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Perspective of radiography science – a document analysis of dissertations

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Abstract

Introduction: The aim of this study was to clarify the perspective of radiography science as an academic discipline. A discipline can be studied by discovering the collective use of concepts, especially core concepts. We have previously identified the core concepts as clinical practices in radiography, radiographers' profession, safe and high-quality radiation use, and technology in radiography. The relationships between these concepts have not been studied previously. In order to clarify the perspective of radiography science we have investigated further the core concepts, their interrelationships and interdependencies. **Methods:** Altogether, 53 dissertations meeting the inclusion criteria were selected for a qualitative document analysis. The data were first analysed deductively using an extraction matrix comprising four core concepts developed from previous studies, then relational statements were synthesised, and the statements were analysed semantically. **Results:** Analysis revealed the bilateral interrelationships between the concepts and their dependencies. All the concepts were used within healthcare. The rationale for radiography science research was the clinical practice of radiography and the improvement of services in a complex environment as a part of patients' pathways. Safe and high-quality radiation use was investigated as a means to deliver optimal services. Technology was studied as being functional or a means to deliver services. The perspective of the discipline was seen as the combination of humanistic interaction with advanced technology, where safety and quality were a necessity. **Conclusions:** Defining core concepts and their interrelations clarifies the perspective of the discipline and gives radiography researchers a way to argue their viewpoint.

Introduction

Radiography as a concept is multidimensional. It has been used to describe both the practice and science of radiography. The scope of this study was to clarify the science of radiography, as distinct from the professional practice. Radiography science is an academic discipline investigating phenomena related to medical imaging and radiotherapy practice.[1,2] Academic discipline, in this study, is understood to be broader than science, it is the research activities and resulting knowledge, as well as the social and structural setting necessary for research.[3] When defining radiography science, we take an essential view to academic disciplines,[4] stating that radiography science has unique identifying characteristics which denote it has different core concepts to the related disciplines: medical physics, radiology and nursing science. Medical physics endeavours to assess, optimise and analyse medical technology, whereas radiology is a medical specialty for interpreting medical images.[5] Nursing science focuses on facilitating health.[6]

Defining the meaning of an academic discipline's perspective is complex. The perspective of a discipline is close to the concept of a paradigm: a broad concept including worldviews, theories and methodologies shared by the scientific community.[7] A scientific community consists of the practitioners of a specialty sharing common elements of education who are seen as pursuing the same shared goals.[8,9] The concept of a paradigm is not used systematically.[9] For example, in nursing science, Fawcett[10] presents perspective as being a metaparadigm consisting of concepts identifying phenomena of interest to the discipline and propositions that identify the relationships between those phenomena.

In this study, perspective is defined as a particular scientific community's shared worldview on the academic discipline of radiography. The perspective can be seen in the assumptions directing the researchers' studies. Concepts are tools to communicate these assumptions, and they are essential parts of theory.[11,12] A discipline can be studied by discovering the collective use of concepts, as each discipline is characterised by its own body of concepts, methods and aims.[13] Conceptual understanding is vital in understanding the discipline's perspective,[12] particularly in clarifying and specifying core concepts.[14,15] Core concepts convey the epistemological needs of the discipline.[15] Bender[16] argues that demonstration of the interdependency of the core concepts can visualise the discipline.

Defining the core concepts is a prerequisite for developing a coherent body of knowledge for a discipline.[15] The core concepts organise the accumulated specialist knowledge effectively.[17] Research into the exact description of the core concepts of radiography science is scant. Lundgren and Lundén[18] investigated the meaning of concept radiography through etymological and semantic analysis from radiography science perspective. They inferred that its main characteristics were X-ray and radiation, human beings or opaque objects, a process including an act and art, and radiography images. They suggested these to be epistemological concepts of the discipline.

In Finland, the origin of radiography science diverged from nursing science and Sorppanen[19] derived core radiography concepts from the nursing science metaparadigm (person, health, environment and nursing). She proposed that the core concepts should be the clinical radiographers' work, the environment in healthcare in the context of a radiographer's expertise, health and illness and the person. As the metaparadigm concepts of nursing science are still being debated in the discipline,[16,20] in our earlier study we decided to identify the core concepts of radiography science; we did this by investigating the phenomena the discipline studies without any presumptions.[21] We identified the core concepts as the radiographers' profession, clinical practices in radiography, safe and high-quality radiation use and technology used in radiography.[22]

Aim

The study aims to clarify the perspective of radiography science as an academic discipline; our objective was to clarify the previously identified definitions of the core concepts within dissertations in the field of radiography, and to investigate their interrelations and co-dependencies.

