SoR
THE SOCIETY OF RADIOGRAPHERS

The use of simulation in enhancing pre-registration education and training of therapeutic radiographers

Guidance document — September 2022

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Nicky Hutton and Sarah-Jane Ketterer completed this work whilst on secondment to the Society of Radiographers.

Executive summary

Guidance for the use of simulation in enhancing pre-registration education and training of therapeutic radiographers

Background

Recruitment and retention of key NHS staff has been an ongoing challenge[1–3]. In 2021, the number of whole-time equivalent (WTE) therapeutic radiographers in post was estimated at 3,640[4] and the NHS radiotherapy workforce had a vacancy rate of 8.4%. It is recognised that the radiotherapy workforce needs to expand to meet the increasing demand for oncology services, requiring a 45% increase in therapeutic radiographers by 2029[5].

Challenges in student recruitment and retention have been well documented[5–11]. Poor retention among trainee radiographers has been attributed to several reasons, including placement experience[11–13]. This has been further exacerbated by the impact of COVID-19, both on the availability of placements and on placement experience[11,14].

The Health Education England (HEE) allied health profession (AHP) workforce reform programme has enabled the Society of Radiographers (SoR) to invest in significant activity around key areas of workforce transformation, including driving innovation in pre-registration practice-based learning, where the role of simulation is key.

Simulation-based education (SBE) is a well-established educational tool[15] allowing students to develop skills in a controlled environment, with debriefing and reflection being an integral component. The use of SBE has been shown to have a positive effect on knowledge, skills and confidence, and, most importantly, patient-related outcomes[16]. The updated SoR Education and Careers Framework states that a range of both face-to-face and virtual learning environments, including skills and simulation-based sessions, should be offered to most effectively support and enhance students' learning experience[17].

It has been demonstrated that SBE can offer an ideal opportunity to develop problem-solving capabilities and to produce graduates who will be agile learners in clinical practice, an important consideration in the continually evolving environment of radiotherapy[18]. In recent years there has been increased interest in the use of simulation as educators seek to optimise student experience and ensure placement opportunities can be used effectively and efficiently, with the Chief Medical Officer for England highlighting simulation as one of the top five priorities for the NHS[19,20]. At an international level the World Health Organization (WHO) has published documents related to the use of simulation education, emphasising the benefits for students and overall quality of care[21].

The Association for Simulated Practice in Healthcare (ASPiH) has produced standards for simulation-based education frameworks[22], incorporating best

practice from published evidence mapped to existing quality assurance processes currently in use across the UK and internationally, including the Health and Care Professions Council (HCPC) standards[23].

There is a national drive to develop simulation to make it more readily and equitably available to all pre-registration students and staff, so that the future workforce can meet the demands of providing safe and effective care[24]. Current HEE work is leading to the development of a national simulation strategy to ensure equity of access to simulation[25].

This SoR guidance document used a modified Delphi research method to elicit consensus opinion and provide evidence for the recommendations made and the key priority areas for the use of simulation to enhance pre-registration education of therapeutic radiographers. Evidence from this Delphi research emphasises the role simulation could play in enhancing placement experience. This includes improving preparation of students for placement, consolidating placement knowledge and providing equity of placement experience.

The cost-effectiveness of simulation in radiotherapy and its role in replacement of clinical hours are beyond the scope of this project, but these are areas that should be explored in the continued evaluation of simulation interventions. There is, however, a clear need for reducing attrition from pre-registration courses, and the perceived benefits of enhancing placement experience support the development of a collaborative approach to educational delivery using simulation.

Project aims

- Define simulation to aid understanding and maximise input into the development of the guidance for pre-registration therapeutic radiography programmes.
- Gain insight into current simulation provision within pre-registration therapeutic radiography programmes.
- Establish consensus opinion on the priority areas for simulation in the pre-registration education and training of therapeutic radiographers.
- Provide a simulation model, including key components of briefing and debriefing, and a template to improve mapping of simulation activities to learning outcomes within pre-registration programmes.
- Stimulate increased collaboration between higher education institutes (HEIs) and clinical placement providers for facilitation of simulation.
- Encourage continual evaluation and dissemination of simulation activities to enhance the current evidence base.

Approach

A multi-stage mixed method approach was undertaken, guided by a project steering group.

1. Initial scoping survey across UK HEIs delivering pre-registration HCPC-approved therapeutic radiography programmes of education (n=14) to determine current provision for simulation.

2. A consensus study using a modified Delphi research methodology across UK HEIs (n=14), NHS radiotherapy clinical healthcare providers (n=59) and private radiotherapy providers (n=15) to gather consensus opinion on the priority areas for simulation within pre-registration education and training of therapeutic radiographers.

3. Dual-moderator focus groups with key stakeholders, including SoR Patient Advisory Group (PAG) representatives (n=4) and SoR student member representatives (n=4).

Key findings and discussion

All HEIs delivering pre-registration therapeutic radiographer training provide some level of simulation. As expected, provision and access to facilities varied significantly across providers, with challenges to wider implementation being largely resource focused.

Understanding of the term simulation also varied, with differing opinions on activities that constitute simulation. The following definition was agreed with the steering group and shared with the expert panel during each Delphi survey round to help focus responses on a common understanding of simulation and associated activities.

“Simulation is a technique — not a technology — to replace or amplify real experiences with guided experiences that evoke or replicate substantial aspects of the real world in a fully interactive manner.”[26]

Recommendations

1. HEIs and clinical placement providers involved in training and education of therapeutic radiography students should seek to align simulation activities with programme learning outcomes and the HCPC standards of proficiency.

2. Partnership working between each HEI and their local clinical placement providers will provide maximum impact, allowing local decisions to be made regarding how simulation can be best used within programmes, including the timing and location of simulation delivery.

3. Simulation activities should align to a process model and include briefing and debriefing to support good quality simulation and achievement of learning outcomes.

4. There are four overarching themes where educators should focus simulation efforts to ensure maximum gain for student learning and experience. These are aligned to the relevant HCPC standards of proficiency.

Response rates to the Delphi survey rounds were 57% for round one (n=50) and 48% (n=42) for round two. These were broken down by stakeholder demographic, as detailed in Table 1.

Delphi round	HEI response rate (%)	NHS radiotherapy provider response rate (%)	Private radiotherapy provider response rate (%)
Round one	85.7	55.9	33.3
Round two	78.5	52.5	0

Table 1: Response rates broken down by stakeholder demographic for each survey round

Round one of the Delphi consensus study identified a total of 104 areas of the curriculum that could be delivered via simulation. Thematic analysis was undertaken and results were grouped into 29 themes; these themes were returned to participants in round two.

Analysis from round two identified 15 themes that reached consensus. These were divided into four principal themes: communication; treatment and imaging scenarios; radiotherapy treatment planning; and mandatory training. These were aligned to the HCPC standards of proficiency[23] for radiography where relevant, providing recommendations for the focus of simulation activities that could have the greatest impact on enhancing student learning and experience.

Both the Patient Advisory Group and student member focus groups identified a number of priority simulation activities that aligned with those identified in the Delphi study. The key areas were communication and confidence, which apply to both student confidence levels and patient experience.

1 Communication skills

(HCPC standards 8 and 9 — be able to communicate effectively and be able to work appropriately with others)

Theme
Initial simulations should address the key interactions with patients, including introductions, developing rapport and information giving
Side effect advice and management
Difficult conversations with patients and carers, understanding the characteristics and consequences of verbal and non-verbal communication and how this can be affected by differences of any kind, including (but not limited to) protected characteristics, intersectional experiences and cultural differences
Professional development skills — confidence, resilience, interview skills

Table 2: Communication themes reaching consensus

2 Treatment and imaging

(HCPC standard 14 — be able to draw on appropriate knowledge and skills to inform practice)

Theme
Foundational simulation activities to prepare students for first clinical placement, including machine and equipment familiarisation
General set-up principles (perform the full range of radiotherapy processes and techniques accurately and safely)
Understanding regional and cross-sectional anatomy of the head, neck, limbs, thorax, pelvis and abdomen (including anatomical landmarks)
Clinical interpretation and evaluation of 2D and 3D images and appropriate action to optimise accurate dose delivery to the target volume
Electrons and superficial treatment techniques
Challenging scenarios and problem-solving — decision making, dealing with errors, changes in patient contour and anatomy, medical emergencies, patients with diverse needs

Table 3: Treatment and imaging themes reaching consensus

3 Radiotherapy treatment planning

(HCPC standard 14 — be able to draw on appropriate knowledge and skills to inform practice)

Theme
Planning workshops — pre-treatment and computed tomography (CT) scanning processes
Dosimetry, techniques and beam arrangements, both radical and palliative

Table 4: Radiotherapy treatment planning themes reaching consensus

4 Mandatory training

(HCPC standard 15 — understand the need to establish and maintain a safe practice environment)

Theme
Clinical observation skills, basic life support and resuscitation
Infection control and correct usage of personal protective equipment (PPE)
Manual handling

Table 5: Mandatory training themes reaching consensus

The Delphi survey also gathered consensus opinion on specific simulation activities that are commonly used in each year of training. It is acknowledged that different aspects of the radiotherapy curriculum will be delivered at different times across programmes, and also that students will develop their skills at different speeds; therefore year group simulation topics are provided in these guidelines for reference only.

Supplementary data was collated providing information on the perceived goals and benefits of simulation, current simulation provision and delivery, future vision for simulation use and challenges and barriers to wider adoption.

Conclusion

The Delphi process, alongside the focus groups, has provided a robust method for identifying key recommendations for the use of simulation in enhancing pre-registration education and training of therapeutic radiographers. This includes areas of the radiotherapy curriculum that are a priority to be delivered via simulation and the timing of simulation activities within each year group.

This guidance is supported by multi-professional case studies demonstrating how areas of the curriculum can be delivered via simulation, with the expectation that these are used as a guide and tailored to meet the learning outcomes of course programmes.

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Background

Recruitment and retention of key NHS staff is an ongoing challenge[1–3]. In 2021, the number of WTE therapeutic radiographers in post was estimated at 3,640[4] and the NHS radiotherapy radiographic workforce had a vacancy rate of 8.4%. The workforce grew by 28% between 2012 and 2021[4] and it is recognised that this expansion needs to increase significantly to meet the escalating demand for cancer services and to deliver care to the 438,000 new cases expected to be diagnosed each year by 2035[5,9]. It is understood that a 45% increase in therapeutic radiographers is needed by 2029[5].

Challenges in student recruitment and retention have been well documented[5–11] and more recently recognised as a strategic priority in the transformation of the NHS and care workforce. Poor retention among trainee radiographers has been attributed to several reasons, including placement experience[11–13]. This has been further exacerbated by the impact of COVID-19, both on the availability of placements and on placement experience[11,14].

The Health Education England (HEE) allied health profession (AHP) workforce reform programme has enabled the Society of Radiographers (SoR) to invest in significant activity around key areas of workforce transformation, including driving innovation in pre-registration practice-based learning, where the role of simulation is key to support pre-registration education and training.

As per the Health and Care Professions Council (HCPC) standards of education and training[27], learning in a clinical environment is integral to therapeutic radiographer education and training. The HCPC standard of education and training 5.4 states: “Practice-based learning must take place in an environment that is safe and supportive for learners and service users.” Simulation-based education (SBE) is a well established educational tool allowing students to develop skills in a controlled environment, with debriefing and reflection being an integral component, and can be used to supplement and enhance clinical placement experience[15]. Figure 1 shows a process model for components required for a successful simulation, based on the “phases in simulated-patient based simulation”[28]. Further discussion on the use of simulation models and the individual components can be found in Appendix 2. The use of SBE has been shown to have a positive effect on knowledge, skills and confidence, and, most importantly, patient-related outcomes[16]. The updated SoR Education and Careers Framework states that a range of both face-to-face and virtual learning environments, including skills and simulation-based sessions, should be offered to most effectively support and enhance students’ learning experience[17]. It has been demonstrated that simulation can offer an ideal opportunity to develop problem-solving capabilities and to produce graduates who will be agile learners in clinical practice, an important consideration in the continually evolving environment of radiotherapy[18].

