussed the research curriculum positively at their institution tended to have more positive views towards the utility of these skills. Highlighting the potential career pathways that a student can undertake is helpful in allowing students to better understand how research skills are relevant to them. When research skills were taught in isolation from clinical practice, students failed to see the relevance. This underscores the importance of contextualising research education to the roles that our MIRT students will be doing in the future.

Many participants highlighted that the professional culture within radiography in clinical settings did not always highly value the pursuit of research and where radiographers do not feel confident both completing research themselves and critically appraising existing research, a concept that has been highlighted widely within existing literature.[3,20–22] Those with higher confidence in research and evidence-based practice are more likely to have positive attitudes and integrate research findings within their practice.[23] In order to advance research within our profession, we need a coordinated effort that includes effective education, professional leadership and a targeted effort to address barriers for clinicians.[4,24,25]

Limitations

Whilst this study focused on undergraduate curricula, it is important to note that in many countries there are pre-registration educational programs that are presented at differing educational levels. This limits the transferability of the study findings to programs that are not focused at an undergraduate level. Furthermore, only one institution per country was considered, not representing all the national education diversity.

Additionally, the focus group sessions for this study were held in English, which was not the native language of all participants. This may have led to some difficulty for participants in accurately

articulating their thoughts and ideas, and for some to feel less confident giving voice to their thoughts.

Furthermore, while all care was taken to ensure that the curricular analysis was as accurate as possible, the data collected did give a very high-level summary as opposed to an in-depth exploration of learning. Future research could potentially explore the curriculum components in more detail to give a more nuanced understanding of research education in the MIRT space.

Conclusion

This study's results highlight the significant variability between the way in which research education is approached within different institutions internationally for MIRT students. Whilst this variability is inevitable, the impact of this means that there is a diversity of skills amongst practising MIRT professionals. The impact of research education moves beyond simply whether an individual has skills and impacts on the value in which they place on research in their professional career, thereby influencing more broadly the professional culture within medical imaging and radiation therapy.

Ethics approval and consent to participate

According to Slovenian national regulations, ethical approval by the National Medical Ethics Committee is required only for studies involving patients or patient-related data. This study did not involve patients. Institutional approval was therefore obtained from the Dean of the Faculty of Health Sciences, University of Ljubljana.

Author contributions

LM: Writing - Original Draft, Conceptualisation, Methodology, Investigation, Visualisation, Supervision, Writing- Reviewing and Editing.

NJ: Conceptualisation, Methodology, Investigation, Writing-Reviewing and Editing.

BM: Conceptualisation, Methodology, Investigation, Writing-Reviewing and Editing.

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Availability of data

Data required for this study may be made available by the author(s) upon reasonable request.

Generative AI use

Not applicable.

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Conflict of interest statement

The authors declare that they have no competing interests.

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Appendix A. Supplementary data

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