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Title: Qualitative content analysis of image interpretation education in UK pre-registration diagnostic radiography programmes

Abstract

Introduction: Image interpretation is a required capability for all UK pre-registration programmes in diagnostic radiography to meet the needs of graduate practice. It also provides a potential educational foundation for future advanced clinical practice. The aim of this study was to explore how image interpretation education is designed, delivered, and assessed within contemporary UK pre-registration diagnostic radiography programmes.
Methods: Qualitative content analysis of open-source image interpretation curriculum data extracted from UK Higher Education Institute (HEI) websites.
Results: Extracted search data was initially coded and three overarching themes emerged, image interpretation education vision, operationalisation, and delivery and assessment.
Conclusion: This study identified significant heterogeneity in all aspects of UK pre-registration image interpretation education which may suggest an equal heterogeneity can be expected in the image interpretation knowledge, skill, confidence between newly registered practitioners.
Implications for practice: There may be a need for clearer expectations on HEIs by professional and regulatory bodies to ensure consistency in pre-registration image interpretation education.

Keywords:

Image interpretation, education, diagnostic radiography

Introduction

The Health and Care Professions Council (HCPC)[1] identify that diagnostic radiographers, must be able to "*distinguish between normal and abnormal appearances evident on images*" (Standard 13.14)[1], *"distinguish disease and trauma processes as they manifest on diagnostic images"* (Standard 14.35)[1] and "*be able to appraise image information for clinical manifestations and technical accuracy, and take further action as required*" (Standard 14.10). However, HCPC do not specify what modalities, pathologies, or to what level of proficiency or detail is expected of practitioners. Nor is it explicitly articulated how these findings are to be communicated or in what format, although radiographers must be able *"to demonstrate effective and appropriate verbal and non-verbal skills in communicating information, advice, instruction and professional opinion to service users, colleagues and others"* (Standard 8.1)[1].

The Society and College of Radiographers (SCoR)[2] has long considered image interpretation to be within the scope of practice of graduate radiographers and the professional body identifies different modes in which this can be communicated, including 'red dot' abnormality flagging systems, a preliminary clinical evaluation (PCE) or comment, and through formal clinical reporting. The SCoR clearly define the expectations for each communication mode[2] and since 2006, has outlined that higher education institutions (HEIs) are expected to include the principles of image assessment and reporting into pre-registration programmes to ensure

graduates emerge competent to provide a PCE with the skills further developed during preceptorship.[2] Whilst SCoR guidance is more prescriptive and goes beyond the HCPC, there is still ambiguity as to what education and competencies are required. It is important to note that all pre-registration Diagnostic Radiographer programmes require formal approval by the HCPC as the statutory regulatory body, yet SCoR accreditation by the professional body is not mandatory.

As has been eluded to, there is ambiguity by the professional and regulatory bodies around what the term image interpretation incorporates but the knowledge and skills required for image interpretation are multi-faceted and which include but are not limited to, knowledge of anatomy, pathology, radiographic technique, spatial ability, image manipulation, use of search strategies, discriminating between normal & abnormal findings, correlating with clinical information and decision making.[9] Inclusion of these within the pre-registration curricula therefore requires a considered and scaffolded approach. In 2009, Hardy and Snaith[10] surveyed UK pre-registration programmes. They concluded HEIs had formally embraced and incorporated image interpretation education to meet emerging expectations at that time. However, they identified significant variation in education delivery between institutes and raised uncertainty whether graduates would emerge with appropriate and sufficiently developed image interpretation skills to meet clinical need. Anecdotally, it is the experience of the authors in their roles as academics, external examiners, and assessors across a range of UK Radiography programmes that this disparity and variation still exists.

A paucity of research evaluating UK pre-registration radiography image interpretation education has largely remained with more contemporary curricula research focused on the evaluation of postgraduate education in the context of advanced clinical practice.[8,11,12] Pre-registration education is critical in the development of 'first post' image interpretation capabilities and may provide a potential educational foundation for potential future postgraduate image interpretation education and progression to advanced clinical practice roles.

Aim: The aim of this study was to explore the image interpretation curriculum within contemporary UK pre-registration diagnostic radiography programmes.