The research questions are:

1. How have the core concepts been defined in dissertations in the field of radiography?
2. What kind of interrelations do the core concepts exhibit?
3. What kind of dependencies exist between the core concepts, if any?

Methods

Qualitative document analysis (QDA) was used as a methodology. QDA requires that data are examined and interpreted in order to elicit meaning, gain understanding and develop empirical knowledge.[23] In this study, the documents analysed were doctoral dissertations from the field of radiography. Dissertations were chosen because they are assumed to contain in-depth conceptual descriptions and are therefore suitable for studying the discipline. The assumption was based on the fact that dissertations serve as evidence of the capability of doctoral candidates to conceptualise, design and conduct research in the discipline.[24]

Data collection

The data search was conducted in May–July 2022. Two databases were searched without date limitations, the Oatd (open access theses and dissertations) and the ProQuest database for dissertations and theses. The inclusion criteria were: doctoral dissertation of any study design from the radiography science field that investigated the core concepts studied in this research; published in English; published electronically; and open access.

Search words were derived from the previously identified core concepts. To identify studies related to the profession of radiographers we used the exact search words 'radiographer', 'radiotherapist', 'radiation AND therapist', 'radiological technologist', 'nuclear medicine technologist'. To identify clinical practice in radiography we used 'clinical AND radiography', and to identify safe and high-quality radiation we used 'quality AND radiography' and 'radiation AND safety'. Lastly, for technology in radiography we used: 'technology AND radiography'. The final data consisted of 53 dissertations (Fig. 1).

Data extraction, analysis and synthesis

The data were first analysed deductively.[25] Data were extracted with an extraction matrix,[26] developed for this purpose and based on our previous studies.[21,22] The extraction matrix included all four core concepts, the circumstances in which the concepts were used within the dissertations and the possible interrelationship between each concept. The extraction matrix was pilot tested. After deductive analysis, relational statements were synthesised[27] and finally, synthesised statements were analysed semantically[28] (Fig. 2).

The data corpus consisted of all parts of the main text of the dissertations, except for the methodology description, resulting in 8777 pages of text. The data were entered into NVivo 20 software. We used NVivo text query search using the exact words 'radiographer AND profession', 'clinical AND practice', 'safe AND quality AND radiation' and 'technology' and their truncated and stemmed forms to identify all the ways in which the core concepts were used in the data. The text query search yielded 61,594 hits in NVivo. The dissertations were then analysed individually in NVivo, by reading all the search-word hits and the paragraphs before and after the hit, to see how the concept was used in that situation. An analysis unit was an entire passage containing the same meaning. Passages were reduced, although the original idea was maintained. The reduced sentences were further expressed in a more abstract way. The analysis was reiterated until no new concept descriptions were generated.

In the statement synthesis phase, all the reduced sentences containing two or more concepts were further investigated. Their relationships were organised and combined to obtain general statements among the concepts. Statements were typified as causal (cause of the other), concurrent (existing together), conditional (occurs only in the presence of third concept), time-ordered (some period intervenes between first concept and the second), necessary (one and only one concept/event can lead to the second concept or event) or sufficient (the