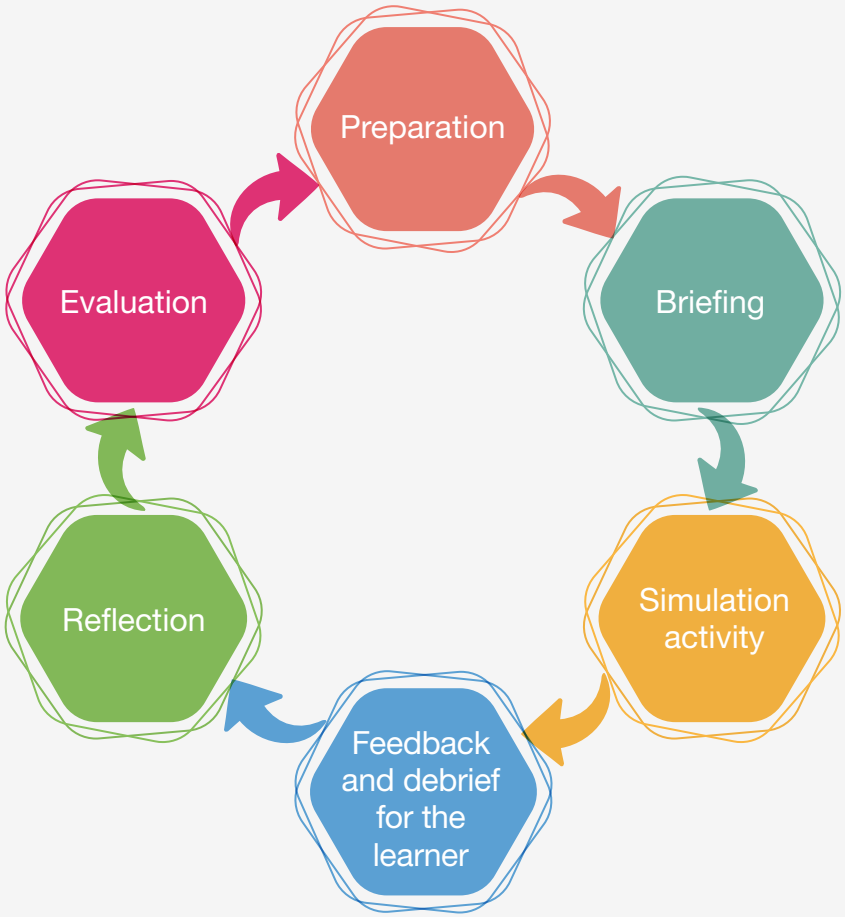


Figure 1: Simulation process model

Over the past decade there has been increased interest in the use of simulation as educators seek to optimise student experience and ensure placement opportunities can be used effectively and efficiently, with the Chief Medical Officer for England highlighting simulation as one of the top five priorities for the NHS[19,20]. At an international level, the World Health Organization (WHO) has published documents related to the use of simulation education, recognising its application across a diverse range of health professions and the value it can add to teaching, learning and assessment of clinical skills[21]. The WHO also highlights evidence from the literature indicating that simulation can benefit both students and patients and improve overall quality of care.

The Association for Simulated Practice in Healthcare (ASPiH) has produced standards for simulation-based education frameworks[22], incorporating best practice from published evidence mapped to existing quality assurance processes currently in use across the UK and internationally, including the HCPC standards[23].

There is a drive to develop simulation to make it more readily and equitably available to all pre-registration students and staff so that the future workforce can meet the demands of providing safe and effective care[24]. Ongoing HEE work is leading to the development of a national simulation strategy to ensure equity of access to simulation[25].

This SoR guidance document used a modified Delphi research method to elicit consensus opinion and provide evidence for the recommendations made and the key priority areas for the use of simulation in pre-registration education of therapeutic radiographers. Evidence from this Delphi research emphasises the role of simulation in enhancing placement experience. This includes improved preparation of students for placement, consolidating placement knowledge and providing equity of placement experience.

Poor placement experience is a common reason for attrition from programmes[11–13] and therefore enhancing and optimising clinical placement experience will contribute to improving student retention.

The cost-effectiveness of simulation in radiotherapy and its role in replacement of clinical hours are beyond the scope of this project but are areas that could be explored within the continued evaluation of simulation interventions. It is recognised that evaluation of cost-effectiveness poses a number of challenges and needs to be considered against the benefit of the specific intervention[29]. Data is scarce, and as simulation can vary significantly in the components that create the learning experience (high cost versus low cost, high fidelity versus low fidelity) and in the skills being taught, making comparisons can be difficult. There is, however, a clear need to reduce attrition from pre-registration courses, and so the perceived benefits of enhancing placement experience support the development of a collaborative approach to educational delivery using simulation.

The value of simulation in supporting those in specific ‘return to practice’ programmes, together with the capability of simulation to support internationally qualified radiographers, requires further exploration, but will benefit from the partnership working between higher education institutes (HEIs) and local clinical sites recommended in this document.

Introduction

> **“Simulation is a technique — not a technology — to replace or amplify real experiences with guided experiences that evoke or replicate substantial aspects of the real world in a fully interactive manner.”**
>
> Prof D M Gaba, The future vision of simulation in healthcare[26]

In 2021 two HEE-funded ‘radiotherapy simulation champion’ posts were established within the SoR, with the goal of developing national guidelines for the use of simulation in pre-registration therapeutic radiographer education. The remit of these posts involved the construction and delivery of a series of Delphi surveys to allow for key stakeholder input in the development of the guidelines. A modified Delphi methodology was used to reach consensus on key themes and timing of simulation activities across the UK. This was supplemented by a steering group and both patient and student focus groups.

Scope and purpose

This guidance document makes key recommendations to facilitate partnership working between educators, both in the academic and clinical setting, to prioritise areas where simulation can have the most impact in enhancing the training of pre-registration therapeutic radiography students.

The themes highlighted provide a template for activities that can be embedded in varied stages of radiotherapy educational programmes. Case studies have been provided alongside the themes where relevant.

Method

A multi-stage mixed-method approach was undertaken, guided by a project steering group. The steering group included representation from a range of stakeholders: HEI educators, clinical educators, patients, therapeutic radiography students, HCPC, and AHP and medical simulation experts. Meetings were held before and after each Delphi round to provide an opportunity for regular review and input to the process. The full project methodology can be found in Appendix 1. The stages were as follows:

1. Initial scoping survey across UK HEIs delivering pre-registration HCPC-approved therapeutic radiography programmes of education (n=14) to determine current provision for simulation.

2. A UK-wide consensus study using an online platform and a modified Delphi research methodology across HEIs (n=14), NHS radiotherapy clinical healthcare providers (n=59) and private radiotherapy providers (n=15) to gather consensus opinion on the priority areas for simulation in the pre-registration education and training of therapeutic radiographers. Named panel participants were asked to collaborate with their teams on questionnaire responses to incorporate wider opinions and experience.

Round one of the Delphi study sought to gain insight on all areas of the curriculum that the panel felt could be delivered by simulation. Additional, non-Delphi supplementary questions were included to elicit opinions on the wider goals of simulation and current barriers to implementation. Round two presented the Delphi findings from round one to participants and asked them to rank the identified themes based on their 'importance' and 'desirability' for delivery via simulation.

Consensus was set as being achieved when all the following criteria were met:

- a mean rating of ≥4.0
- a coefficient of variation (CV) of ≤30%
- ≥75% agreement (% of panel members scoring 4 = important/desirable or 5 = very important/very desirable on the Likert scale).

3. Dual-moderator focus groups with key stakeholders, including SoR Patient Advisory Group (PAG) representatives (n=4) and SoR student member representatives (n=4) to identify stakeholder perspectives on the key areas where simulation has potential to enhance experience and optimise outcomes. The responses were transcribed, analysed and aligned to the survey results.

Ethical permission was obtained from the Institute of Life Course and Medical Sciences Research Ethics Committee at the University of Liverpool (reference number 10926).

Limitations

The evidence base around the use of simulation in AHP education is continually expanding as provision grows and new resources are developed. This guidance document provides a template for educational practice that can be added to as further applications evolve. Although the guidance highlights priority areas for the use of simulation, it is not intended to be restrictive.

The complexity and diversity of educational delivery across facilities is acknowledged, as is the differing access to resources. This current work also reflects the challenges highlighted within the evidence base, where variation in perceptions of the aims and outcomes of simulation, along with what activities can be encompassed in simulation, is apparent[30–32].

This emphasises the need for ongoing evaluation and dissemination of simulation activities to supplement the evidence base related to the effectiveness of simulation education, and to allow for continuing development and improvement. This is further highlighted in the HEE national framework for simulation-based education[24]: “There is a need to implement mechanisms that develop and sustain collaborative networks within and across geographical and institutional boundaries that will support the dissemination of innovative practice. This principle recognises the complexity of determining quality outcomes derived from SBE and places a strong emphasis on the need for evaluation.”

Radiotherapy champions

During the radiotherapy champions secondment project, there have been a number of actions undertaken. These include the following:

- Convening of a multi-professional simulation steering group.
- Ethical approval from the University of Liverpool Institute of Life Course and Medical Sciences Research Ethics Committee.
- Initial scoping survey across UK HEIs delivering pre-registration HCPC-approved therapeutic radiography programmes of education (n=14) to determine current provision for simulation.
- A UK-wide consensus study using a modified Delphi research methodology across HEIs delivering pre-registration HCPC-approved therapeutic radiography programmes of education (n=14), NHS radiotherapy healthcare providers (HCPs) (n=59) and private radiotherapy providers (n=15) to gather consensus opinion on the priority areas for simulation in pre-registration education and training of therapeutic radiographers.
- Dual-moderator focus groups with key stakeholders, including SoR PAG representatives (n=4) and SoR student member representatives (n=4).
- Engagement with working parties to encourage engagement and sharing of practice (Operational Delivery Network managers group (NHS England), SoR Heads of Radiography Education Group, SoR Simulation Special Interest Group, HEE regional workforce action groups).
- Article outlining the project in SoR journal *Synergy*, February 2022[33].
- SoR simulation guidance document.
- Full project methodology and results provided as an appendix to the guidance document (Appendix 1).
- Alignment of multi-professional case studies to key themes in the guidance document.

Recommendations

1. HEIs and clinical placement providers involved in training and education of therapeutic radiography students should seek to align simulation activities with programme learning outcomes and the HCPC standards of proficiency.

2. Partnership working between each HEI and its local clinical placement providers will provide maximum impact, allowing local decisions to be made regarding how simulation can be best used within programmes, including the timing and location of simulation delivery.

3. Simulation activities should align to a process model and include briefing and debriefing to support good quality simulation and achievement of learning outcomes.

4. There are four overarching themes on which educators should focus simulation efforts to ensure maximum gain for student learning and experience. These themes are aligned to the relevant HCPC standards of proficiency.

Curriculum

The expert panel identified a total of 104 areas of the curriculum that could be delivered via simulation. Thematic analysis was completed on the responses and they were grouped into 29 themes; those themes were returned to participants in round two, and 15 themes reached consensus. These themes are grouped into four overarching areas: communication; treatment and imaging scenarios; radiotherapy treatment planning; and mandatory training. Full results can be found in Appendix 1.

1 Communication

Communication has been highlighted as an area of the pre-registration radiotherapy curriculum where simulated delivery could provide benefit. This benefit is realised by the student in their confidence to address a variety of communication situations that can occur during clinical placement. Clinical educators and radiotherapy teams may find benefit in relation to the amount of support students may require with communication when on placement and also in how the student communicates and integrates within the radiotherapy team. Finally, the benefit may be further realised by the patients who students care for during their clinical placement, in their ability to communicate effectively and confidently to meet diverse patient needs.

Of the 15 themes that reached consensus, four related to communication. Table 6 shows each of the four communication themes with a sample of the responses provided by the expert Delphi panel, student member focus group and PAG focus group, and links to example case studies where simulation has been used to teach communication techniques.

Students discussed the importance of not only knowing about the type of information patients will require and the timing of this (for example, first and last day patient consultations), but also understanding the common questions that patients may ask and, importantly, how to deal with them. They stated a preference for this being part of initial simulations to prepare them for their first interactions with patients in the clinical environment.

Theme	
Patient consultations (including delivery of first/last day discussions and information giving)	
Sample of survey responses	
"Patient communication e.g. 1st day chats" "Patient pre- and post- treatment information chats" "Communication and information giving skills development"	"I found that the actors were so good! I feel like there should've been more of it. Obviously due to COVID this was not possible, but we only had it in the first year. You do see so many people who react very differently, so having the actors was definitely helpful."
Student focus group	
"I thought the first day chats in 1st year and all the communication were most useful. Before placement I was a bit stressed about a patient asking me something on the first day and having no idea how to respond."	"I definitely think the communication tasks were very useful. I am certain I would've been more hesitant to start talking with patients if I had not had that simulation training and previous practice with the actors … The communication was definitely the most important thing."
Patient Advisory Group focus group	
"One thing I think you really need to emphasise with students is that they need to speak in measured tones … the communication can feel like a machine gun … It's all very, very quickly delivered … and therefore I'm sure they don't follow the instructions as they should do. It can make people quite nervous if instructions are delivered in that way. So, I think you need to practise with students how to deliver instructions in a measured way." *Empathy* " … I think empathy is very important for these situations ... I arrived at my appointment very stressed because I was worried ... However, I had a really nice experience with the sonographer, who was really empathetic and understanding of my situation."	" … just somebody putting their hand on your shoulder means an awful lot to some people in these situations." *Involving patients in conversations* " ... There are conversations that take place as if you were not in the room and can leave you feeling as if you're a spare part." "Conversations can also feel quite coded, which can be concerning." "It's getting people to understand what it might be like if they were sitting on the other side as well."
Simulation case studies	
Simulated First Day Information Giving	Simulated Learning Weeks

Table 6: Consensus communication themes and supporting focus group information

Theme

Difficult conversations with patients and carers (e.g. dealing with anxious and claustrophobic patients, patients with additional communication needs, distressed patients)

Sample of survey responses

"We felt that the development of communication skills could be developed through simulation, especially when dealing with a challenging or difficult interaction."