Objectives: The objectives of this study were to:

1. Explore how image interpretation education is designed, delivered, and assessed in UK pre-registration diagnostic radiography programmes
2. Use the findings to inform recommendations for future image interpretation education curriculum design and research

Methodology

Qualitative content analysis: This study employed an in-depth qualitative content analysis[15] of educational curriculum documentation freely available in the public domain (open-source) from UK HEIs pre-registration diagnostic radiography programme websites. Content analysis is an established and frequently used method to interrogate text data applied to analyse online data

sources.[15,17] Erlingsson and Brysiewiczb[16] summarise content analysis as systematic method to gather and convert significant volumes of data into a summary of important findings. This type of analysis not only enables interrogation of the language used but also context allowing the authors to draw assumptions ascertaining the position of the work in relation to other studies [15,17].

Ethical considerations: Being open-source data, formal ethics approval was not required or sought for this study.[18,19] However, the following ethical considerations were addressed. To maintain anonymity and confidentiality of all HEI courses and individuals, all collected data has been de-identified. [19] Authors did not perform initial data extraction for HEIs or programmes with which they hold current or prior affiliation and analysis of each programme was performed by all authors.

INSERT FIG 1 HERE
Figure 1: Summary of research design

Inclusion criteria: Programmes were only included in the study if they were a UK based pre-registration diagnostic radiography programme approved by the HCPC. This was confirmed by searching the HCPC website and with cross reference to the SCoR directory of pre-registration programmes, though not all are approved by the SCoR.

Open-source searches: Manual open-source data searches adapted from Rew et al.,[4] were conducted for each programme in two stages:

1. An initial search on the official HEI landing page to identify relevant programme data
2. Secondary searches using the unique programme and module codes identified in stage 1

Each search was repeated across a range of search engines and repeated by more than one author to identify potential omissions. Search engines included Google Chrome, Microsoft Edge, Mozilla Firefox.

Data extraction: Extracted data was only collected from official HEI landing pages for each programme from July 2020 to October 2020. Third party data sources were excluded. Extracted data included programme and module documentation and codes, programme structure and module credits, programme, and module level aims, learning outcomes, indicative content, delivery and assessment details, programme resourcing, timetabling, and marketing material. All data was extracted and manually transcribed into an Excel spreadsheet.

Data analysis: Extracted data was manually coded by each author individually for each programme, then combined with any disagreement resolved collaboratively. Emergent themes and sub themes were identified from the coded data. The coding and thematic analysis stages were iterative and occurred concurrently with multiple stages of revision and re-coding.

Findings

34 pre-registration Diagnostic Radiography programmes across 27 UK HEIs (see Figure 2) met the inclusion criteria and were included within the study. On commencement of data collection, it became apparent there was variation in relation to completeness and quality of the extracted data available for each programme. Of these, 37% (n=10) were considered to provide significant information about the programme and module structure and content enabling detailed analysis and were classified as 'green', approximately 40% (n=11) provided information outlining module titles and basic programme information and classified as 'amber'. 22% (n=6) of courses provided limited or sparse information on programme and module structure offering minimal opportunity for analysis, which were classified as 'red'. This demonstrates that there is significant variation in the degree of open-source information available between different UK HEI landing pages.

INSERT FIG 2 HERE
Figure 2: distribution of included HEIs and courses across the UK.

The study findings are divided into three overarching themes (see Table 1); vision of the programme in relation to image interpretation education, operationalisation of how image interpretation education is structured within a programme, and an exploration of how dedicated image interpretation modules are delivered and assessed.

INSERT TABLE 1 HERE
Table 1: Summary of emergent themes & sub themes

Vision Theme

Overarching rationale: This first sub theme explores the rationale or mandate for image interpretation education provided within programme level documentation. 59% of programmes (n=16) provided an overarching rationale or vision with clear aims for image interpretation education. Of these, most provided broad overarching aims to develop skills in image interpretation, without exploration of which specific areas or modalities were considered or that this skill is a core capability to the radiographer's role. 22% (n=6) identified the need to develop skills in commenting or PCE and 15% (n=4) further contextualised this to support the role of radiographer reporting. Only a single HEI programme made a direct link to clinical reporting in postgraduate education. 11% (n=3) directly referred to the expectations of the SCoR[2], while two (6%) directly addressed the HCPC[1] standards of proficiency or first post competencies.