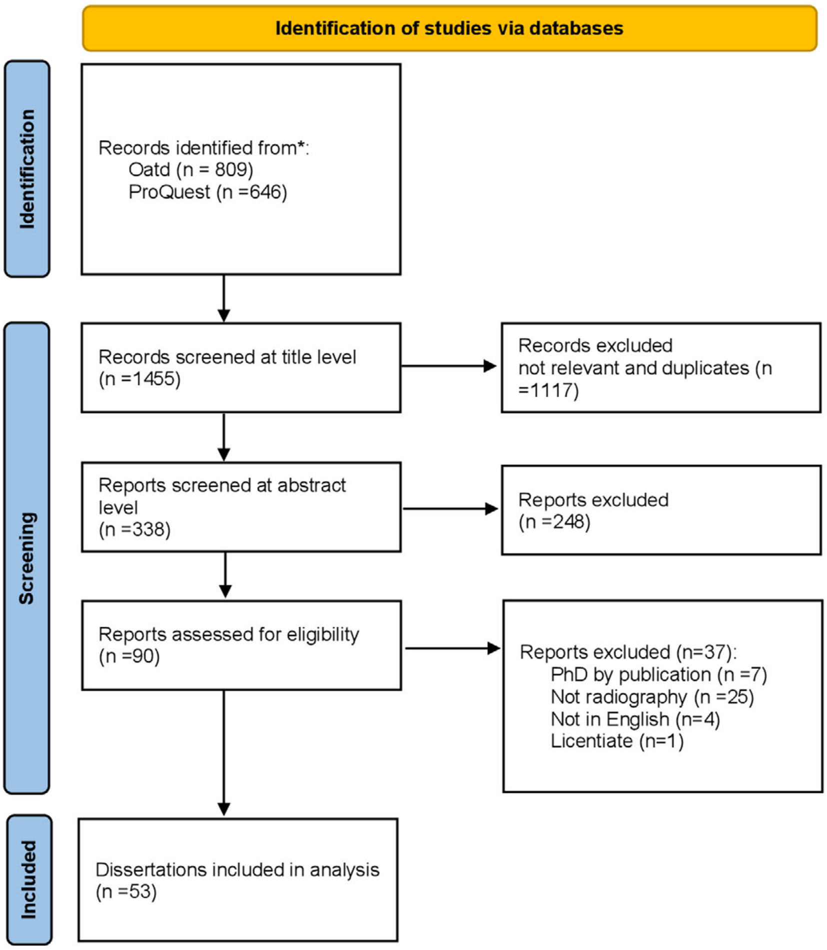

Figure 1. Data selection process.

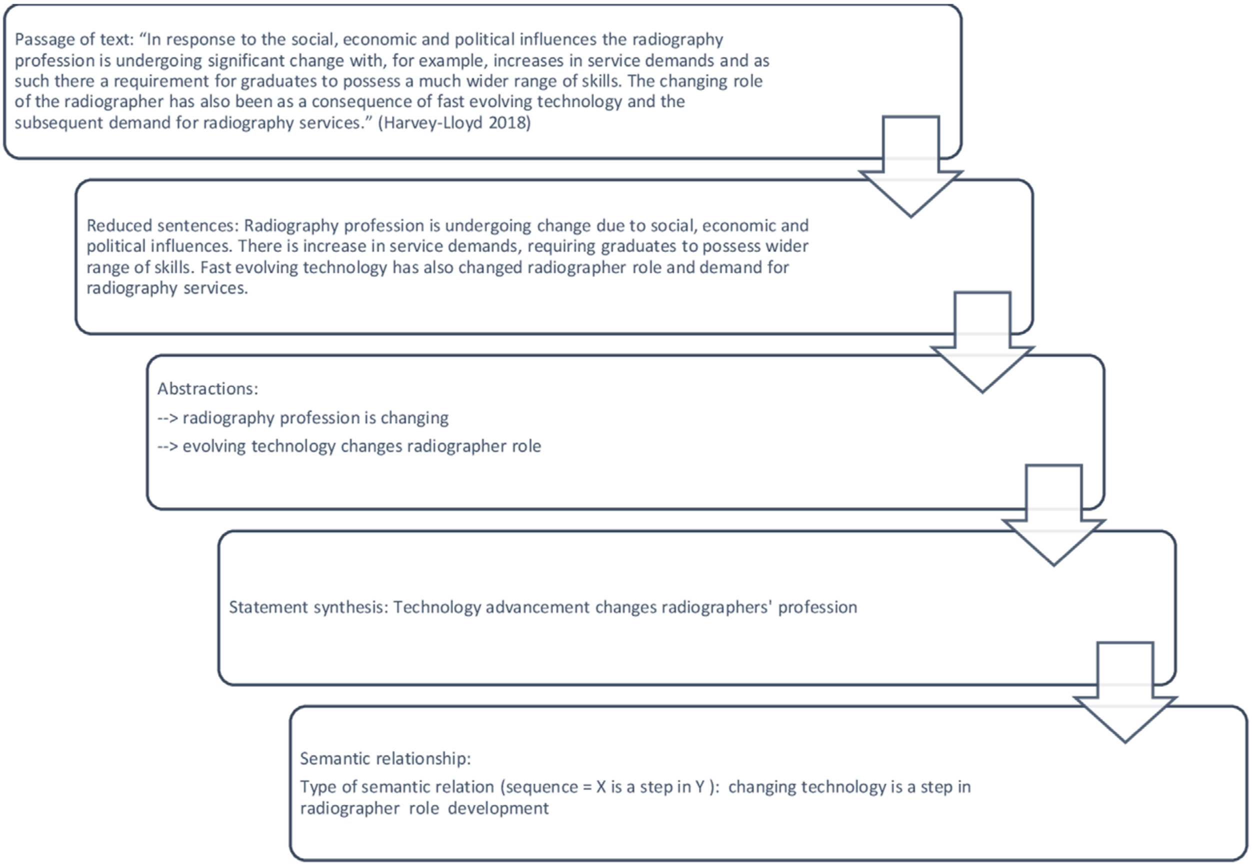

Figure 2. An example of data analysis process.