"Interpersonal communication with patients and carers, including general conversations, empathetic conversations and difficult conversations"

Student focus group

Difficult questions: knowing what to say

"Nervous about saying the wrong thing — practice helped with this."

"Maybe a session on difficult questions and conversations could be useful."

" ... probably having some proper advanced communications simulation at some point would be useful, but also making people aware of some of the key things to say and to avoid saying."

" ... I think the actors made a big difference. If we had just practised on each other, I don't feel it would have been effective. It made it easier to get in the zone and to practise communication with the various emotions a patient may experience."

" ... communication, particularly around difficult conversations … would have been our number one choice."

"I have had patients express that they are struggling with their mental health, or with money, when I was in my second year. I think it would be useful to have a guide of talking points or basic responses."

Patient Advisory Group focus group

Being clear with communication: recognition that the patient is vulnerable/ often scared

"I think communication is critical … I think it's understanding that when people are frightened that you must be even more clear than normal."

"What about training in hiding emotions? I do think that if you're giving out, you know messages which people perhaps don't want to hear, or are difficult, not betraying your emotions is something that you really need good training in."

Simulation case studies

Difficult Conversations with Patients and Carers

Simulated Telephone Communications

Table 6 (continued): Consensus communication themes and supporting focus group information

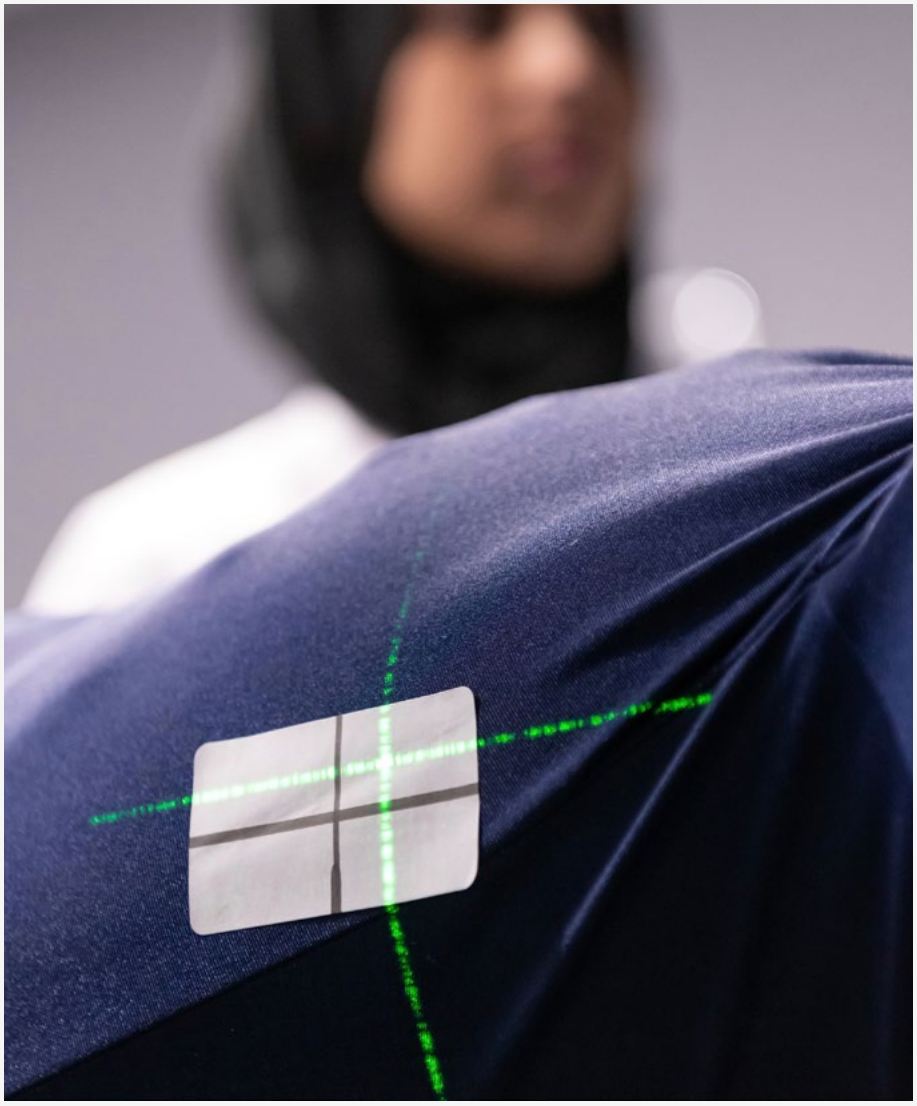
Theme	Theme
Giving advice on side effects and their management	Professional development skills i.e. confidence, resilience, interview skills
Sample of survey responses "Management of side effects" "Assessments and advice"	**Sample of survey responses** "Resilience, empathy, interview skills" "Peer support and discussion" "Interview simulation/practice"
Student focus group " … The first few times I had been asked, it was clear to the patient that I was a bit taken aback because I didn't know what to say. However, the more I have been on clinical the more I have got used to hearing these types of questions. The responses eventually become routine."	**Student focus group** *Peer learning — inspiring — nice to share knowledge* "When you have a really bad week, it can be helpful to have reassurance and support from second or third year students, who have had similar experiences." " ... because we are all students it can feel easier as a first year student to ask a third year student for help, as they may find it intimidating to ask another radiographer, particularly as they are very busy. I think a buddying system could be really nice."
Patient Advisory Group focus group " ... when it's not actually your duty to actually give them [the patient] news; I think one of the big issues is that you are often the person that the patient gets access to. While the person who is qualified to give you the news is often not as accessible as the people that you actually see in these situations."	

Table 6 (continued): Consensus communication themes and supporting focus group information

2 Treatment and imaging scenarios

A range of treatment and imaging scenarios were highlighted throughout the Delphi process as key areas where simulation could provide benefit, often when preparing students for their first clinical placement but also to consolidate learning and prepare students for their subsequent placements.

Of the 15 themes that reached consensus, six were treatment and imaging specific. These ranged from familiarisation with machinery and equipment and general set-up principles to awareness and understanding of rare or complex radiotherapy techniques. Table 7 details these six themes and the survey and focus group responses aligned with them.



Theme

Machine and equipment familiarisation

Sample of survey responses

"Learning how to operate the linear accelerator"

"Safe and accurate use of machinery"

Student focus group

Handset use

"I liked the handset … it gave me a little idea of what goes on and a feel for the handset itself."

Masks

"The amount of patients who come in, especially head and neck patients. If you can tell them you've tried one of them before it can be a relatable talking point."

Theme

General set-up principles (e.g. patient alignment, reproducibility, shifts to isocentre)

Sample of survey responses

"Initial exposure to patient set-ups"

"Patient orientation. Difference between isocentre and patient moves. Effect of set errors. Effect of changes to patient outlines"

"All techniques EXCEPT TBI [total body irradiation] can be demonstrated on virtual environment for radiotherapy training (VERT) — Complex techniques to help with understanding like CSI [craniospinal irradiation]"

Student focus group

"Lining actors up felt 'low stakes' … get more involved because you're not worried about making mistakes."

"Practical and directional stuff"

Patient Advisory Group focus group

Patient positioning etc.

"I think some of the practical things … can sometimes feel like you're a slab of meat ... Some of these things are very intimate procedures. Also being respectful of their dignity … like not making them walk around with a gown … I understand you have to remain professional, but I think these things make a difference to the patient experience."

Simulation case studies

Radiotherapy Prostate Patient Set Up

Formative / Summative Assessment of Palliative Radiotherapy Treatment Delivery

Simulated Radiotherapy Set Up – Pelvis

Introduction to Patients with Open Wounds

Table 7: Consensus treatment and imaging themes and supporting focus group information

Theme

Understanding of anatomical landmarks and cross-sectional anatomy

Sample of survey responses

"Anatomy practice/cross-sectional anatomy"

"Improve anatomy knowledge"

Theme

Electrons and superficial treatment techniques

Sample of survey responses

"Electron and superficial set-ups (skin apposition)"

"Skin app (electron treatment)"

Simulation case studies

Skin Apposition Breast Scar Setup

Theme

Clinical interpretation and evaluation of 2D and 3D images

Sample of survey responses

"Image matching!!!!! (The biggest issue we have now) CBCT/kV [kilovoltage]"

"Understanding the concept and use of imaging, both kVs and CBCT; having the time to discuss plans virtually in the practical setting and the discussion of PTV [planning target volume]/GTV [gross tumour volume] and OAR [organs at risk]"

"Online imaging training and image analysis"

Student focus group

Cone-beam computed tomography (CBCT) in particular

"I liked the handset … it gave me a little idea of what goes on and a feel for the handset itself."

Table 7 (continued): Consensus treatment and imaging themes and supporting focus group information

Theme

Challenging scenarios and problem-solving (e.g. decision-making, dealing with errors, changes in patient contour/anatomy, medical emergencies, patients with diverse needs etc.)

Sample of survey responses

"Patient care — role play scenarios — Problem-solving scenarios — machine breakdown, errors"

"Dealing with difficult situations (e.g. caring for patients with dementia)"

"Dealing with unwell patients/medical emergencies"

Student focus group

Advanced scenarios — patients with diverse needs (examples given: transgender, dementia, blind, deaf)

"I think it would be good if there was a simulation with diverse people involved. For example, having someone blind, deaf, transgender or someone from the LGBTQ+ community come in so that we can experience how to approach and communicate effectively with diverse people."

Patient Advisory Group focus group

Advanced scenarios

"I just wondered whether when you do these simulations, you do them on the whole spectrum. I mean, do the students get the opportunity to do simulations on really poorly patients, who are not mobile, patients who've got Alzheimer's, patients who are on the autistic spectrum?"

Simulation case studies

Head and Neck Mask Making

Table 7 (continued): Consensus treatment and imaging themes and supporting focus group information

3 Radiotherapy treatment planning

The biggest proportion of clinical placements are spent on treatment units, with pre-treatment placements being of shorter duration. This is generally necessary to ensure achievement of the specific learning outcomes necessary to meet the HCPC standards of proficiency for registration. This highlights a particular indication for the use of simulation to enhance understanding of pre-treatment pathways and processes; themes that reached consensus can be found in Table 8.

Familiarisation with pre-treatment CT scanning processes reached consensus as a priority for delivery using simulation. Benefits included increased student confidence levels, less support required for equipment familiarisation and improved student and patient experience.

Alongside CT scanning processes and techniques, dosimetry techniques were also highlighted as a priority, to allow students time to produce treatment plans and to understand beam arrangements and the effect that changes to patient anatomy and contours can have on planned volumes and dosimetry.

Theme	
Workshops — CT scanning processes	
Sample of survey responses	
	"Introduction to CT scanner"
	"CT scanning for pre-treatment"
Simulation case studies	
	Pre-treatment Head and Neck Immobilisation and Communication Scenario

Theme	
Dosimetry, techniques and beam arrangements (radical and palliative)	
Sample of survey responses	
	"Dose distribution in relation to tumour and related anatomy"
	"Dosimetry plan generation"
Simulation case studies	
	Palliative Whole Brain Radiotherapy Planning

Table 8: Consensus radiotherapy treatment planning themes and supporting focus group information

4 Mandatory training

Mandatory training simulations are routinely used in healthcare to promote patient safety and to teach a variety of techniques to a diverse range of people working within the organisation[34,35].

The Delphi process found three mandatory training themes that reached consensus. Table 9 outlines the themes and supporting information from the survey, focus groups and case studies, demonstrating the use of simulation within the themes.

Theme	
Clinical observation skills, basic life support and resuscitation	
Sample of survey responses	"Checking patient vital signs; obs, blood pressure, temperature, pulse etc." "Basic life support"
Simulation case studies	Basic, Immediate and Advanced Life Support

Theme	
Infection control and correct use of personal protective equipment (PPE)	
Sample of survey responses	"Infection control procedures"
Patient Advisory Group focus group	" … do you have programmes which simulate how to deal with patients who got COVID because they've got to be dealt with in a totally different way, haven't they?"

Theme	
Manual handling	
Sample of survey responses	"Manual handling (i.e. learning how to help patients on and off bed safely, and use of wheelchairs)" "Moving and handling in safe ways using kit that is available in clinical environment"
Student focus group	"Even pushing a wheelchair, which on my first placement block was actually very useful, as I feel I did quite a lot of taking patients to and from places in a wheelchair."

