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A National Survey of Operating Theatre Experiences Among English Student Diagnostic Radiographers

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Abstract

Introduction: Theatre radiography is an important part of a diagnostic radiographer's scope of practice, supporting safe imaging during surgical procedures. However, studies indicate that newly qualified radiographers often lack confidence in theatre imaging, particularly using C-arms, and that post-qualification training in hospitals is frequently brief and not competency based. This survey aimed to evaluate pre-registration educational experiences in universities and clinical hospital placements of operating theatre imaging in England for diagnostic radiography students. Exploring preparedness, confidence and competence (technical skills development) in using C-arms within surgical environments, to highlight potential areas for future curriculum development.

Method: A cross-sectional, online survey was distributed to final year students to n=23 universities offering diagnostic radiography training in England. The survey gathered data on demographics, clinical experiences, university experiences and confidence levels in different areas of operating theatre radiography. Questions were a mix of Likert scales, multiple

choice and qualitative responses. Data was analysed using descriptive statistics, and free-text responses were coded to identify common themes.

Results: There were n=84 responses from diagnostic radiography students from all n=7 regions in England. Quantitative responses included clinical placement hours in operating theatres ranged from less than 20 hours to more than 141 hours. With 84% indicating more hours would be beneficial for improving confidence levels. The qualitative data analysis identified common themes to support increased clinical hours teaching and learning in an operating theatre (35.7%) hospital environment, specifically to practice and improve technical competence with C-arm equipment (35.7%), and supplementary C-arm simulation training (83%) within university settings to improve confidence levels of C-arm positioning and locks (50%). Responses demonstrated strong confidence in understanding radiation protection (96%) and patient identification (97%) within the operating theatre to prepare for future employment. Sub themes of supervision, types of operating theatre cases, university simulation, patient interaction, identifying anatomy of images were further explored.

Conclusion: Nearly half of the responses indicated students did not feel confident in using a C-arm within the operating theatre. Students felt that simulation and spending more hours in an operating theatre during clinical placement would help improve confidence levels. The implementation of simulation-based training should be considered in universities, along with dedicating more hours to the operating theatre during clinical placements.

Introduction

Working collaboratively in an operating theatre is a required skill for newly qualified diagnostic radiographers. This includes communicating with other healthcare professionals, utilising a fluoroscopy image intensifier with a C-shaped arm (commonly referred to as a C-arm), and understanding radiation protection.¹ C-arms are an essential imaging modality in orthopaedic operating theatres; however, due to radiation risks, radiographers must receive appropriate training to safely use them.² This includes but is not limited to technical skills of image acquisition and optimisation and the impact upon image quality for surgical review of procedures, repeat imaging will have consequences to increasing unnecessary patient dose and may delay surgical procedures. Tay et al.³ suggest that patient safety could be negatively impacted if newly qualified radiographers' confidence is inhibited, particularly if they find the operating theatre environment, interprofessional working and equipment intimidating or challenging.

A study by Tay, Wei, and Chong⁴ found that on the job training for newly qualified radiographers was, on average, only two weeks in duration and not always competency based. Underpinning the concept that pre-qualification training and education play a potentially crucial role in increasing student radiographers' skills in the operating theatre to prepare them for being newly qualified diagnostic radiographers.

A literature review by Rowe⁵ found that challenges, such as insufficient hands-on C-arm simulation and educational instruction, could impact radiography students to be unprepared in the operating theatre environment, increasing stress and anxiety. Timm and Schnepfer⁶ further emphasise the importance of interprofessional clinical placements for healthcare students to improve teamwork, enhance collaborative practice, and foster practical learning. Naylor and Faulkes⁷ specifically studied interprofessional communication among diagnostic radiography students in a simulated operating theatre environment, observing improved confidence levels and team skills. Partner et al.⁸ suggest that longer, week-based simulation activities could effectively build students' confidence, communication, and patient-centred care skills, potentially serving as an alternative to clinical placement. These immersive experiences can help foster collaboration, clarify professional roles, and enhance teamwork in realistic, high-pressure scenarios, thereby better preparing students for real-world healthcare settings.^{9,10}

This study aimed to investigate the educational experiences of English diagnostic radiography students learning operating theatre radiography, exploring how clinical placement and university teaching shape their preparedness, confidence and technical competence (skills development) in using C-arms within surgical environments, and identifying potential areas for future curriculum development.