presence of the first concept guarantees the presence of the second concept). A statement could be simultaneously more than one type.[27]

In the third analysis phase, semantic relationships were analysed to gain a deeper understanding of the concepts' significance towards each other (see Supporting Information S1 for a more detailed semantic analysis).[28]

Trustworthiness and rigour

The quality and trustworthiness of qualitative research can be defined by its credibility, transferability, dependability and confirmability.[29] The credibility of this study is enhanced by referencing it to original data and displaying the inferences made.

The extraction matrix was pilot tested by ST and EM. Ten dissertations were randomly selected and ST and EM analysed the selected dissertations using the extraction matrix. The matrices were compared to seek for similarities and the possible need for further development. The matrix was found to be relevant for the study and both authors discovered similar ways in which the concepts were used. The only difference was how the circumstance where a concept was used was defined. This was discussed and clarified. Following this, the data analysis was primarily done by ST, but discussion and reflection were conducted continuously with the whole author team.

There is no database for only radiography dissertations. In the data selection phase, it was not always clear whether a dissertation was investigating phenomena related to radiography science. Dissertations from other fields than radiography, such as medical physics, psychology, radiology, dentistry, public health, education or engineering were excluded. If, however, it was uncertain whether a dissertation was in fact radiography research, we ran a background check on the author and decided to include dissertations if the researcher had a background in radiography research. As radiography science is not clearly defined and there is no consensus even on the name of the discipline, it is a difficult task to identify all dissertations made in the field.

ST, EM and MS have been involved in the practice, education and research in the field of radiography. The understanding of the research area is beneficial in analysing the data but might introduce a bias. As researchers in radiography, we are also governed by the same assumptions as our study subjects. This was tackled through discussion in the research team and with an outsider perspective, given by a nursing scientist HLK. The interpretation of the data is not based on our own preferences but generated from data.

Findings

Overall description of the dissertations

The selected 53 dissertations, documents D1–D53 (see Supporting Information S2 for full details), were published between 1998 and 2020 and they come from the United Kingdom (n = 31), the United States (n = 17), Australia (n = 2), Canada (n = 1), Hong Kong (n = 1) and South Africa (n = 1). Most dissertations led to a Doctor of Philosophy (PhD, n = 35), followed by a Doctor of Education (EdD; n = 11).

The core concepts in the dissertations

All core concepts were used within healthcare, including all types of healthcare environments: private/public sector, urban/rural areas and primary/special healthcare (Table 1). Based on the data, clinical practices in radiography can be understood as a service in the healthcare environment or in the everyday actions, procedures and care in a radiography context. The radiographers' profession consisted of radiography professionals and radiography work, controlled by professional values and legal requirements. Safe and high-quality radiation use was defined as operating with radiation, compliant with the safety culture and quality requirements. Technology in radiography consisted of equipment and the impact of technology.

Interrelations and dependencies of core concepts

In the following, each core concept's bilateral interrelations and dependencies are described. First the type of relation and status of dependency is stated, followed by the reasoning. Relational statements are presented in Table 2.

Clinical practices in radiography – the profession of the radiographer

These concepts have a concurrent relation, because they coexist: the radiographers' profession guarantees safety and quality of services, as well as individual care in clinical practice. The concept of the radiographers'

Table 1. Core concepts of radiography science and their definitions.