Table 9: Consensus mandatory training themes and supporting focus group information

Activities

Round one of the Delphi study asked participants what they felt the role of simulation was for each of the individual student year groups. These responses were analysed separately by year and reported back in round two, when participants were asked to indicate whether they considered each theme to be a priority for the specified year group. There were 38 themes that met consensus across the duration of the programme: 12 themes for Year 1; 11 themes for Year 2; and 15 themes for Years 3 and 4. Those themes that reached agreement of >75% were grouped into the eight themes in Table 10 (see full methodology in Appendix 1 for breakdown of themes and percentage agreement).

There were two themes (bladder scanning and student assessment) that reached consensus but do not fit within the topic areas above; these can be found in the full results in Appendix 1.

It is acknowledged that different aspects of the radiotherapy curriculum will be delivered at different times across programmes in the UK, and so these year group simulation topics are only a guide. They highlight the topic areas where simulation is often used and demonstrate the continuum of skills that a student will be required to develop throughout the duration of their training.

Themes across year groups
Foundational simulation activities to prepare students for first clinical placement, including machine and equipment familiarisation
General set-up principles (perform the full range of radiotherapy processes and techniques accurately and safely)
Understanding regional and cross-sectional anatomy of the head, neck, limbs, thorax, pelvis and abdomen (including anatomical landmarks)
Clinical interpretation and evaluation of 2D and 3D images and appropriate action to optimise accurate dose delivery to the target volume
Electrons and superficial treatment techniques
Challenging scenarios and problem-solving — decision making, dealing with errors, changes in patient contour and anatomy, medical emergencies, patients with diverse needs

Table 10: Priority themes for simulation across all year groups

Each of the themes is detailed in Figures 3–10, showing the continuum of learning and topic areas as the student progresses through their training. The colour coding for each year can be seen in Figure 2.

Figure 2: Year group colour coding

The number of topics raised in round one, themes after thematic analysis and the number of themes reaching consensus for each year group are given in Table 11 and the full results in Appendix 1.

Year group	Topic areas raised	Themes after thematic analysis	Themes reaching >75% agreement
Year 1	36	24	12
Year 2	24	21	11
Years 3 and 4	21	20	15