Terminology used: The terminology used (Table 2) was wide-ranging. 41% (n=11) of HEIs were consistent in using the same terminology throughout, whilst others used multiple terms even within the same programme documentation. Most referred to was image interpretation, followed by PCE, and commenting. It was interesting to note that clinical reporting was a widely used term though, as defined by the SCoR[2] is not an expectation of pre-registration education.

INSERT TABLE 2 HERE

Table 2: Frequency of terminology used to describe image interpretation education

Areas covered:

Documentation was often vague or ambiguous about what modalities, pathologies, body regions were taught within the programme or a particular module. The frequency in which image interpretation was considered towards a particular body system, pathology, or modality is summarised in Table 3.

INSERT TABLE 3 HERE
Table 3: Frequency of areas of content covered

In terms of modality, conventional radiographs were most widely referred to specifically. The appendicular skeleton, or skeletal generally, was most widely considered followed by the chest and abdomen equally. Only one programme specifically referred to paediatrics and this was in relation to non-accidental injury [sic]. It is interesting to note there were a relatively large number of programmes incorporating education in relation to other non-practical aspects of image interpretation practice such as governance and medicolegal issues.

Operationalisation Theme

Credits: The volume of credit allocated to image interpretation delivery varied significantly across the HEI sector, ranging from 20 to 140 credits over the duration of a programme. The average number of credits allocated to image interpretation was 62.7, with a median of 60 and a mode of 20. These averages are based on modules incorporating image interpretation in their title or containing identifiable dedicated image interpretation content.

Scaffolding and location within course (and type of course): Module level learning outcomes and indicative content was not available for all programmes, limiting the ability to identify and evaluate the location and scaffolding of image interpretation for 38% (n=14) programmes. Where available, programme composition typically included both dedicated image interpretation modules and modules with a component of dedicated image interpretation content. The latter was often in combination with a wide variety of other content with no direct clinical or pedagogical relevance. Four (11.7%) programmes had a single identifiable dedicated module on image interpretation within the programme structure, whilst all other programmes had two or more dedicated modules. Several programmes contained a strand of image interpretation modules (or dedicated module content) spanning across the entire length of the programme, providing evidence of both vertical and horizontal scaffolding of the image interpretation within programme design.

Indicative image interpretation content: This sub theme identifies commonality in indicative image interpretation content across each year of the pre-registration programmes. These are summarised in Figure 3 for three-year programmes only, three years being the common programme length with only Scotland currently having a fourth year of delivery.

INSERT FIGURE 3 HERE

Figure 3: Summary of indicative image interpretation content by academic year for three-year long programmes.

Year 1: Indicative content included describing anatomy including, "basic radiographic anatomy", normal and abnormal appearances, anatomical variants, and common pathologies, critique of the radiographic image and the inclusion of a systematic evaluation. The focus of several modules at this level are on the appendicular and axial skeleton, with some (14%, n=5) programmes including the chest region.

Year 2: Appendicular and skeletal image interpretation in year 2 is indicated by 16% (n=6) programmes, whilst others progress to chest and abdomen having focused on the skeleton in year 1. Content at this level included decision making, search strategies, use of correct terminology to describe findings, image perception, decision making and how to escalate findings. Content also often includes consideration of mobile and theatres and other imaging modalities.

Year 3: Recurring areas of focus are axial, appendicular skeleton and chest. In programmes these are distinguished from the other years by exploring more complex patient presentation to include traumatic conditions. Five (14%) of programmes indicated including CT Head interpretation within this final year. Understanding of normal is expanded to include developmental changes and normal variants. The level expected is identified as being that required for first post competency, as an abnormality alert leading to the production of a PCE or preliminary image evaluation (PIE). Exploration of descriptive interpretation or report writing is commonly included. Image quality continues as a common component.

Year 4: Common indicative content for programmes with a fourth year included trauma imaging, mammography, ultrasound, CT, MRI, and other specialist procedures.