Method

An online, cross-sectional pilot survey (Microsoft Forms 365, 2025) consisted of 20 questions, which contained after pilot testing and consensus of the research team, a pragmatic balance of collecting sufficient and valid data on key domains to reliably answer the questions, and to avoid participant burned and fatigue when completing. Long surveys can impact lower completion rates and become unrealistic overburden of tasks. The survey was split into five sections: consent, demographics, experiences of clinical placement, learning at university, and confidence levels. The survey was piloted beforehand to test readability (content mapped to study aims and research questions to include all the themes being explored), flow of text (relevance and appropriateness of wording, and review of feedback to reduce ambiguous wording or misinterpretation of questions). The survey layout of the domains into logical grouping to improve the flow and clarity of questions, and online accessibility (ease of access and returning response data through the software). The questions were a mixture of open (free-text qualitative response) and closed (Likert scale) questions. The recruitment criteria were third-year students in diagnostic radiography degree programmes within England. Third-year students were specifically chosen because they would have a longitudinal (three-year) learning experience, offering mature insights and perspectives on university and clinical placements, and providing relevant insights to reduce bias from incomplete training experiences.

Sample size calculations were not feasible since not all universities publicly disseminate pre-registration student cohort data. With an uncertain sample size, an estimate of variability

was derived from English data on the 2020/21¹¹ diagnostic radiography first-year student intake (n=1,299). The third-year cohort, (starting in 2020/21 (year 1) and progressing through 2021/22 (year 2) to 2022/23 (year 3) was expected to be larger due to students entering into this cohort to repeat years of training and or assessments or from students re-attending after interrupting from previous cohorts. But this assumption also mean the original overall cohort size (n=1,299 in 202/21) would likely also suffer attrition¹² and other factors within the third year cohort (such as students leaving, interrupting or dropping down in to a lower cohort year to repeat assessments/training) which would likely reduce the available cohort sample size from the original n=1,299. Thus, a convenience sampling method was employed using a list of universities offering a BSc (Hons) diagnostic radiography degree programme within England.¹³ Institutional ethical approval for the survey was obtained from Canterbury Christ Church University, (ETH2425-S22/RPR/HP).

The survey was emailed to the programme leads of n=23/29 universities in England, asking each universities programme lead for assistance as a 'gatekeeper' in advertising the survey (and participant information materials) and distributing the survey online link to their third-year students. The programme leads of each university had publicly available email contact details through their university websites advertising their radiography programmes, no direct student email address was accessed to protect data governance and to comply with the anonymous survey responses. New university radiography programmes n=6/29 that had not advanced to complete a full cycle of third-year student graduation were excluded.^{11,12} A copy of the survey in included in the supplementary materials.

The recruitment invitation email to the university programme leads included the student's participant information letter, which detailed the study background, consent, withdrawal details, and researcher contact information. The first section of the online survey included mandatory consent questions before participants could proceed. The survey ran between December 2024 and February 2025, with a reminder email sent to universities in January 2025 to maximise responses.

Response data was downloaded from Microsoft Forms (Microsoft 365, 2025) and analysed in SPSS (IBM v.29.0.2.0, 2025). Descriptive statistics included frequency and percentages of responses. Likert scale data were summed for single-item ordinal data and cross-tabulated with demographics to identify trends or patterns. Chi-Square test of independence assessed associations between demographics (categorical variables of the n=7 regions of England, gender, and age range of 6 groups from 18-65+ of participants), and Likert responses (confidence level ordinal response). The Kruskal-Wallis test was used for multiple independent groups, and the Mann-Whitney U Test compared ordinal Likert scores (dependent variable) against gender (independent variable). Correlation analysis was not undertaken as the response variables were predominantly categorical or ordinal, and the aims were to explore the difference rather than define a linear relationship). Qualitative data from open questions were colour-coded for themes, noting recurring topics and quotes.

Results

There were $n=89$ respondents to the survey; five responses were excluded because the respondents were second-year students and, therefore, not eligible to complete the survey. The demographic data showed representation from all seven regions within England, with the largest number of responses from the Southeast region ($n=41$; 49%; Figure 1).