Table 11: Numbers of topics raised for each year group

Communication

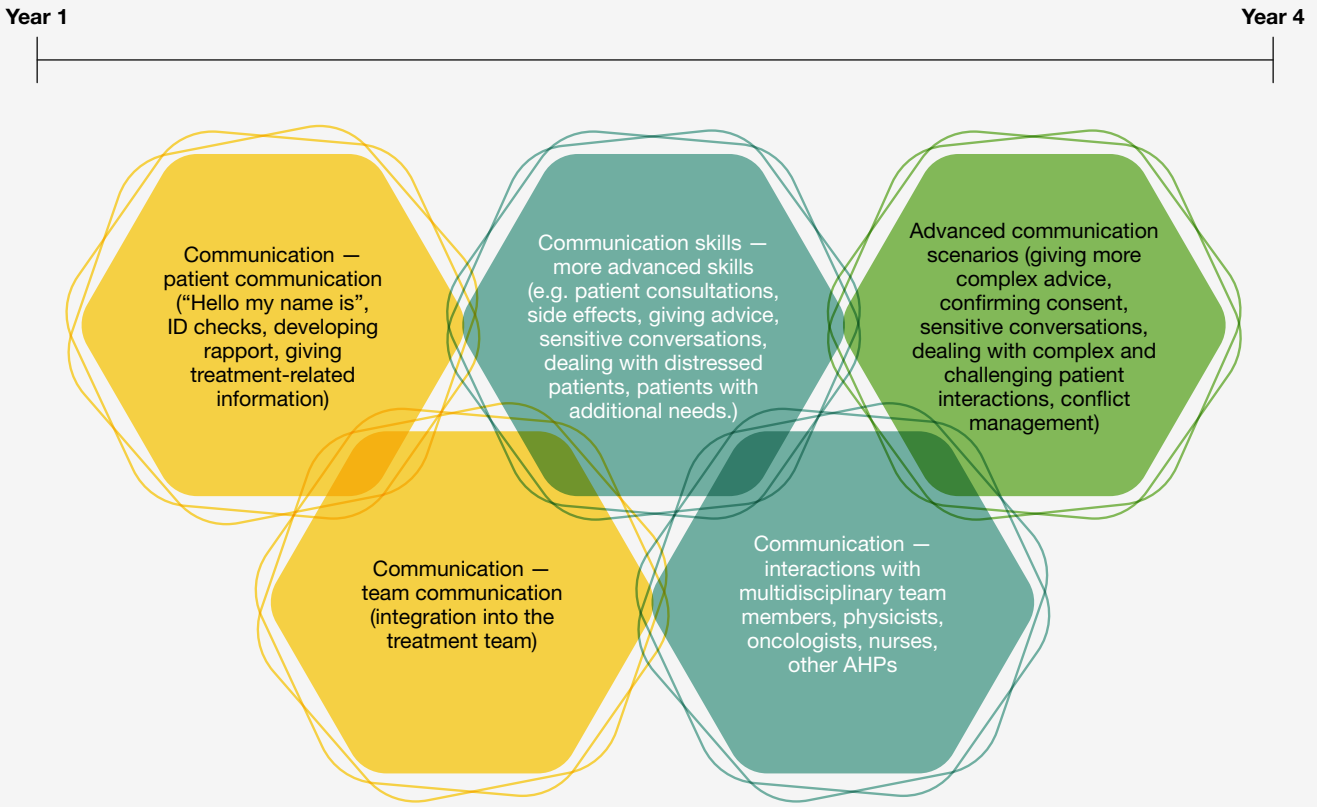


Figure 3: Communication themes across year groups

Imaging

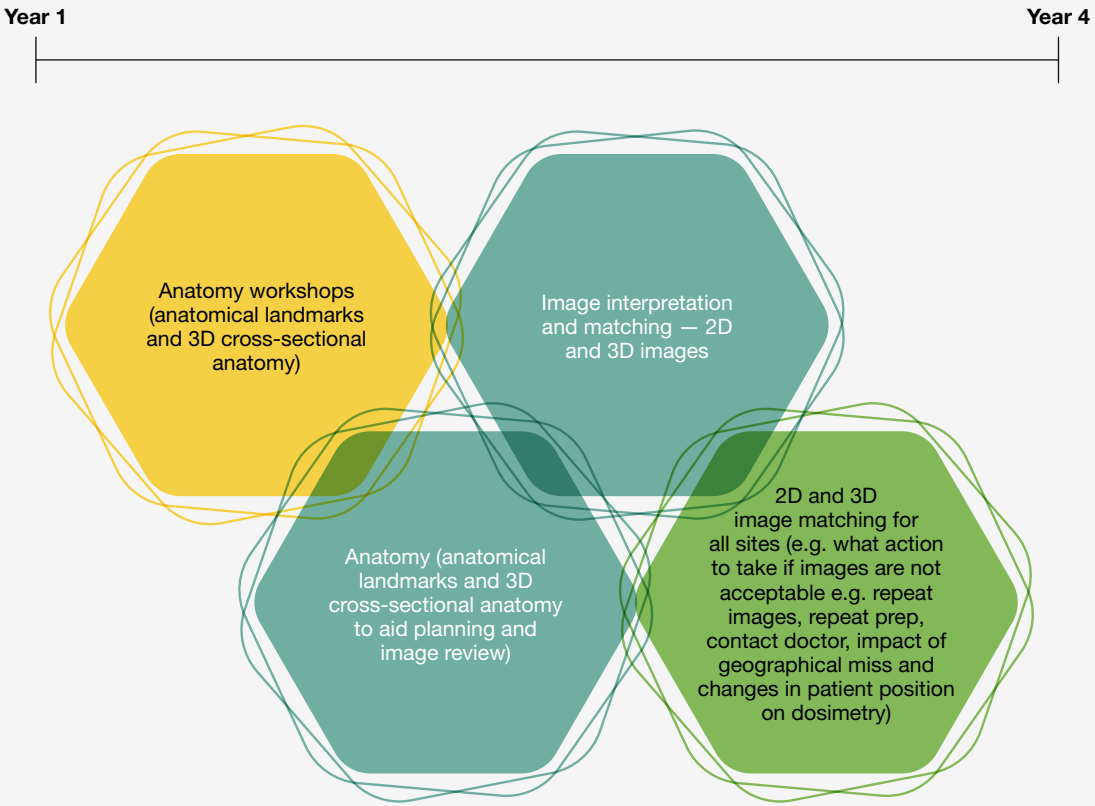


Figure 4: Imaging themes across year groups

Techniques

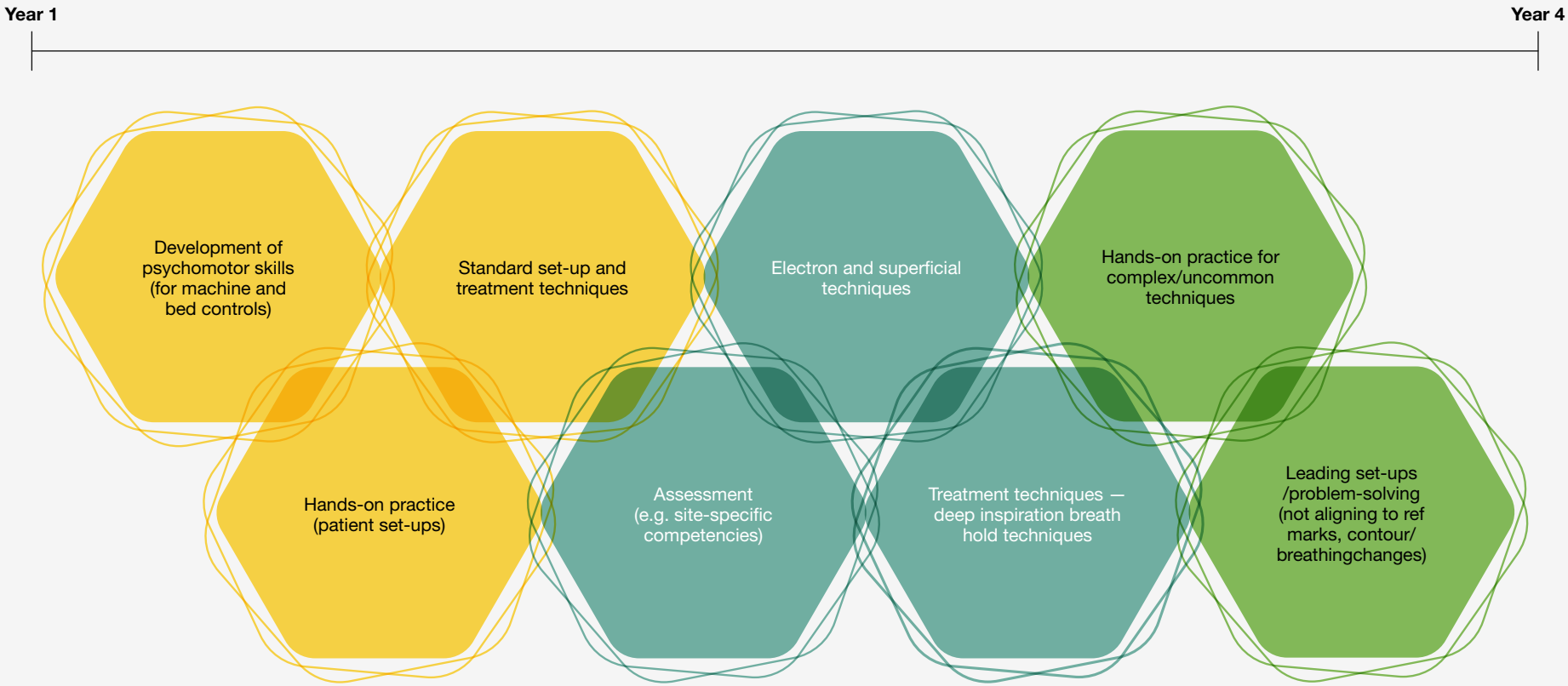


Figure 5: Technique themes across year groups

Pre-treatment and planning

Figure 6: Pre-treatment and planning themes across year groups

Professionalism and professional development

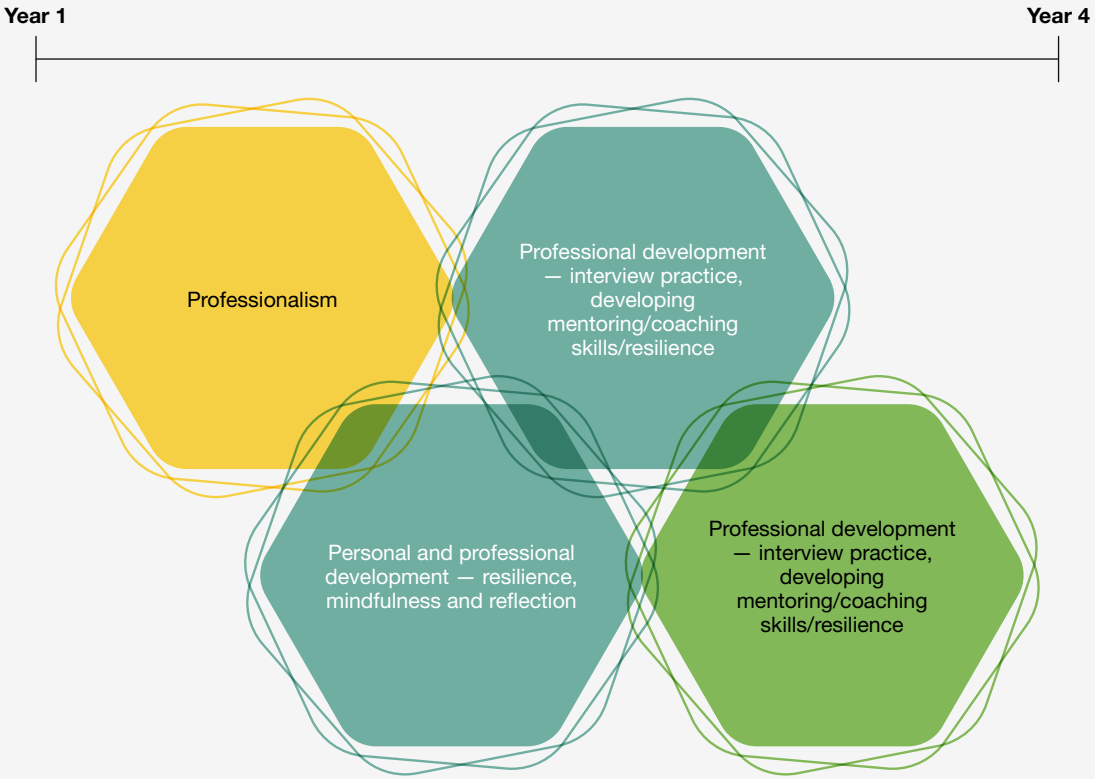


Figure 7: Professionalism and professional development themes across year groups

Patient pathways

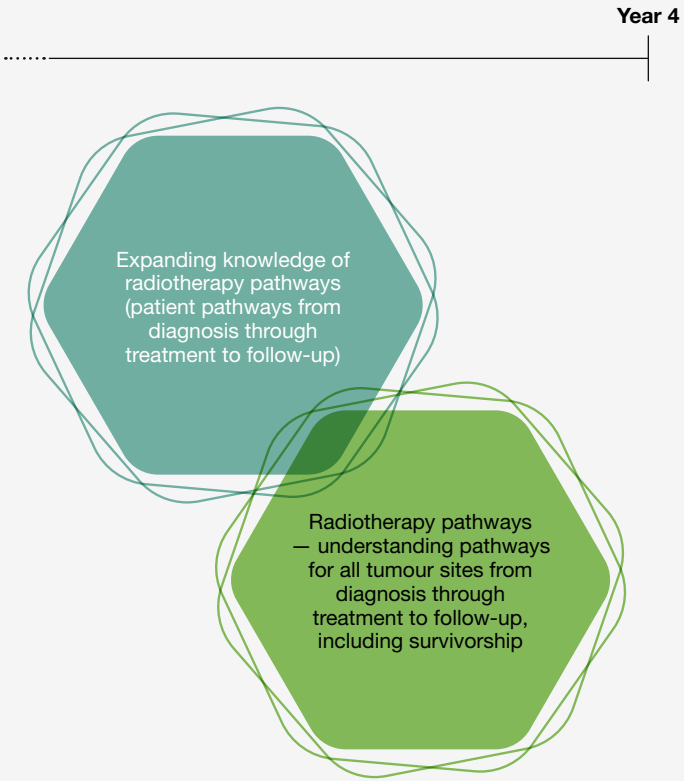


Figure 8: Patient pathways themes across year groups

Mandatory training

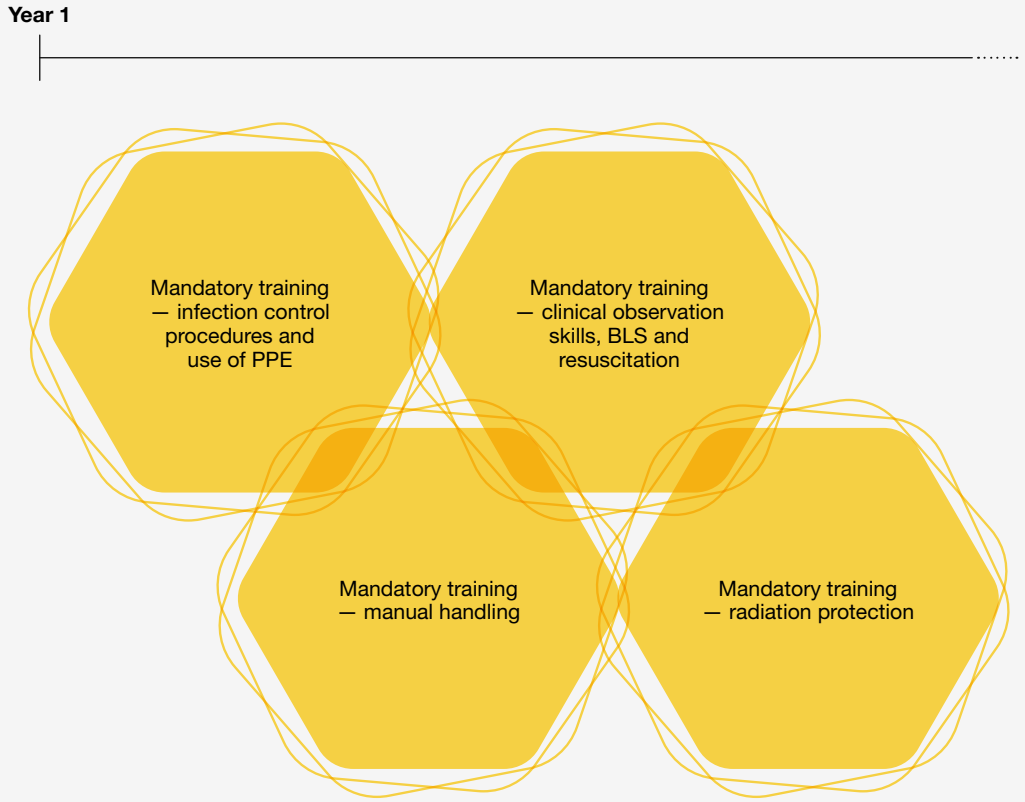


Figure 9: Mandatory training themes across year groups

Interprofessional learning

Figure 10: Interprofessional learning themes across year groups

Supplementary

As indicated, round one of the Delphi study incorporated a series of additional, non-Delphi questions to elicit opinions on the wider goals and value of simulation, current delivery patterns and challenges and barriers to implementation. The key themes that arose are highlighted in Appendix 1. Each column identifies a supplementary question and responses are listed vertically in order of response frequency.

Goals of simulation

The key themes that arose regarding the goals of simulation were related to provision of a safe, controlled and unpressurised environment for students to gain confidence and prepare for clinical practice. Simulation was viewed as a tool to optimise and supplement clinical experience by facilitating improved preparation for practice. This preparation should allow practical application of theory, familiarisation with machinery/techniques, development of professional skills and improvements in efficiency. Other goals highlighted included opportunities for problem-solving, improving patient safety, equity of experience and the potential to reduce pressure on clinical placement providers. The need for realism and appropriate debriefing were also indicated.

Current simulation practice

It was encouraging that there was a broad range of current simulation practice demonstrated across HEI providers. Key activities included approaches to improve skills in:

- the delivery of radiation therapy techniques
- communication
- treatment planning
- imaging

The use of the virtual environment for radiotherapy training (VERT) system was common and mandatory training also ranked highly, along with personal and professional development activities. Some participants used simulation as part of assessment, and for supporting students who were struggling to meet learning outcomes. Other activities included error analysis, IPL, patient care, peer learning, team working and radiotherapy workflows.

Future vision

The responses that related to a future vision for simulation (given unlimited resources) reflected the desire for investment in equipment and resources, such as a training linear accelerator, VERT installation/upgrades, simulated patients and dedicated staff and simulation facilities. Other interesting areas that arose related to expanding the use of simulation for both student support and promotion of the profession.

Value of simulation to the radiotherapy curriculum

The most common response about the value of simulation to the radiotherapy curriculum related to the practical application of theory and undertaking this in an unpressurised environment. This was closely followed by enhancing placement experience, giving equity of experience in clinical practice and as a tool to increase placement capacity. Another common response was in relation to optimising clinical placements and preparing students for placements; this included a range of areas such as imaging, communication, planning, anatomy, patient set-ups and student confidence. There was also discussion of simulation being a teaching aid and being used to help explain complex techniques. Finally, patient safety was highlighted as being a valuable output of simulation for the radiotherapy curriculum.

Value of simulation to therapeutic radiography students

Respondents highlighted the value of simulation to therapeutic radiography students along similar lines to the value of simulation to the radiotherapy curriculum. This included highlighting the benefits of learning in an unpressurised environment and increasing confidence and engagement with learning. The differences when asked about the value of simulation to therapeutic radiography students related to the benefits of peer learning and team working.

Value of simulation to patient experience

The most common response when asked about the value of simulation to patient experience was communication. Instilling confidence in students to develop effective communication skills and rapport with patients, resulting in better patient experience, was listed as a high priority. Improved student performance and reducing patient anxiety were also highlighted within this section.

Challenges with implementation

The most common theme that emerged from responses about challenges with implementation of simulation was resources; this was broken down into availability of time, equipment, staff, training, cost and dedicated space for simulation. The requirement for partnership working and the lack of realism in simulated activities were also raised as challenges.

Barriers to wider adoption

The barriers to wider adoption were similar to the themes raised about the challenges with implementation and were resource focused. Further barriers were related to perceptions and awareness of simulation, linked to a lack of sharing of practice and limitations of the evidence base in supporting the benefit of simulation activities.

Further considerations

A free text box in the supplementary section allowed participants to highlight additional considerations. The need for continued collaboration, along with evaluation of the impact of simulation activities, was indicated.

"Researching/evaluating the value of simulation activities is essential. It is too easy to fall into the trap of undertaking simulation activities just because we can. We need to be sure of their benefits/impact. Sharing the results of evaluation is just as important and so having some agreed/common outcome measures is necessary. This will allow comparison of results across HEIs/centres."

The importance of linking simulation to key learning outcomes and the essential nature of appropriate debriefing was also highlighted, along with the potential for simulation to continue to develop in the future (e.g. augmented reality approaches) and the role it can play in preparing students for placement and post-qualification working.

"We feel there is real potential in the use of simulation to better prepare students for clinical placements and first jobs."

Areas for further consideration included the need for training in simulation/facilitation:

"As a department we found some of these questions difficult to answer due to our current lack of experience with delivering/receiving simulation sessions. If simulation were to be brought in on a wider level it must include training for radiographers/ educators in how to deliver this."

There was recognition that availability of guidance will help to work towards overcoming some of the current barriers to simulation that were outlined.

Conclusion

The Delphi process, alongside the focus groups, has provided a robust method for identifying key recommendations for the use of simulation in enhancing pre-registration education and training of therapeutic radiographers. This includes areas of the radiotherapy curriculum that are a priority to be delivered via simulation and the timing of simulation activities within each year group. The importance of using a validated simulation process model, to include the essential components of briefing and debriefing, has been highlighted. The project has also indicated the necessity for continued evaluation of simulation interventions to supplement the current evidence base, particularly in relation to achievement of learning outcomes. There is scope for significant future development and collaboration in terms of sharing of practice and collaborative research initiatives. Dissemination of simulation practice will be key to wider adoption, and use of forums such as the SoR Simulation Special Interest Group (SimSIG) can be instrumental in providing a platform for sharing ideas and experience.

Simulation practice will continue to develop and evolve as techniques and technology advance. It is hoped this document and the supporting multi-professional case studies will act as a live resource, alongside the HEE simulation frameworks and networks[24], to support the development and enhanced use of simulation in the future.

Acknowledgements

Our thanks go to all the clinical placement providers, HEIs, student and PAG members who contributed to this professional body guidance document. The project would not have been possible without input and advice from our steering group members, who generously and cheerfully gave us their time.

Thanks also go to Professor Heidi Probst from Sheffield Hallam University, for her invaluable guidance, encouragement, advice and support throughout the duration of the project.