Delivery and Assessment Theme

Delivery approaches: Wide variation in delivery approaches were identified across the programmes. Modes of delivery include face-to-face, blended, online with both synchronous and asynchronous approaches. Face-to-face synchronous being the most common delivery approach identified from the data. Class delivery appeared to range from apparent purely didactic lectures to blended learning approaches to include alignment with clinical placement. Class delivery included lecture, tutorial, practical, seminar, workshop, image viewing session, clinical placement, tutor directed, and self-study approaches. Due to the limited data available it was not possible to review delivery methods employed within the Virtual Learning Environment. Determining the specific teaching approaches taken and the degree of opportunity for peer-to-peer and peer-to-academic engagement was challenging due to the limited availability of open-source data specifically about delivery. It might be reasonable to presume that classes such as tutorials, practicals and image viewing sessions are interactive in nature, and may include teaching approaches such as critical thinking or problem-based

learning. However, it was generally not possible to determine or isolate specific teaching approach examples.

Five HEIs made explicit reference to use of PACS within their dedicated image interpretation module documentation, again limited detail was available to determine exactly how PACS was being utilised for delivery or assessment within most programmes. It was possible to identify that PACS was being used to support review of cases for image interpretation delivery at two centres. Shaderware software was also utilised to compliment delivery at two centres. Equally, it was not possible to determine how this software was used in an image interpretation education context. Overall, 26 out of 27 centres are using a range of delivery approaches and enough evidence was extracted to determine strong constructive alignment between the curriculum and delivery for 5 HEIs.

Summative assessment: Findings presented under this sub theme summarise data extracted from dedicated image interpretation modules only. The degree of open-source assessment data varied from full access to both current and prior assessment strategies for a specific cohort and session, to limited or no assessment data being accessible at all. For those HEIs where assessment data was available, significant variations in assessment strategies were identified.

Identifiable summative assessment approaches for image interpretation included written examination, clinical assessment, objective structured clinical examination (OSCE), computer-based assessment (CBA), case study, portfolio, and coursework. Where data was available, almost all HEIs appear to be employing a combination of multiple assessment approaches. Data for two HEIs suggests they were employing solely a final examination for 100% of the module summative assessment. The written examination was the most frequent form of summative assessment approach being adopted within dedicated image interpretation modules. How these examinations are designed or administered is almost impossible to glean from the available data. There was clear use of examination questions incorporating authentic, anonymised clinical cases by two HEIs. The use of online continual, low stake assessment items to assess aspects of image interpretation could also be explicitly identified within two programmes. It is suspected that formative assessment approaches will likely be widely adopted within many HEIs, however this data was not identifiable within the extracted curriculum documentation in relation to image interpretation.

Discussion

The findings from this study provide evidence suggesting that image interpretation is embedded into most UK pre-registration Diagnostic Radiography programmes, however with significant variation or heterogeneity in approach and content. This supports previous findings by Hardy and Snaith[10], whilst McNulty et al.[6] reported similar variations when comparing the radiography curriculum globally.

What, how and where pre-registration image interpretation is taught, would appear to vary dramatically. Whilst image interpretation is a requisite for HCPC accredited programmes to address the standards of proficiency[1] (and the SCoR[2] where courses are also approved), the

identified heterogeneity may be reflective of potential varied interpretation of the somewhat ~~ambiguous~~ limited specific regulatory and professional guidance provided in relation to graduate image interpretation practice. Similarly, the heterogeneity in terminology and purpose used within programme and module documentation, mirrors the variation and lack of consistency in image interpretation purpose and terminology more broadly within the profession and published research as noted within the introduction.

A core skill of the diagnostic radiographer is to be able to critically assess images in terms of technical adequacy and quality. In the terms of image interpretation, is this the same as being able to "*distinguish between normal and abnormal appearances evident on images*" [1] or are image 'critique/evaluation' and interpretation separate processes? Preliminary clinical evaluation (or preliminary image evaluation) or commenting, are terms defined by the SCoR[2] for the practice expected of graduate radiographers and these terms featured commonly within programme documentation. 'Clinical reporting' and the development of 'report writing skills' were also terms frequently used within pre-registration programme documentation. 'Reporting' is deemed a separate task by the SCoR[2], one that requires further postgraduate education. This raises the question, should this term be used to describe the educational activities undertaken at pre-registration level? Yet, SCoR[2] also considers the principles of image assessment and *reporting* as required content within the pre-registration curriculum, while HCPC fails to provide definitions of any of these terms.