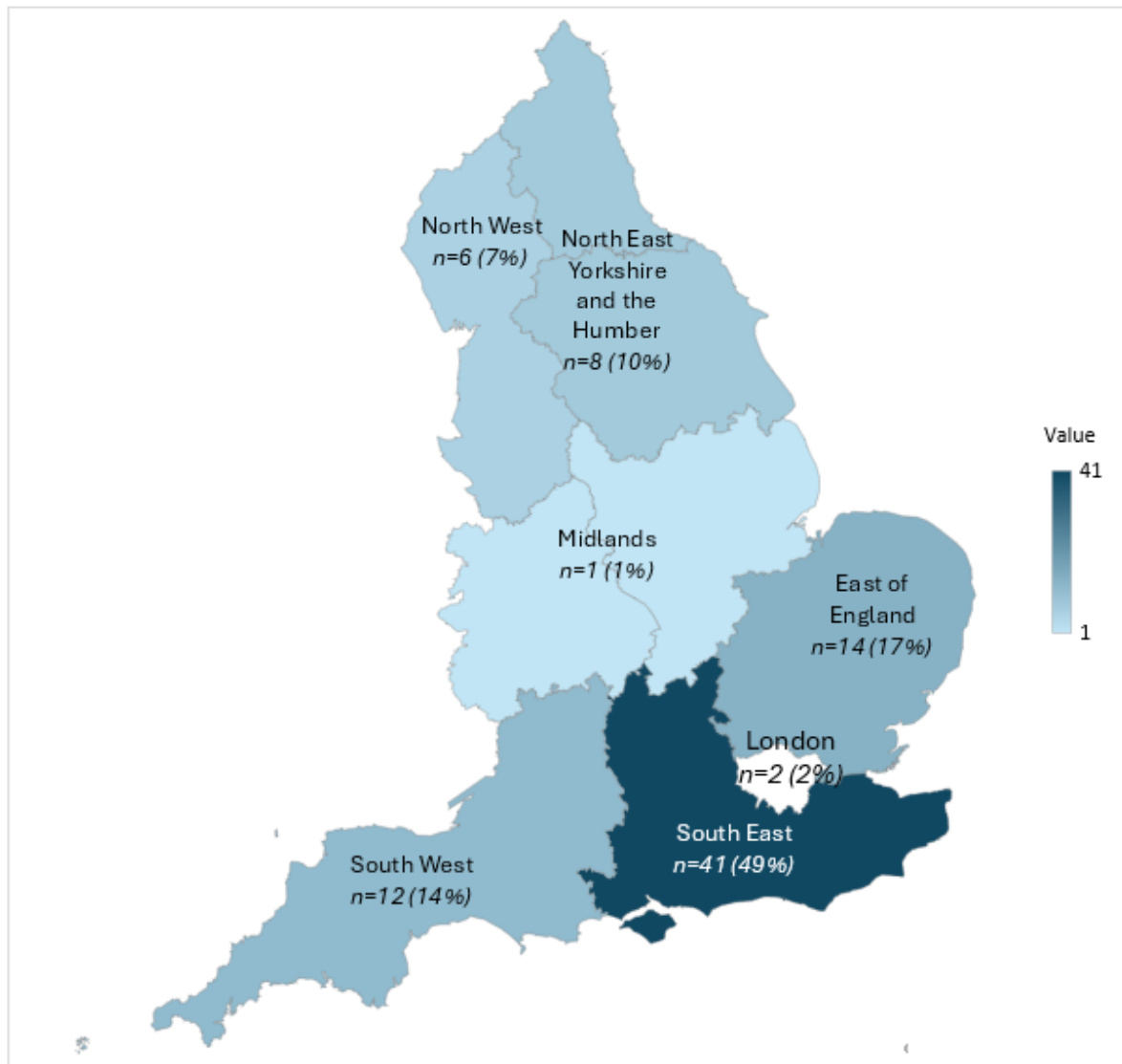


Figure 1 Choropleth map of England, with each region shaded based on the number of responses and percentage of total responses.

The gender sample displayed female (81%) and male (19%) pre-registration students, which was similar to the distribution across the post-registered profession.¹⁴ There was no statistical association between geographic region and gender ($p=0.66$). Notably, there were no responses for non-binary, other, or prefer not to disclose categories. The largest age range category was 18-24 (60%; Figure 2). A higher proportion of younger students was noted in each region compared to any other age range category ($p=0.02$).