Project methodology and results

Appendix 1 — September 2022

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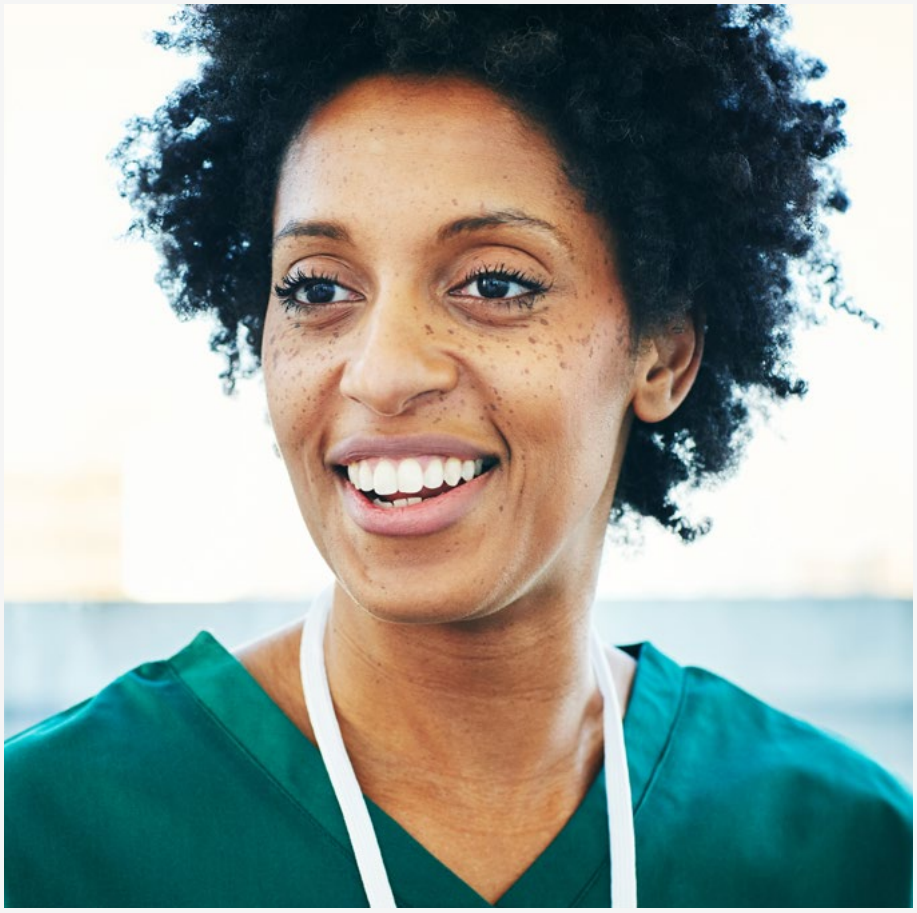

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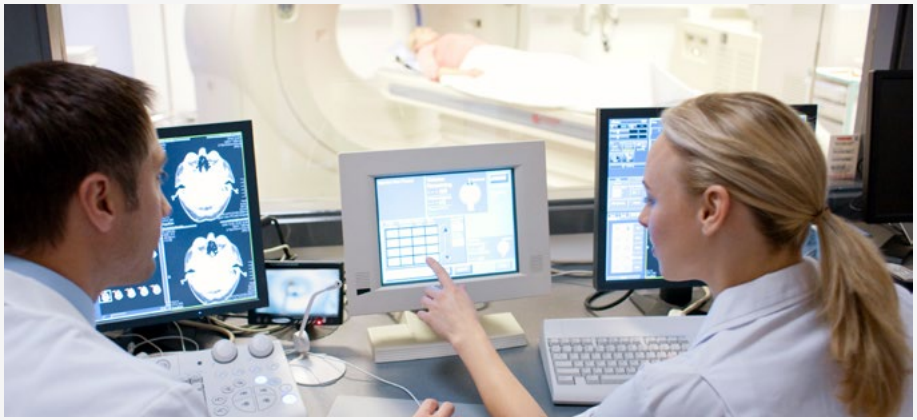
Methodology

The Delphi method

There is a range of definitions of the Delphi technique in the literature. It can be described as an iterative, multi-stage process that seeks to gather expert opinion on a topic and combine this to form a group consensus[1]. Dalkey and Helmer (1963) highlight Delphi as a method used to obtain the most reliable consensus of opinion of a group of experts by a series of intensive questionnaires interspersed with controlled feedback[2]. Ultimately, all definitions agree that the aim of the technique is to achieve agreement among a group of experts on a specific issue where none previously existed[3].

The popularity of the Delphi method in healthcare research has increased over recent years, as it is seen as a flexible and effective method for enhancing efficient decision-making in health and social care[4]. This increase in use has been linked to the fact that, similar to standard questionnaires, it allows for inclusion of a large cohort of participants across a range of geographic locations and expertise[5,6]. As per the definitions above, data is gathered through a series of structured surveys, referred to as 'rounds'. Each survey is completed anonymously by participants defined as 'experts' within the field of study, and the responses from the rounds are summarised and fed back to participants at each individual stage of the process.

The exact technique for implementing Delphi has evolved to encompass a number of modifications, dependent on the aims of the study being undertaken[3]. This variation in approach is related to the lack of formally agreed guidelines for Delphi, but highlights its flexibility and suitability for investigating diverse subject areas. The first round of what is termed the 'classical Delphi' generally adopts a more open form and collects a range of qualitative comments, which are fed back to the participants in a quantitative form for the second round of the survey. Qualitative data can also be collected through focus groups or interviews to inform the rounds of the Delphi, and this is often referred to as a 'modified Delphi'. This modified method was adopted for the current study to allow for a broader range of stakeholder input, as further detailed in the inclusion criteria.



Participants

Steering group

A steering group was established to provide oversight for each stage of the Delphi process. To ensure representation from a wide range of stakeholders in the field of simulation, membership of the group included higher education institution (HEI) educators, clinical educators, patients, therapeutic radiography students, Health and Care Professions Council (HCPC) representatives and allied health professional (AHP) and medical simulation experts. Inclusion criteria for the group members are detailed in Table 1.

Meetings were held before and after each Delphi round to provide an opportunity for regular review and input to the process. The terms of reference for the steering group can be viewed in Appendix A.

Inclusion criteria — steering group

1	Academics	Has managed diagnostic or therapeutic radiography courses in an HEI (i.e. head of department/school/team, deputy head of department/school/team) HEI simulation leads
2	Clinical practitioners	Radiotherapy managers, practice educators, clinical therapeutic radiographers
3	Students	Currently enrolled on an undergraduate or postgraduate radiography pre-registration course
4	Society and College of Radiographers (SCoR) Patient Advisory Group (PAG)	Currently or previously a user of diagnostic or therapeutic radiography services
5	Health Education England (HEE)	Works in the field of simulation
6	HCPC	Currently or previously in a role that contributes to the development of health policy
7	AHP simulation experts	Leaders of AHP simulation provision, simulation researchers

Table 1: Steering group inclusion criteria

Delphi panel

The expert Delphi panel was composed of key stakeholders with active involvement in the process of educating pre-registration therapeutic radiographers. Those that met the criteria outlined in Table 2 were invited to participate. Contact was initially made with the relevant leads at all HEIs in the UK delivering pre-registration HCPC-approved therapeutic radiography programmes of education (n=14), NHS radiotherapy providers in the UK (n=59) and UK private radiotherapy providers (n=15). Each department manager was asked to provide a named contact who could complete the surveys, to ensure these were sent to the most appropriate people. Named panel participants were then asked to collaborate with their teams on questionnaire responses to incorporate wider team opinions and experience and provide a team consensus. This was felt to be particularly important due to the variation in simulation experience/access across HEIs and radiotherapy providers.

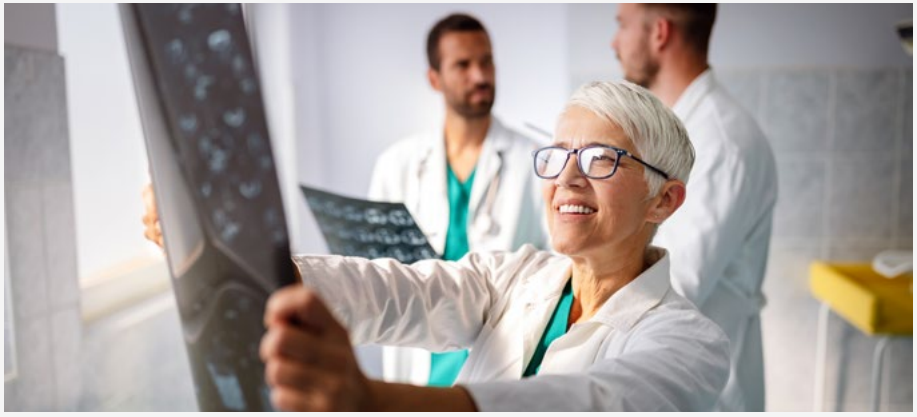
Inclusion criteria — Delphi panel

1	Academics	Have managed diagnostic or therapeutic radiography courses in an HEI (i.e. head of department/school/team, deputy head of department/school/team) HEI simulation leads
2	Clinical practitioners	Radiotherapy managers, practice educators, clinical therapeutic radiographers

Table 2: Delphi panel inclusion criteria

There was an expectation that there would be three planned ‘rounds’ of Delphi surveys, aiming to gain a predefined consensus of 75% agreement, which is the median threshold in the majority of similar studies. The surveys were administered via an online questionnaire (Alchemer) and distributed to the named contacts via an email link.

The Delphi approach necessitates continued time commitment from participants; it is recognised that the length of the process can affect participant motivation and engagement and may account for the decreasing response rate observed in some studies[3]. A number of actions were therefore taken to increase engagement with the Delphi rounds. These included provision of a video introduction to the round one Delphi, a social media communication strategy to keep SCoR members updated on the project and clear guidance within each survey on expected completion times and options to save and return to limit ‘survey fatigue’.



Focus group methodology

While the primary aim of the project was to gain consensus from colleagues directly involved in the education of pre-registration students, it was also essential to gain insight from students and service users. This was achieved through dual-moderator Society of Radiographers (SoR) student member and SCoR Patient Advisory Group (PAG) focus groups, with the aim of identifying stakeholder perspectives on the key areas where simulation has potential to optimise outcomes. The responses were transcribed, analysed and aligned to the survey results.

A focus group is defined as a powerful research technique that collects data through small group interaction, where the researcher provides the focus and the data emerges from the interaction itself[8]. This form of qualitative research approach is becoming more common in radiotherapy education evaluation, particularly for analysing perceptions of topics such as reflective practice and advanced roles[9]. Focus groups can allow for a structured means of investigating participant views on a particular topic within a group forum, and are useful in exploring knowledge and personal experience in relation to specific issues[9,10].

Barbour and Kitzinger (1999) highlight the advantages of focus groups in exploring people's opinions and allowing participants to generate their own queries, frameworks and theories while exploring their personal priorities in their own individual language[10]. One of the principal advantages of focus groups over other methods is the opportunity to observe a large amount of interaction on a topic in a limited amount of time — an important consideration in the context of a time-limited project[11]. They allow the researcher to extract both diverse and consensus responses of a verbal and non-verbal nature from a group of individuals at the same time[9]. The intensity of responses and non-verbal cues are an important advantage of focus groups that cannot be replicated by questionnaires or surveys.

Focus groups have the potential to produce richly detailed information and encompass diversity of responses[12]. They allow an opportunity for open questions, which is useful for collecting data from smaller groups of people[12]. This is pertinent in consideration of the current study, where it was anticipated that there would be approximately four/five people in each of the focus groups. The goal of interactions within these smaller groups is to explore attitudes and feelings about the research topic in a non-threatening environment[12]. The intent is to encourage interaction among participants to enhance the quality of the output.

Focus groups can also be helpful in involving participants who may be more anxious in a one-to-one setting where they are the sole focus of the researcher's attention[10]. Although it is acknowledged that there are challenges associated with discussing thoughts in a group environment, there is an advantage to having the input and support of other group members, which can work to encourage contributions from those who may normally be more reticent[9]. This suited the format of the current project as focus groups allowed for this interaction and discussion while also facilitating gathering of data in a short time frame. The focus groups also allowed for more debate around perceptions because participants questioned each other and offered differing viewpoints, something that could not have happened using a different approach, such as in an individual interview or questionnaire scenario. This added value to the discussion as participants were able to elaborate on varying experiences and viewpoints. Wright et al. (2012) highlight the advantage of focus groups in providing a platform for participants to discuss similarities and differences in opinion, allowing the researcher to gather direct evidence of these in a more free-flowing environment than a direct interview situation[9].

Delphi procedure

Ethical permission was obtained from the Institute of Life Course and Medical Sciences Research Ethics Committee at the University of Liverpool (reference number 10926; see Appendices B and C for details). Department managers from HEIs and both NHS and private radiotherapy providers were contacted via email with information about the study, including a short background, key dates and the level of commitment required, and asked to provide a named contact for their department. The named contact was used for all subsequent correspondence with each department, or the department manager where no named contact was provided. All rounds of the Delphi study were conducted using Alchemer online questionnaire software.