Core concept	Definitions and properties
Clinical practices in radiography	*Definitions*: 1) Patient service in different healthcare environments (incl. clinics, wards, mobile units), in contrast to, for example, academia. 2) The everyday actions, for example, diagnostic or therapeutic procedures and care occurring in the radiography context. *Properties*: 1) Service in different parts of patient pathways. 2) Producing images or treating a disease by means of radiation, magnetic resonance or sound waves. 3) Brief time with patients/customers. 4) Technical environment.
Radiographers' profession (professionals in this group are known as radiographers, radiological technologists, medical radiation technologists, nuclear medicine technologists or radiation therapists/radiotherapists)	*Definitions*: 1) Work that needs qualification and education to operate 2) Legal entitlement to perform radiographic procedures, as well as legal and ethical responsibilities. 3) Compliant with standards of professional regulatory bodies and accepted standards of practice. *Properties*: 1) Continuous professional development and lifelong learning to maintain skills and competences. 2) Values include behaving with respect, trust, dignity, nonjudgemental attitude, and maintaining privacy and confidentiality. 3) Work includes technical and human factors. 4) Provide high-quality and effective service.
Safe and high-quality use of radiation	*Definitions*: 1) operating with radiation, compliant with safety culture and quality requirements. *Properties*: 1) use is beneficial at correct doses but potential to cause biological damage, if not compliant with safety culture and quality requirements 2) contributes significantly to the overall dose of population. 3) The radiation doses should be kept as low as reasonably practicable for their intended use. 4) Potential benefits must always outweigh harms.
Technology in radiography	*Definitions*: 1) Physical devices and equipment in diagnostic and therapeutic practice (hard technology). 2) Impact technology has on values, patient care and the interaction between humans and technology (soft technology). *Properties*: 1) Used producing images or treatments 2) Advancing rapidly. 3) Makes processes more efficient.

Table 2. Relational statements indicating bilateral interrelations of core concepts and examples of data.

Core concepts	Example from the data	Relational statement
Clinical practices in radiography – radiographers' profession	'Although radiography does not have a veritable monopoly on practice, the majority of work undertaken by radiographers is only performed by those who have the legal entitlement to call themselves radiographers. . .This ensures dominance of practice remains with radiographers. Using this argument, it could be claimed radiographers have an overall monopoly on practice'. (D13)	The radiographers' profession has a monopoly on radiography practice
	'Radiological technologists continually solve a variety of problems as they go about their daily duties in clinical practice. . . This finding supports the researcher's assumption that technologists with a high capacity for reflective judgement (in the context of the profession) are more likely to provide high quality patient care and radiological services'. (D15)	Radiographers solve problems and make decisions to adapt to individual needs of patients and to ensure quality and safety in clinical practice
	'Patient participants openly disclosed that feelings of separation and isolation experienced when undertaking a CT scan are relieved by the thought that somebody is continually watching over you. The human presence was shown to make patients feel protected and safe. Patients are reassured by a human presence even if it is in the form of a human voice over the intercom system'. (D42)	Radiographers act as mediators between clinical practice and patient
	'The complexity of the healthcare environment in which radiological technologists work continues to increase. Contributing to this complex environment are factors such as staffing shortages, continual advanced technological innovation, constraints in the economic practice, and increasing diversity in patient populations being served'. (D40)	Clinical practice is complex and changing, compelling radiographers to redefine roles and responsibilities
Clinical practices in radiography – safe and high-quality radiation use	'Generally, to ensure safety in the healthcare system, radiography builds a strong environment of radiation protection for patients and practitioners through the culture of safety which is demonstrated in radiographers' behaviour, decisions and actions of everyday practices'. (D38)	Safety is paramount in clinical practice of radiography
Clinical practice – technology	'The imaging equipment has become an important component of health services delivery in both developed and developing countries. This suggested therefore that no quality healthcare services were delivered to patients without recourse to diagnostic imaging equipment'. (D32)	Clinical practices depend on technology
	'Technology has been associated with almost every development in radiation therapy. It has impacted through the improvements of the equipment, delivery of treatment, computer calculating capacity improvement as well as electronic appointment booking systems'. (D16)	Advancement of technology changes clinical practice
	'Both patients found the use of the automated breathing instructions and communication via a microphone to be unusual, with the latter patient saying "I couldn't or didn't want to speak back to a computer". X lost contact with the radiographers when they left the room without informing the patient of their whereabouts. The patient only knew "they [radiographers] weren't in the room"'. (D6)	Technology dehumanises clinical practices and human presence is necessary
Radiographers' profession – safe and high-quality radiation use	'Radiographers worldwide, including Oman, use their professional knowledge to justify radiographic examinations to ensure low radiation doses delivered to patients'. (D38)	Radiographers protect the public from radiation using their professional knowledge
	'Modern treatment delivery systems deliver a high dose of radiation in a very short period. Typical treatment volumes are small with fewer margins for error. Optimal care and safety demand comprehensive knowledge, and awareness based on the magnitude of radiation that may be delivered in a short period. Optimal care demands knowledge informed radiation therapists since errors regarding typical	Radiographers apply radiation safely

(*Continued*)

Table 2. Continued.