Operating theatre experiences among English student radiographers

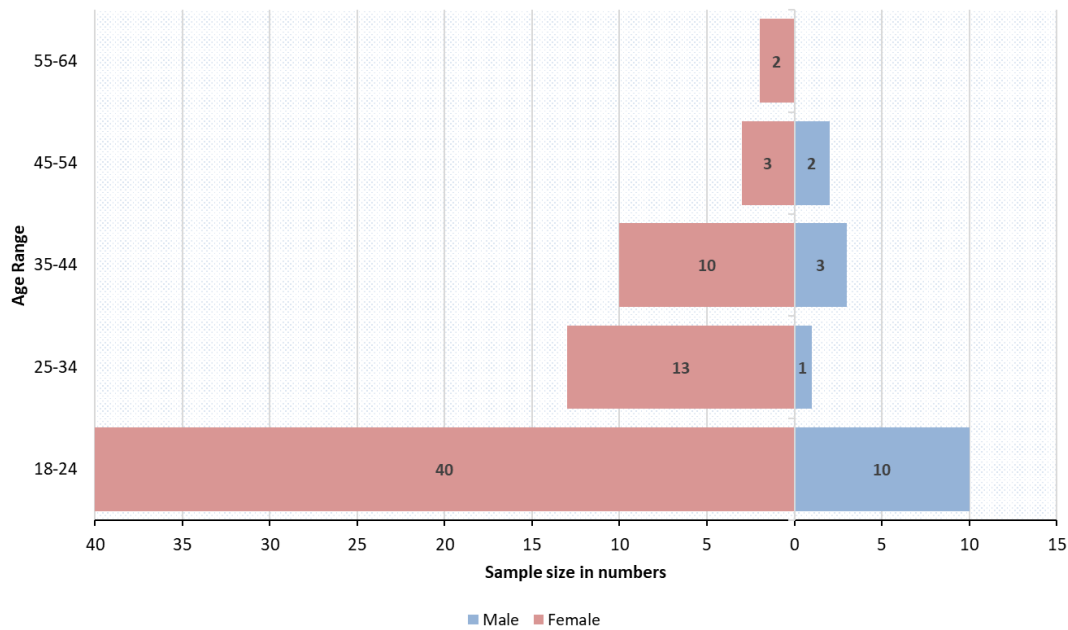


Figure 2. Summarised population pyramid of participants' demographics (age range versus responses numbers by gender).

Time spent on placement

Students were surveyed regarding their experiences within an operating theatre environment during placement (Figure 3). No statistically significant associations were found between clinical placement hours and demographics of regional representation ($p=0.55$), age range ($p=0.21$), or gender ($p=0.44$). Additionally, 48% of students reported 40 hours or less in an operating theatre environment.