The following definition was agreed with the steering group and shared with the expert panel during each Delphi survey round to help focus responses on a common understanding of simulation and associated activities when answering survey questions:

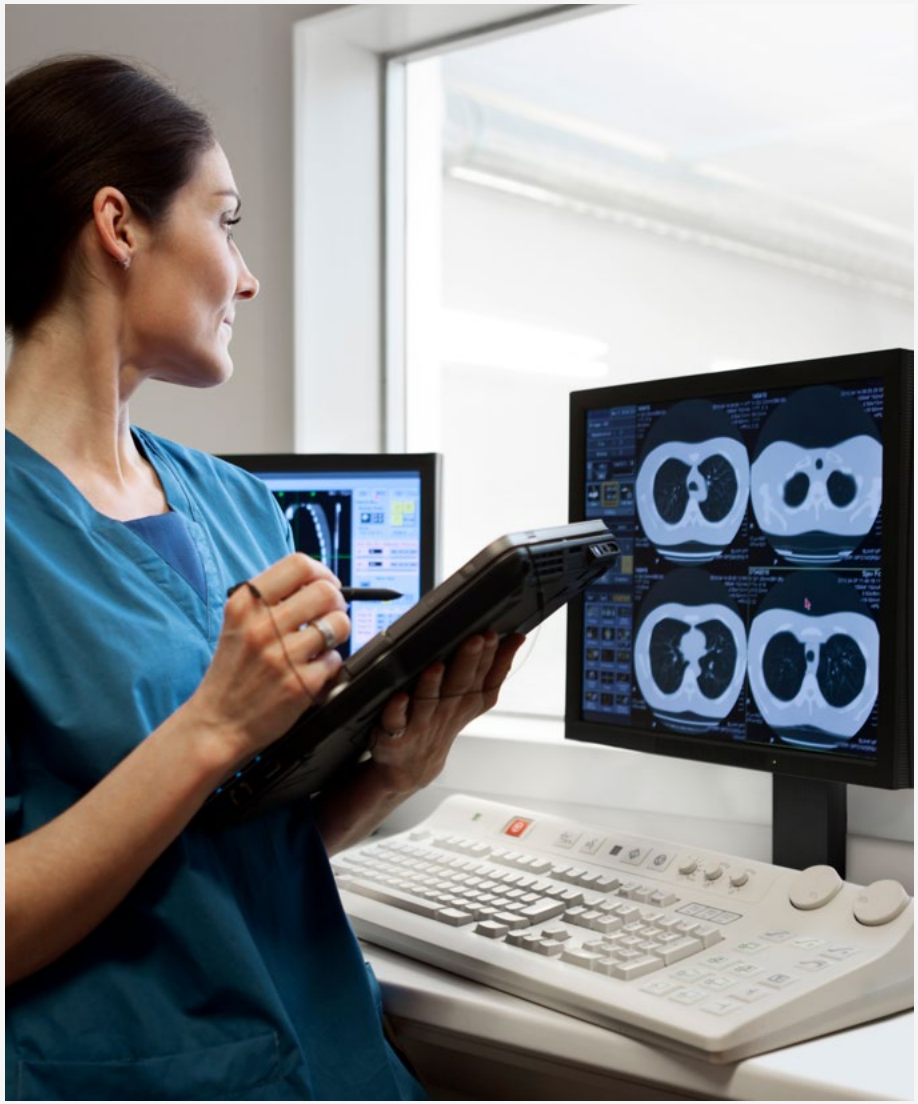
> **"Simulation is a technique — not a technology — to replace or amplify real experiences with guided experiences that evoke or replicate substantial aspects of the real world in a fully interactive manner."**
>
> Prof D M Gaba, The future vision of simulation in healthcare[26]

A briefing pack was emailed to participants for the round one survey; this included a welcome video explaining the Delphi process, instructions on completing the survey as a collective single response from each institution and the participant's ID number, plus relevant literature on the use of simulation in healthcare education and training. For round two, the briefing included information to assist in completion of the survey, a reminder of key dates and a summary of the responses from round one.

Before each round participants were asked to consent both to completing the survey and for their anonymised responses to be used in publications and discussions. They were also asked to provide their ID number to maintain confidentiality and anonymity and so that each of their responses throughout the Delphi study could be correlated. Finally, participants were asked to choose their role from a drop-down menu of 'higher education institution', 'clinical placement provider' or 'other'.

Round one

Round one consisted of five open-ended questions asking participants to list all areas of the radiotherapy curriculum that they felt could be delivered via simulation and what they felt the role of simulation was in each of the years of training. Examples were not given so as not to influence the thoughts of the participants; however, the Delphi approach allows participants to reflect on their own opinions in subsequent rounds based



on the anonymised opinions of others[14]. The welcome video encouraged participants to give as many responses to these questions as possible, using their whole team to ensure a varied and thorough response.

Round one was piloted using the test function within the survey platform Alchemer, and distributed to a small number of steering group members for completion and feedback. Alchemer rated the survey as 'low fatigue' and 'high accessibility' and estimated the time required for completion as eight minutes.

Thematic analysis using NVivo qualitative data analysis software (QSR International Pty Ltd. Version 12, 2018) was used to identify repeated comments, which were amalgamated into key themes. Two members of the project team individually reviewed and agreed on the 29 themes. Any disagreement on themes was discussed within the project team and with the project steering group. During analysis, care was taken to maintain wording used by the participants to ensure the themes reflected the original comments from round one. Topics that were ambiguous and had no further explanation, or those identified as not deliverable using simulation, were removed at this stage.

Round one included supplementary questions to gather information about the wider use of simulation and future ambition. Questions focused on the goals of simulation, current simulation delivery, future vision for simulation and where simulation could benefit the radiotherapy curriculum, students and patients. Finally, participants were asked about the challenges of using simulation and current barriers to wider adoption. A summary table of these results can be found in Appendix D.

Round one was open for 26 days. Non-responders were followed up by email on day 20 and reminders were given on social media and via the SCoR Radiotherapy Advisory Group (RAG) and other relevant working groups.

Round two

In round two the topics from round one were presented back to the Delphi panel grouped into themes, with the wording kept as similar as possible to the original responses. Round two required participants to rate both the importance and desirability of each theme using a 1 to 5 Likert scale (1 = very unimportant/undesirable, 2 = unimportant/undesirable, 3 = neither important/desirable nor unimportant/undesirable, 4 = important/desirable, 5 = very important/very desirable). Participants were given the option to choose the middle point of neither unimportant nor important and neither undesirable nor desirable, so as not to force a choice if there really was no preference or experience in that topic area.

Consensus was set as being achieved when all the following criteria were met:

- A mean rating of ≥4.0
- A coefficient of variation (CV) of ≤30%
- ≥75% agreement (% of panel members scoring 4 = important/desirable or 5 = very important/very desirable on the Likert scale).

Each question in section 1 of round two had an additional question asking if the panel members' department had experience of using simulation in the given topic area. A free text box was given for further information, and as part of the consent process for round two participants could choose whether or not to consent to further contact about their simulation experiences.

Round two was tested via the survey platform Alchemer by the project team and had input from the SoR knowledge manager and the steering group. Alchemer rated round two as 'low fatigue' and 'high accessibility', with an estimated completion time of 28 minutes. The project team ensured that the survey was broken down into manageable sections, with reminders of the 'save and return' function built into the survey platform. A PDF of the questions was also provided in the briefing pack to give full transparency about the number and type of questions.

Results

Round one

Table 3 presents the number of panel members responding in each round. The response rate for round one was 57%. Of the 88 panel members, 15.9% (n=14) were HEIs, 67% (n=59) were NHS radiotherapy providers and 17% (n=15) were private radiotherapy providers; detail of the response rate by each of the demographic groups is shown in Table 4.

Number of participants invited	88*
Number of participants responded	50
Response rate (%)	57
Number of topics suggested	104
Number of topics after thematic analysis	29

** Number of departments (each department was asked to collaborate and respond with a consensus opinion)*

Table 3: Round one response rates

HEIs	12/14
NHS radiotherapy centres	33/59
Private radiotherapy centres	5/15

Table 4: Round one response rate for each demographic group

Regional response rates are detailed in Figure 1. this was used to focus reminders via RAG, the Radiotherapy ODN managers and the communication plan.

Round one response rate by region

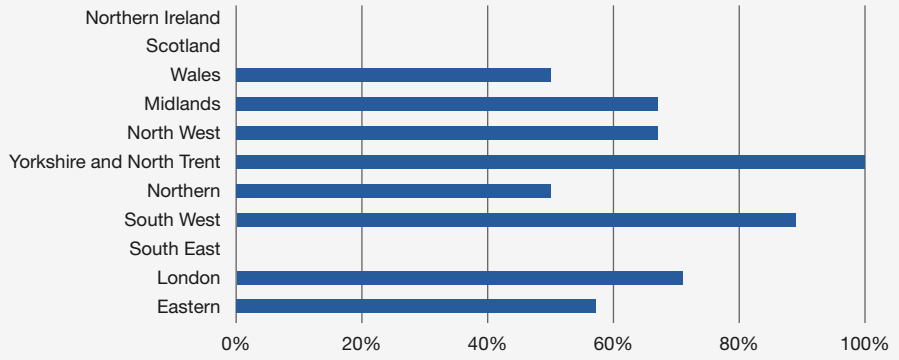


Figure 1: Round one regional response rates

The expert panel identified a total of 104 topic areas within the radiotherapy curriculum that could be delivered via simulation. These were grouped into 29 themes using thematic analysis software NVivo and presented back to the expert panel in round two.

Round two

The round two welcome email, social media updates and a presentation to RAG prior to round two reminded participants that non-response to round one would not prevent them from responding to round two.

Number of participants invited	87*
Number of participants responded	42
Response rate from original panel (%)	47.7
Response rate by those that responded to round one (n=50) (%)	84
Number of topics reaching consensus	15

** Number of departments (each department was asked to collaborate and respond with a consensus opinion)*

Table 5: Round two response rates

Round two response rates (Table 5) were slightly lower than in round one, as expected with a Delphi methodology[3]. The main difference was the drop in response rate from the private radiotherapy providers, from 33% (n=5) in round one to 0% (n=0) in round two. Response rates from the HEIs were 85.7% (n=12) and 78.5% (n=11) in rounds one and two respectively, and those from NHS radiotherapy providers were 55.9% (n=33) and 52.5% (n=31). These are shown in Tables 5 and 6.

Two partial responses were removed from the analysis because they only answered a small percentage — 6.8% (n=4) and 10.2% (n=6) — of the total questions in section 1 about areas of the curriculum deliverable via simulation. It was agreed by the project team, and verified by the steering group, that the importance and desirability of those questions answered had not been considered alongside the importance and desirability of the remaining questions, and for that reason the responses should be removed.

One complete response was removed due to answering 'strongly disagree' to all questions; therefore it was felt that this did not add value to the project.

The removal of the above three responses affected some borderline themes and meant that five extra themes that were close to reaching consensus then met the criteria for consensus. It was thought best to be cautious when making this decision and it was decided by the steering group that including borderline themes was better for a guidance document than ruling themes out due to anomalies in the data.

One participant formally withdrew from the study between rounds one and two due to lack of time to commit to round two.

The additional questions in section 1 of round two asked if the panel members' department had experience of using simulation in the given topic and if an example could be provided. Panel members were asked to consent to further contact to discuss these examples; 95.5% (n=40) consented with only 4.5% (n=2) requesting no further contact.

HEIs	11/14
NHS radiotherapy centres	31/59
Private radiotherapy centres	0/15

Table 6: Round two response rate for each demographic group

Response rates were again broken down by region for each round for targeted communication and to demonstrate the variety of responses and input into the Delphi process (Figure 2).

Round two response rate by region

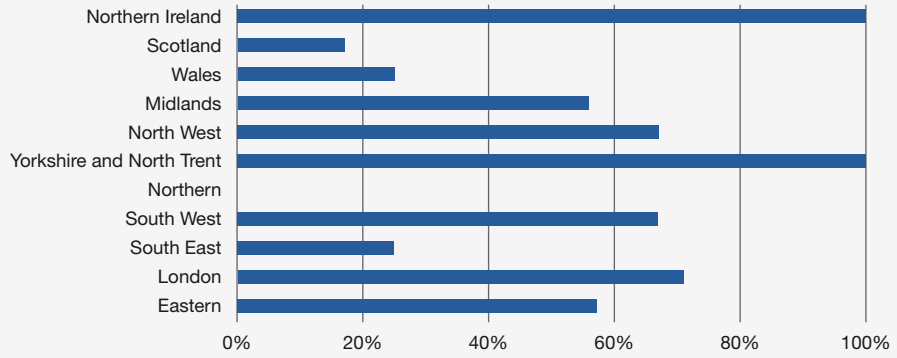


Figure 2: Round two response rate by region

There were 29 themes returned to panel members in round two and the mean scores, percentage agreement and CVs showed agreement from participants regarding the importance and desirability of simulation for 15 topics (shown in green in Table 7). It was decided by the project team and the steering group that a third round would not be required, as data from round two provided enough data to enable ranking of the top 15 themes reaching consensus.