Core concepts	Example from the data	Relational statement
	small fields have potentially crippling, and even fatal consequences'. (D17)	
Radiographers' profession – technology	'It has already been argued that radiographers cannot function without the hard technology of their "imaging machines"; whereas nurses may view technological tasks as an adjunct to their daily work, radiographers are wholly dependent upon it'. (D6)	The radiographers' profession depends on technology
	'With the tremendous technological advancements that are happening in radiography today, there is an increasing and unequivocal need to update professional knowledge and understanding'. (D8)	Technology advancement changes the radiographers' profession
	'Radiographers highlighted that working with state-of-the-art equipment portrayed them as technical experts and gave them a sense of increasing professional status: "Radiographers' relationship to technology is important in constructing their professional and self-identity"'. (D35)	The radiographers' professional identity is linked to technology
Safe and high-quality radiation use – technology	'As a consequence of the move to digital imaging it is thought that there are several advantages such as "higher patient throughput, increased dose efficiency, and the greater dynamic range of digital detectors with possible reduction of radiation exposure to the patient"'. (D37)	Advancing technology may increase safe radiation use
	'More recently, it is argued that since operators and observers tend to favour excellent image quality a patient's radiation dose may increase, thus a higher exposure than normal is selected for a particular examination, referred to as "exposure creep" or "dose creep"'. (D29)	Advancing technology may decrease safe radiation use
	'Physical image quality assessment methods are designed for assessing the "total" X-ray imaging system performance and also for evaluating the performance of individual components. These methods form the basis of acceptance testing prior to commissioning a new piece of equipment in clinical practice. They also form the basis for the decisions made for assessing equipment performance over time'. (D50)	Quality assessment is needed in clinical practice to ensure safe technology use

profession in relation to the concept of clinical practice is also functional. This includes the profession's monopoly over the practice and its control over safety and quality and includes the profession's role as a mediator between the technical environment and humanistic interaction.

There is interdependency between the concepts. Radiographers give their professional knowledge and skills to provide services and the profession depends on clinical practices for their professional mandate (D3; D4; D10; D13; D16; D18; D31; D38; D47; D48). The profession has some level of autonomy in relation to practice, even if much of the work is governed by protocols (D9; D13; D14; D28; D37).

The profession applies its values to provide ethical care (D1; D2; D13; D25; D27; D32; D33; D40; D42; D46; D48). Radiographers solve problems and make decisions to adapt to individual patient needs and to ensure quality and safety in clinical practice (D9; D15; D21; D27; D37; D42; D44; D47; D48).

Radiographers are mediators between clinical practice and patients. For a radiographer, the clinical practice environment is commonplace, whereas to a patient it is alien (D16; D48; D49). The information and compassionate care radiographers give alleviates patients' anxiety and fears (D1; D6; D16; D41; D42; D48; D49). Radiographers also see themselves as a bridge between technology and care (D6; D46; D48).

Clinical practice in radiography is complex, radiographers have to deal with both technical and human factors. Clinical practice is changing due to societal changes, for example, a shortage of healthcare professionals, which has compelled professionals to redefine roles and responsibilities. (D2; D4; D5; D8; D10; D11; D14; D15; D20; D35; D40; D43.) The advanced roles of radiographers in clinical practice has improved service and patient care quality (D5; D8; D23; D34; D39; D43; D52).

Clinical practices in radiography – safe and high-quality radiation use

These concepts are necessarily related, because clinical practices in radiography can only be of a high quality only if there is safe radiation use. Safe and high-quality use of radiation is a way to provide excellent services. There is also a functional relationship; radiation is used for diagnosis or treatment in clinical practice – clinical practice is dependent on safe and high-quality radiation use. High-quality in radiation use refers to compliance with safety culture and quality requirements.

Safety is integral to clinical practices in radiography, especially radiation safety or safety in magnetic resonance imaging (D9; D17; D19; D26; D33; D38; D40; D50). Clinical practice is governed by protocols, which ensure safe conditions (D39; D42) and a safety culture is essential (D16; D38). Not all diagnostic modalities use radiation. Ultrasound uses sound waves, and magnetic resonance image production is based on magnetism. However, safety and quality are also essential in these modalities (D11; D12; D45).