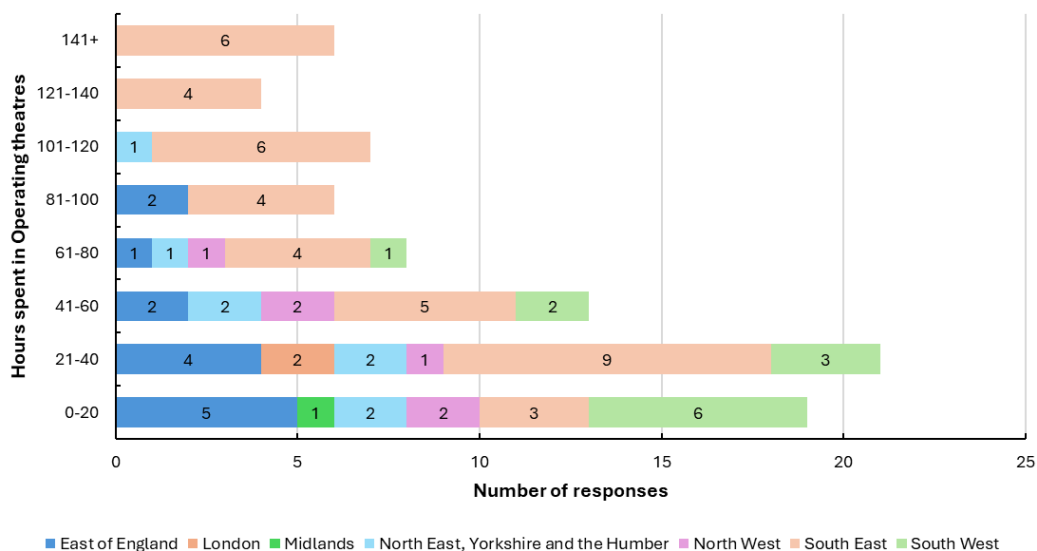


Figure 3. Association between regional category of responses (numbers) and hours (range) spent in an operating theatre environment during radiography training.

Responses indicated (84%) that more hours in an operating theatre on placement would be beneficial to students' confidence levels. There was no specific trend in responses on

additional hours of experience (categorical) to demographics of the region ($p=0.73$), age range ($p=0.46$) or gender ($p=0.15$). Contextual highlights included the provision of access was insufficient to gain enough regular exposure to improve and maintain confidence and retention of technical skills such as C-arm controls, range of surgical procedures, and dexterity in manoeuvring the image intensifier ($n=40/84$) or building relationships with staff within these areas ($n=25/84$). Responses included long gaps (months to years) between theatre rotations ($n=20/84$), causing students to lose skill development. Triangulation of themes highlighted consistency in responses about anxiety, citing insufficient hands-on practice, rushed assessments, poor supervision, and teaching that was perceived as a barrier to post-registration competence and meeting employer expectations. Specific free-text responses included:

"You don't go with the same radiographer each time, and I find when you're up with someone new, they don't let you do anything, so I find it hard to build competence. More time would mean I could build more relationships with radiographers in theatre." Student 1.

"It would give us the opportunity to put into practice what we have learnt in university. I know what the C-arm is, I've moved it into theatre with the radiographer, and pushed the exposure button, but I have not yet moved the equipment into position as the surgery is commencing (the radiographer always does this), which is a concern as I'm in my third year. Over the three years, I've only been to five theatre cases." Student 3.

"I have been in theatre twice on placement, once in year two for four days and once so far in year three for two days. I have not yet carried out my theatre assessment purely because I think more time is needed." Student 45.

"100%.... It's nerve-wrecking. It's an element of the job that needs working collaboratively. It can be awkward in as much as the C-arm isn't the most delicate piece of equipment, depending on its make and age!" Student 59.

"The more practice/ observing theatre cases allows us to understand how things work better, increasing confidence for when we qualify." Student 33.

Responses demonstrated a clear motivation to learn and an understanding of their needs. Responses demonstrated consistent recommendations for dedicated scheduled operating theatre placement blocks, annual refresher training to maintain competency, and enhanced supervision to improve confidence.

Responses to questions centred around if qualified radiographer supervision in operating theatres were supportive of learning experiences of theatre radiography on placement, demonstrated 75% agreed, with no association in responses by demographics of the region ($p=0.45$), age range ($p=0.06$), specifically in the 18-24 years, and gender ($p=0.06$), with 72% of females and 94% of males agreeing.

The reported ranges of theatre radiography cases attended by students on placement (Figure 4) demonstrated no statistically significant association between the type of theatre case and the demographics of the region ($p=0.71$), age ($p=0.91$), or gender ($p=0.39$). The two most common types of operating theatre experienced on placement by students were urology ($n=77/84$) and trauma orthopaedics ($n=71/84$).