Almost all programmes appear to incorporate image interpretation of skeletal trauma on conventional radiographs. This may reflect that PCE is seen as a progression of the red dot flagging system which historically focused on skeletal trauma.[20] Conventional skeletal trauma is also the most common area for radiographer reporting. [21,22] The findings of this study suggest conventional chest or abdominal imaging interpretation is not explicitly taught in all programmes. As a HCPC proficiency requirement (Standard 14.31), diagnostic radiography graduates should be able to perform standard head computed tomography (CT) examinations and assist in other CT examinations and within other modalities. Is there a clinical need to further develop image interpretation in other areas such as CT head image interpretation within pre-registration programmes? The findings from this study highlight that several HEI providers are already delivering a broader range of image interpretation content beyond conventional radiography, however to what depth and specific purpose was not determined.

Within this study, the scaffolding and articulation of image interpretation education between theory and practice within the clinical setting was typically not implicit. Prior research by Lundvall et al.[7] highlights the essential role of clinical placement learning as part of the educational journey for evolving practice and development of embodied knowledge. Clinical practice is a critical learning environment for learning in action and helps students to transfer knowledge and skill to unfamiliar or unexpected situations. Interestingly one HEI specifically identified as part of their overarching programme rationale that there was a distinct focus on common pathologies, with an aim was to develop the transferable knowledge and skills that could be applied when encountering rarer abnormalities. This is an important concept in image interpretation education as we transition from a competency-based model to development of professional capabilities. However, prior research in this area suggests that further education

and training is typically required to increase and maintain accuracy in radiographer image interpretation despite prior knowledge and skill.[13,14] This suggests that image interpretation will require life-long learning, but the role of the pre-registration programme may be to provide the underpinning skills and knowledge to allow this.

Limitations

Several limitations should be acknowledged. The degree of detail and currency of data available via open-source through HEI websites was highly variable. For six programmes, no module level data was available for analysis. Additionally, there was ambiguity and variance within the language used requiring interpretation by the researchers.

There is a presumption that open-source data provided by each HEI is a true reflection of the curriculum as actually delivered and assessed. It should be noted that all programmes included within the study were HCPC accredited, a rigorous process that includes collation and review of delivery and assessment evidence. ~~Review of~~ It is expected by HCPC that an approved programme is delivered as designed, therefore published formally accredited programme data should be considered as an accurate data source for ~~valid approach to gain insight into~~ curriculum design and delivery if it is current and accurate.[23]

Finally, ~~That~~ delivery and assessment practices may have changed in response to the COVID-19 pandemic, which may not been reflected within the open-source data.

Recommendations

It is recommended that there is a need to conduct prospective research exploring the pre-registration image interpretation curricula to establish a more detailed and accurate understanding of image interpretation delivery and assessment to influence future practice. Further research exploring the expectations and clinical need for first post competency image interpretation skills, knowledge, and attitude is also recommended.

It is suggested that there is a need for increased clarity from professional and regulatory bodies regarding image interpretation curricula expectations for pre-registration programmes. This should include increased explicit scaffolding of image interpretation education delivery and assessment within the clinical setting for pre-registration programmes.

Conclusion

Open-source data extracted from HEI websites can provide a novel snapshot of educational curricula at a particular point in time, noting that this approach provides a predominantly 'broad brush' overview. The findings from this study identified significant heterogeneity in all aspects of the image interpretation educational curriculum to include the rationale for image interpretation, terminology used, content, credit volume and location with the programme, how delivery is scaffolded, areas and modalities taught and that programmes are employing

multiple and varied forms of assessment. This suggests that there is limited standardisation in what, how or when image interpretation is delivered or assessed and hints to ambiguity to the explicit purpose of image interpretation within the broader pre-registration curriculum. If graduates are in part a product of their educational journey, we should likely anticipate heterogeneity of image interpretation knowledge, skill, and confidence between newly registered practitioners. It is also unclear as to what extent (if any) the pre-registration curriculum provides a foundation for future advanced clinical practice education in image interpretation. In keeping with other standards, a clearer definition of image interpretation role and scope for the graduate practitioner would be helpful.

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