Clinical practice – technology

The relationship between these concepts is sufficient because the presence of the first concept guarantees the presence of the second concept. If technology changes then clinical practices should reflect the change and vice versa. If there is advancement in technology, then there ought to be advancement in practice. The relationship is also conditional – a human presence is needed – and time-ordered. The relationship is both functional, when technology is used to provide services, and causal, when an advancement in technology changes the clinical practice and clinical practice advancement changes the technology.

There is interdependency between the concepts. Clinical practices in radiography are dependent on a functioning technology. Without the equipment there are no practices to conduct, and high-quality healthcare services are dependent on imaging and radiotherapy equipment (D14; D32; D36). With malfunctioning technology, the diagnosis or treatment cannot be done safely and with adequate quality (D32).

Rapidly advancing technology has changed practices (D8; D14; D20; D36). For example, practices are changing and becoming more automated and requiring less hands-on skills (D17; D29). Automation can add safety and decrease variability between operators (D39), but can also have a negative effect; clinical practices in radiography have also been described as a dehumanising production line due to the constantly improving efficiency (D13; D14; D48). Technological advancement can facilitate improvements in the workflow, which can be seen as positive for efficiency and providing more time with patients (D14; D29). However, they can also be negative for patient–radiographer interaction if the workflow improvement leads to less time with patients (D29) and distances users from the processes (D14; D17; D37; D46).

Patients can feel isolated alone in a room with technology (D6) and a human presence during procedures provides patients with reassurance. Retaining some control over the situation gives patients confidence (D6; D42).

Radiographers' profession – safe and high-quality radiation use

The relationship between these two concepts is necessary, because knowledgeable radiographers are needed to ensure safe and high-quality radiation use. Only if there are knowledgeable professionals can safety be ensured. The relationship is functional, radiographers protect the public from radiation and apply it safely.

A radiographer uses ionising radiation for diagnostic or therapeutic purposes (D2). A radiographer is crucially placed to optimise dose and image quality (D9). As equipment operators, radiographers have a critical role in ensuring radiation safety (D20; D22; D24; D30; D33; D43). Radiographers protect patients, themselves and other healthcare professionals from radiation (D5; D19; D24; D37). They need to use appropriate criteria for assessing image quality to recognise what is acceptable (D44; D50).

Safe and high-quality radiation use depends on the radiographers' professionalism (D17; D38). They deliver radiation treatment safely and accurately and provide patients with sufficient information (D16; D20; D51). Deficiency in the radiographer's knowledge or lack of compliance with radiation safety practices increases unnecessary exposure of patients and personnel (D20; D53). The social norms and attitudes of radiographers affect their radiation protection practices (D22).

Radiographers' profession – technology

The relationship between these concepts is causal, because technology causes effects in the radiographers' profession. It is also conditional: humane care in technological environment can occur only in a professional's presence. Radiographers are dependent on technology at work; there is no diagnostic imaging or radiotherapy without functioning technology (D6; D9; D13; D14; D42). Radiographers need to be skilled in technology use and update their skills and their knowledge whenever necessary (D6; D16; D24; D38; D42). They apply their knowledge of technology to the individual care of patients (D16; D30; D42).

Technological advancement and automation develop and change the profession of radiographers (D4; D8; D11;

D13; D16; D20; D28; D37; D43). Technological advancement also requires new competencies and expanded roles (D6; D8; D11; D13; D28; D38). Technological advancement is not seen as an exclusively positive change as automation eliminates some tasks previously done by radiographers (D4; D17; D35). The attitude of professionals towards technology will affect how they use it (D14).

Professionalism in radiography is often related to radiographers' technological competence in patient care (D1; D9; D6; D35).

Safe and high-quality radiation use – technology

The relationship between these concepts is conditional and somewhat conflicting, due to advancing technology both increasing and decreasing safe and high-quality radiation use. We need the presence of a third concept, the radiographers' profession and/or quality assessment measures, to determine how these two concepts are interrelated. If technology advances, then safe and high-quality radiation use increases; however, this is only true if there is a knowledgeable professional present and quality assessment measures are performed routinely.

Safety requires safe use and care of equipment (D6; D42). Advancing technology is usually designed to produce high-quality images with less radiation exposure (D14; D29; D37; D45) or fewer side effects from the radiation therapy (D16).