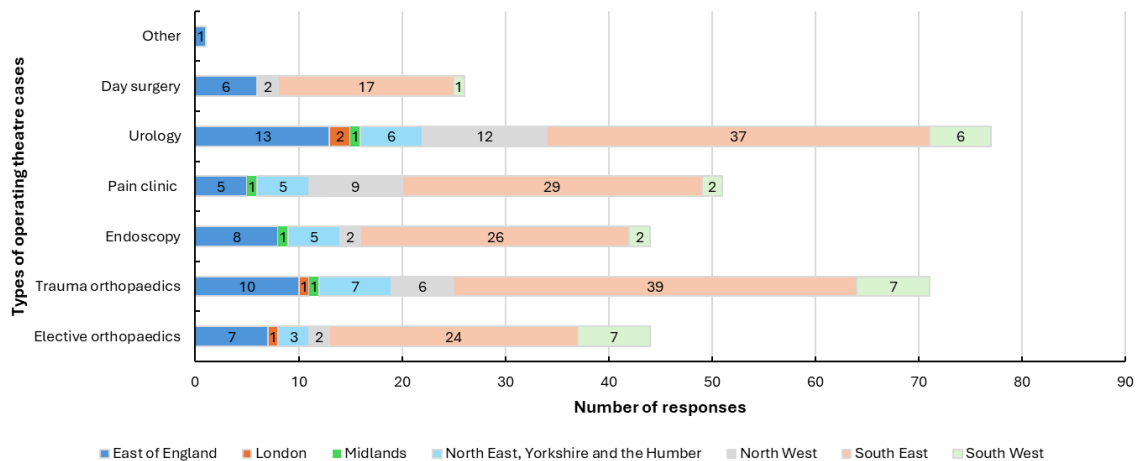


Figure 4. The association between the regional category of responses (numbers) and the experience of different types of operating theatre cases during radiography training.

Learning at university

Responses around the learning experiences of theatre radiography in university environments demonstrated that the majority (81%) of students had not received simulation training of theatre radiography on their university campus. However, there was a statistically significant association between clinical placement hours in the theatres category and demographics of the region ($p=0.03$), but not by age ($p=0.63$) or gender ($p=0.97$). Free text responses expanded on the type of simulation they had received, with the majority stating:

“We had a small group session practising positioning a C-arm over a phantom within a standard X-ray room.” Student 35.

“Use of the C-arm in a clinical skills situation. Using a mannequin and doing real-life exposures”. Student 77.

Responses to understand if more educational resources, lectures or course material on theatre radiography would assist confidence levels; 51% responded yes, whilst 25% answered maybe, and 24% answered no. Expanded qualitative responses identified common themes around realistic C-arm equipment hands-on training to manipulate and position the equipment, set controls and locks, and manoeuvre equipment around obstacles ($n=35/84$), procedure-specific (orthopaedic nailing and pinning imaging) knowledge ($n=25/84$), simulation-based pressure-free mock environment learning over lectures ($n=25/84$), theatre environment knowledge of roles, etiquette, protocols, sterile fields,

communication, etc. (n=15/84), and anatomical image interpretation and optimisation (n=12/84).

“The views required for different procedures. e.g. knowing they will expect a hip anterior-posterior (AP) and lateral first, then knee AP and lateral in a femoral nailing. Understanding more of what happens in common operations so the needs of the surgeons can be anticipated better.” Student 2.

“A theatre simulation would be brilliant for students to gain skills and confidence, so when they go out into practice, they will have a familiar understanding of the environment and equipment.” Student 64.

Students’ reported confidence levels

Responses indicated students' perceived rating of confidence in operating a C-arm, with 50% feeling confident, and 6% felt very confident (Figure 5). There was no significant association with regional demographics (p=0.55), but gender was significant (p=0.00), as 81% of males felt confident compared to 50% of females. Age was also significant (p=0.00), with the youngest age category showing the most confidence in using a C-arm (18-24; 60%).