However, with advancing technology 'dose creep' has been identified; this means that even though technology is designed to provide lower doses, operators are not using these features as efficiently as possible. A technique that was valid with older equipment is not necessarily valid with new equipment (D14; D22; D29). The increase in the overall use of medical imaging technology contributes to the overall radiation dose transferred to the population, even though the technology itself is designed to reduce the dosage (D14; D36).

Quality assessment measures are needed regularly to ensure the technology is working within the safety limits and unnecessary radiation exposure is avoided (D16; D32; D42; D50).

Discussion

This study aims to clarify the perspective of radiography science as an academic discipline. The perspective can be seen in definitions and interrelations of the core concepts. The core concepts are broad and reflect assumptions made by emerging radiography researchers. Radiography science seeks answers to how to develop the profession of radiographers by: investigating advanced roles; professional values and the work of radiographers in clinical practice; safe and high-quality radiation use in healthcare contexts, and the optimal use of diagnostic imaging and radiotherapy technology. Clinical practice is the context where radiography science investigations often occur, and often provides the rationale for doing research. Radiography science investigates radiography services in a complex and evolving environment and as a part of patients' pathways. Safe and high-quality radiation use is studied in radiography science as a means to deliver optimal services in clinical practice.

Based on the findings of this study, radiography science is not concerned with developing new equipment, but when new equipment is developed, then radiography science investigates its functionality for clinical practice. Technology studies are often connected to safe and high-quality radiation use, for example, how to optimise patient doses with new equipment or techniques.

The interdependency between the core concepts may indicate that the presence of dependent concepts is a way to differentiate radiography science research from the related disciplines of medical physics, nursing science and radiology. Whereas medical physics is focused on assessing, optimising and analysing medical technology,[5] radiography focuses on the functionality of the technology to the health service. Radiography and nursing science share a similar history originating from healthcare professions in many countries. Whereas nursing science has evolved into research focusing on health[6] radiography science has focused more on diagnostic and therapeutic processes. The most obvious difference between radiology and radiography science is the fact that radiology is a medical specialty and radiography is not. However, they do both operate in the same field, that is, medical imaging. As a medical specialty, radiology aims at improving health by more accurate and efficient diagnosis[29,30] or treatment methods.[30,31] According to this study, radiography science aims to investigate these services and how to provide them safely and humanely in a technical environment.

There is still much to discover in the discipline of radiography science: the knowledge base, ontology and methodology need to be strengthened. Some global consensus as regards the name of the discipline could help bring the community closer together. Despite the choices made in defining the core concepts being based on previous studies, the acceptance of these core concepts and the entire paradigm of the discipline remains a matter of broad discussion in this field. The novelty of this study is bringing a new set of core concepts into the discussion. We have demonstrated the perspective of radiography science by illustrating the interrelationship between the core concepts and their dependencies. An understanding of the core concepts may deepen with further research. Relational statements (Table 2) can be of use as hypotheses to be tested by future radiography researchers.

Limitations

Data were selected through a database search and only openly available dissertations were included. It is possible there are more dissertations investigating phenomena related to the core concepts but which are not indexed in the databases. Language was a limiting factor, as only those written in English were accepted. This adds a bias to the dissertation publication countries (only English-speaking countries involved) and it is not possible to say where and how much research is done globally in radiography science. The data were selected in accordance with the dissertations investigating only the proposed core concepts. This may exclude other dissertations on radiography science.

Recognising the interrelationships is not an easy task and qualitative analysis has its limitations, such as a possible interpretation bias and a lack of measurability. Interpretation bias was tackled with discussions within the author team.

The data analysis was based solely on documents. There was no interaction with the authors of the documents and we cannot be certain whether the authors identify themselves as radiography researchers.

Conclusions

These findings are significant to radiography science because they define the core concepts and clarify the perspectives of the discipline. The findings of this study can be used for educating radiographers, conceptualising radiography research and building a framework for research in the discipline in order to develop the paradigm in this young academic discipline. Clarifying the core concepts does not exclude the interdisciplinary research needed in medical imaging and radiotherapy, but it gives more tools for radiography researchers to argue their own perspective.

Conflict of Interest

The authors declare no conflict of interest.

Ethical Approval

This study did not include human or animal participants. The study was based on publicly open documents.

Data Availability Statement

Data derived from public domain resources. These data were derived from the following resources available in the public domain: Oadt (https://oatd.org/) and ProQuest dissertations and thesis (https://www.proquest.com).

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Appendix S1
Appendix S2