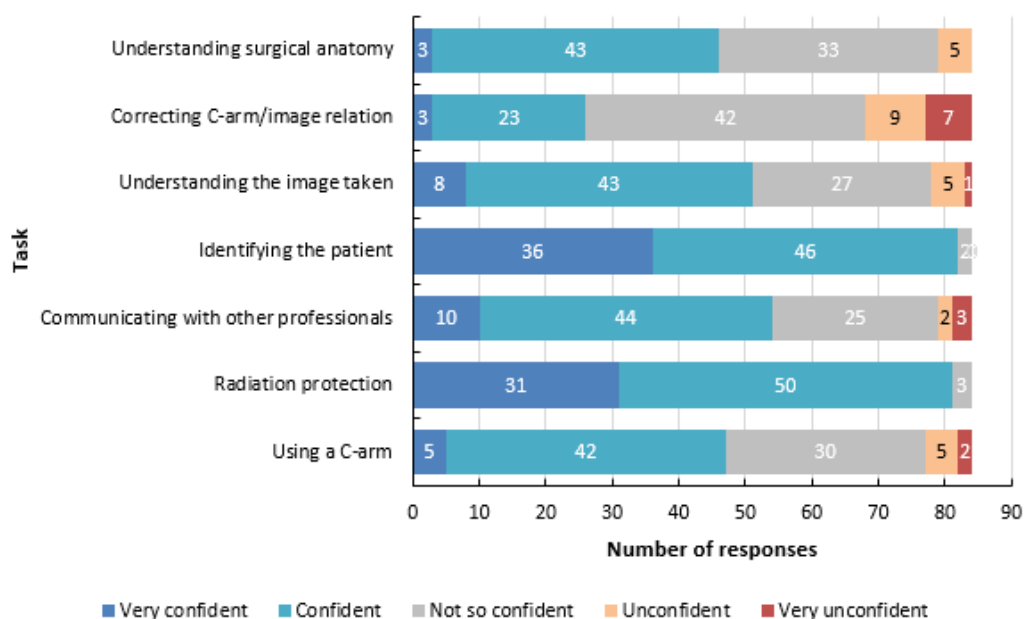


Figure 5. Students’ Likert confidence responses (very confident to very unconfident scale) to various common theatre tasks.

However, the responses indicated that students felt more confident in other areas of theatre radiography. For instance, 96.4% of students reported being confident in radiation protection, which was statistically significant for demographic region (p=0.00) but not age (p=0.92) or gender (p=0.07). Interprofessional communication was noted as strong by 64% of students; they were confident in communicating with other healthcare professionals in a theatre, with no association by region; p=0.68; but gender and age were significant (p=0.00),

although the largest sample size was females and young students (18-24), which may skew the analysis.

Similarly, 97.6% of students reported being confident in identifying the patient, with correlations to regional demographics ($p=0.28$), gender ($p=0.00$), and age ($p=0.00$). While 61% of students felt confident understanding the image taken, correlations to region ($p=0.45$), gender and age ($p=0.00$) matched the trend of young females being predominant in the sample. In contrast, when students were asked to rank their perceived confidence in correcting the C-arm positioning relative to the image taken, only 31% of students reported feeling confident, with no association to regional demographics ($p=0.90$). However, again, the sample make-up affected the results by gender and age ($p=0.00$).

Responses ranked students' confidence in understanding the anatomy required by the surgeon; only 58% felt confident or very confident (with no association to regional demographics ($p=0.41$), but again, the sample makeup affected the results by gender and age ($p=0.00$). When asked if simulation would help improve their confidence levels, 83% of students agreed, 14% were unsure, and 2% disagreed. There was no statistical association with demographics such as region ($p=0.11$), age ($p=0.31$), or gender ($p=0.44$).

Expanding on what would help improve confidence levels in the operating theatre identified reoccurring themes of improving collaboration and communication skills ($n=25/84$), supervision with qualified radiographers ($n=20/84$), building competence through addressing procedural knowledge gaps ($n=25/84$), addressing practice time in an operating theatre for hands-on practising experience with the C-arm ($n=30/84$), familiarisation with the environment and simulation ($n=35/84$).

"In all honesty, I think just more time in theatre rather than modalities (I've been in PET-CT and nuclear medicine a lot more than I have theatre)." Student 3.

"More discussion with the radiographer beforehand on what to expect in the theatre case." Student 9.

"Step-by-step explanations on how to perform imaging in the most common theatre cases might help hit the ground running when seeing a case in theatre for the first time, instead of having the radiographer try to explain it while the operation is ongoing." Student 19.

Discussion

The findings indicate that 44% of students felt unconfident using a C-arm within an operating theatre, although there is a difference between confidence and competence. The students' confidence rating was based on their experiences and perceived ability to perform an instructed clinical task in the operating theatre, as well as the training to support that role. Although a subjective self-assessment, it does not necessarily correlate to physical ability to perform the task safely, accurately and to a professional standard as judged by the supervising radiographer in theatre. Although competency is related to confidence,

competence was not assessed in the survey because it is considered a practical clinical objective assessment activity and/or observation that students must pass, and it is not feasible to assess through a survey. Confidence reflection may include imposter syndrome¹⁵ traits, which may not necessarily impact the observed or required levels of competence for a student in training. The responses reflected a clear pattern in the students' perception of feeling underprepared due to issues in clinical training and support from supervising radiographers. Key barriers included insufficient hands-on practice with C-arms in operating theatres compared to other imaging modalities, leading to more observation than active participation.

Recommendations to address students' low confidence include increased practical experience with C-arms, whether through simulation or additional clinical placement hours. A review of the responses indicated an emphasis on practical rather than theoretical learning, with many noting the inadequacy of lecture-based approaches for developing the manual dexterity skills that C-arm equipment requires. Students agreed that they would like more time on placement in an operating theatre (85%). Potentially through restructuring the curriculum, regular clinical practice and refresher sessions, consistent and supportive mentors or a mock theatre environment with a dedicated C-arm, to develop confidence.

However, as highlighted by Naylor, Ferris and Burton,¹⁶ clinical placements cannot always fully prepare students for being newly qualified, especially in the operating theatre, as they have always been directly supervised. The survey qualitative responses highlighted issues that supervisors often take over controls too quickly, instead of allowing students to learn to self-correct, manoeuvre the C-arm, adjust controls and settings, and correct image positioning.

Only 19% of students had received simulation training at university, and this training approach could be implemented in more universities to improve confidence levels. Research by Partner et al.,⁸ found that simulation increases confidence levels and could be a suitable alternative to a week's clinical placement, if there are capacity issues. However, Brewer, Harker, and Chambara¹⁷ caution that although simulation is a valuable supplement, it should not be used as a replacement for clinical placement, as it cannot fully replicate high-pressure theatre environments, distracting noisy activity, sterile fields, or surgical setups. Aruzza et al.¹⁸ suggest that a desktop computer-based simulation programme could help improve student radiographers' learning outside of the operating theatre, through virtual immersion into a 3D simulated operating theatre environment, covering skills such as anatomy image acquisition, image quality appraisal, and C-arm equipment operation in a patient/radiation risk free learning environment.

The survey results suggest systemic issues rather than regional, isolated concerns, with simulation a potential key resource for addressing training time, curriculum gaps and competency assessment in a patient-safe, radiation-safe environment. Additionally, there

was a consensus among students that interprofessional communication could be improved within the operating theatre. An example included:

“Confidence would improve if surgeons used a consistent word when they wanted an image taken. They get angry when it’s not taken quickly enough, and my hearing of all the possible terms they can use needs a second or two to grasp what they want.” Student 8.

Communication as a key theme corresponds to a study by Yeo, Gordon and Nusem,¹⁹ where surgeons and radiographers improved verbal communication practice to reduce miscommunication regarding the movement of the C-arm, which improved interprofessional practice, and ultimately reduced screening time (and overall radiation dose per examination), and this would be a low-cost simulation activity (in-person communication skills) to introduce into the learning experience of students.

Limitations

A limitation of the study was the duration of the survey, which may have limited responses. While responses were collected from n=84 third-year students from n=23/29 universities (n=6/29 universities had new radiography programmes that had fully matured to training final year students) across all seven regions, the sample was considered a low-response rate with an uneven distribution, with fewer responses from the London and Midlands regions. There were also unequal response rates between the genders and ages within the survey responses, which was acknowledged as impacting some statistical comparisons. Furthermore, the sample size was not generalisable to all student radiographers' experiences or to reflect the training curriculum of operating theatres and C-arm use across all universities in England.

Conclusion

The survey found that 44% of third-year diagnostic radiography students lacked confidence in using a C-arm, and 59% in understanding the anatomy on the images. However, students felt more confident in identifying patients and radiation safety. The findings revealed that students agreed the operating theatre training was limited, and highlighted perceived barriers to learning interprofessional working, communication, mentorship and preparation for post-registration practice skills.

The responses highlighted that additional training time in theatres (84%) and structured support in practice and simulation environments (83%) would improve their confidence levels, although competence was not assessed in the survey. As 48% of students had less than 40 hours in the operating theatre over the three years of training, this is roughly equivalent to a week’s placement time. Recommendations for future longitudinal follow-up surveys and intervention-based simulation learning studies would inform future curriculum design by identifying which aspects of simulation-based learning may have increased educational value, as well as the relationship between confidence and competence within these clinical tasks.

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