Round two themes — priority areas of the radiotherapy curriculum that could be delivered by simulation

Theme	Rank importance	Mean importance	% agreement importance	CV (%) importance	Rank desirability	Mean desirability	% agreement desirability	CV (%) desirability
Planning — dosimetry, techniques and beam arrangements (radical and palliative)	1	4.5	92.7	13.4	1	4.5	97.5	11.1
General set-up principles (e.g. patient alignment, reproducibility, shifts to isocentre)	2	4.4	92.7	15.2	5	4.4	95.2	14.3
Clinical interpretation and evaluation of 2D and 3D images	2	4.4	90.2	14.3	4	4.4	87.8	15.3
Mandatory training — clinical observation skills, basic life support (BLS) and resuscitation	2	4.4	82.9	20.0	3	4.5	82.9	20.0
Treatment techniques — electrons and superficial treatments	5	4.4	85.0	16.2	2	4.5	90	14.4
Understanding of anatomical landmarks and cross-sectional anatomy	6	4.3	90.2	18.4	6	4.4	92.7	17.7
Communication — professional development and skills i.e. confidence, resilience, interview skills	7	4.3	85.4	16.8	9	4.2	80.5	20.6
Machine and equipment familiarisation	8	4.3	80.5	23.6	7	4.4	85.4	19.1
Communication — patient consultations (including delivery of first/last day information and discussions)	9	4.2	77.3	21.0	8	4.3	81.4	18.3
Communication — giving advice on side effects and their management	10	4.2	79.5	21.1	10	4.2	78.6	21.1

Theme	Rank importance	Mean importance	% agreement importance	CV (%) importance	Rank desirability	Mean desirability	% agreement desirability	CV (%) desirability
Planning workshops — computed tomography (CT) scanning processes	11	4.2	78.0	19.3	11	4.2	78.0	19.4
Communication — difficult conversations with patients and carers	12	4.1	78.6	19.4	13	4.1	76.2	19.8
Challenging scenarios and problem-solving	13	4.1	75.0	20.1	15	4.0	72.5*	24.2
Mandatory training — infection control and correct usage of personal protective equipment (PPE)	14	4.1	80.0	20.5	14	4.1	79.5	22.1
Mandatory training — manual handling	14	4.1	74.4*	29.4	12	4.1	76.3	28.4
Planning — immobilisation and mask-making		3.9	70.7	27.3		3.8	65.0	31.3
Radiation safety — consequences of errors and incidents		3.9	63.4	24.6		3.9	63.4	24.1
Professionalism		3.8	63.4	25.7		3.8	61.0	27.4
Mandatory training — radiation protection		3.8	60.0	29.9		3.7	57.5	29.8
Treatment techniques – deep inspiration breath hold (DIBH)		3.8	63.4	26.1		3.8	62.5	26.7
Radiotherapy physics and quality assurance (QA) (e.g. visualisation of inside of linear accelerator (LINAC), beam profiles, QA checks etc.)		3.8	61.0	29.1		3.5	53.7	32.7
Unusual/complex techniques		3.8	62.5	23.9		3.8	60.0	25.1

Theme	Rank importance	Mean importance	% agreement importance	CV (%) importance	Rank desirability	Mean desirability	% agreement desirability	CV (%) desirability
Switching on procedures — pause and check		3.8	63.4	28.8		3.8	63.4	28.8
Communication — interprofessional working		3.7	60.0	25.4		3.7	62.5	25.8
The use of simulation for student clinical assessments (e.g. site-specific competencies)		3.6	52.5	31.2		3.7	52.5	31.8
Communication — within the radiotherapy team		3.5	56.1	31.0		3.5	51.2	30.8
Planning — tattooing techniques		3.5	56.1	39.9		3.5	60	40.4
Simulation for interprofessional learning		3.4	46.3	29.5		3.4	48.8	30.9
Record-keeping (e.g. treatment documentation, number/type of images taken, patient care activities undertaken)		3.3	48.8	31.5		3.3	51.2	33.1

% agreement = % of panel members scoring '4' (important/desirable) or '5' (very important/very desirable) on the Likert scale; CV = coefficient of variation.
Consensus was considered as a mean score ≥4.0, % agreement ≥75% and coefficient of variation <30%.
** Denotes results that did not meet the % agreement criteria in one aspect of either importance or desirability but were included because the theme reached consensus in all other aspects.*

Table 7: Round two themes – priority areas of the radiotherapy curriculum that could be delivered by simulation

Delphi rounds

Round one

Round one of the Delphi study asked participants open-ended questions about what they felt the role of simulation was for each of the individual student year groups. Thematic analysis using NVivo qualitative data analysis software was used to help identify key themes and develop questions to be presented to the panel in round two. The number of topics raised is indicated in Table 8.

Year group	Topic areas raised	Topic areas after thematic analysis
Year 1	36	24
Year 2	24	21
Years 3/4	21	20

Table 8: Year group simulation activities — number of topics raised for each year group

Round two

Participants were asked if each of the themes listed was a priority for simulation with the given year group. There were 38 themes that met consensus across the duration of pre-registration programmes; 12 themes for Year 1, 11 themes for Year 2 and 15 themes for Years 3 and 4. Consensus was set where ≥75% agreement was reached and these themes are highlighted in green in Tables 9–11. An open question was also included for each year group to allow participants to add any areas not covered by the survey questions.

Year 1

Participants were asked if each of the 24 themes highlighted in round one was a priority for simulation within that year.

Topic number (ranked)	Priority	% agreement
1	Communication — patient communication (“Hello my name is”, ID checks, developing rapport, giving treatment-related information)	97.6
2	Development of psychomotor skills (for machine and bed controls)	92.9
2	Hands-on practice (patient set-ups)	92.9
4	Anatomy workshops (anatomical landmarks and 3D cross-sectional anatomy)	92.7
4	Mandatory training — infection control procedures and use of PPE	92.7
6	Mandatory training — manual handling	92.5
7	Standard set-up and treatment techniques	90.5
8	Communication — team communication (integration into the treatment team)	88.1
8	Mandatory training — clinical observation skills, basic life support (BLS) and resuscitation	88.1
10	Mandatory training — radiation protection	85.4
11	Professionalism	83.3
12	Immobilisation and mask-making	78.6
13	Patient care — side effect assessment and advice	73.2
14	Radiotherapy physics, visualisation of machine components etc.	66.7

Topic number (ranked)	Priority	% agreement
14	Understanding of beam arrangements (visualising beams and understanding of factors that affect beam dosimetry)	66.7
16	Interprofessional learning — understanding other professional roles and where there is shared learning	61.9
17	Assessing skin reactions	59.5
17	Understanding radiotherapy treatment workflow	59.5
19	Imaging (foundations and principles of image review)	52.4
20	Planning — dosimetry (understanding gross tumour volume (GTV), clinical target volume (CTV), planning target volume (PTV), organs at risk, depth dose)	50.0
21	Student assessments (e.g. site-specific competencies)	47.6
21	CT scanning processes	47.6
23	Manual monitoring unit (MU) calculations	16.7
24	Unusual/less frequent/complex techniques	0

Table 9: Year 1 — priority themes for simulation

The open-ended question highlighted five themes from four survey responses; however the project team felt that these areas were already covered in the main questions asked in this round. They were:

1. Tattooing (covered in CT scanning processes/hands-on practice).
2. Treatment documentation and electronic records (covered in hands-on practice/standard set-up and treatment techniques).
3. Hands-on practice of patient positioning to lasers (covered in hands-on practice/standard set-up and treatment techniques).
4. Anatomy, cancer spread, regional lymph nodes (covered in anatomy workshops, anatomical landmarks and 3D cross-sectional anatomy).
5. Mentoring (covered in interprofessional learning/student assessments).

Year 2

Participants were asked if each of the 21 themes highlighted in round one was a priority for simulation within that year.

Topic number (ranked)	Priority	% agreement
1	Anatomy (anatomical landmarks and 3D cross-sectional anatomy to aid planning and image review)	92.9
2	Radiotherapy planning — dosimetry (understanding different types of planning, awareness of reasons for beam arrangement/ volumetric modulated arc therapy (VMAT), producing simple plans)	90.5
3	Image interpretation and matching — 2D and 3D images	85.7
3	Expanding knowledge of radiotherapy pathways (patient pathways from diagnosis through treatment to follow-up)	85.7
5	Communication skills — more advanced skills e.g. patient consultations, side effects, giving advice, sensitive conversations, dealing with distressed patients, patients with additional needs	85.4
5	Radiotherapy planning — CT and magnetic resonance imaging (MRI) scanning processes	85.4
7	Electron and superficial techniques	83.3
8	Interprofessional learning — understanding other professional roles and where there is shared learning	82.5
9	Personal and professional development — resilience, mindfulness and reflection	81.0
9	Assessment (e.g. site-specific competencies)	81.0
11	Treatment techniques — deep inspiration breath hold (DIBH) techniques	75.6
12	Radiotherapy planning — immobilisation and mask-making	73.8
12	Clinical observation skills, BLS and resuscitation	73.8

Topic number (ranked)	Priority	% agreement
14	Manual handling	71.4
15	Decision-making and problem-solving scenarios — e.g. solving problems with set-ups, communication problems, addressing patient complaints	70.7
16	Familiarisation and safe use of LINAC and CT controls	70.0
17	Hands-on patient experience e.g. laser alignment and positioning patients	69.0
17	Switching on procedures (pause and check, record and verify systems and Ionising Radiation (Medical Exposure) Regulations 2017 (IR(ME)R) principles)	69.0
19	Patient consultations — assessing fitness for treatment/referral pathways	66.7
19	Brachytherapy and theatre techniques	66.7
21	Daily machine checks and QA procedures	65.9

Table 10: Year 2 – priority themes for simulation

The open-ended question at the end of round one highlighted four themes from four survey responses. However, the project team felt that these four areas were already covered in the main questions asked in this round, or were not a priority for delivery via simulation as not in widespread clinical use, and only raised by one respondent. They were:

1. Dose calculations (covered in radiotherapy planning — dosimetry (understanding different types of planning, awareness of reasons for beam arrangement/VMAT, producing simple plans).
2. Head and neck shells (covered in radiotherapy planning — immobilisation and mask-making).
3. Bladder scanning ultrasound (viewed more as Year 3/ post-registration skill).
4. Introduction to plan evaluation (covered in radiotherapy planning — dosimetry, understanding different types of planning, awareness of reasons for beam arrangement/VMAT, producing simple plans).

Years 3/4

Participants were asked if each of the 20 themes highlighted in round one was a priority for simulation within that year.

Topic number (ranked)	Priority	% agreement
1	Dosimetry — critical evaluation of treatment plans (e.g. visualisation and understanding of the impact of contour changes and patient/breathing motion on volumes and organs at risk)	95.2
2	Advanced communication scenarios (giving more complex advice, confirming consent, sensitive conversations, dealing with complex and challenging patient interactions, conflict management)	92.9
2	2D and 3D image matching for all sites (e.g. what action to take if images are not acceptable e.g. repeat images, repeat prep, contact doctor, impact of geographical miss and changes in patient position on dosimetry)	92.9
2	Professional development — interview practice, developing mentoring/coaching skills/resilience	92.9
5	Producing site-specific computer plans	88.1
6	Peer-assisted learning — for student to consolidate their own knowledge and increase confidence by mentoring other students	87.5
7	Communication — interactions with multidisciplinary team members, physicists, oncologists, nurses, other AHPs	85.7
8	Student assessments — clinical competency assessments	85.0
9	CT and MRI pre-treatment scanning processes	83.3
9	Leading set-ups and problem-solving e.g. patient not aligning to tattoos, patient in too much pain, contour changes, changes in breathing trace	83.3
9	Electron and superficial set-ups	83.3
12	Hands-on practice for complex/uncommon techniques	78.6

Topic number (ranked)	Priority	% agreement
12	Radiotherapy pathways — understanding pathways for all tumour sites from diagnosis through treatment to follow-up	78.6
14	Use of pelvic ultrasound to assess bladder size prior to radiotherapy	76.2
15	Interprofessional learning — understanding other professional roles and where there is shared learning	75.6
15	Clinical observation skills, BLS and resuscitation	73.2
16	Opportunity to experience different modalities — protons, tomotherapy, CyberKnife® to aid with future employment	69.0
17	Manual handling	65.0
18	Immobilisation and mask-making	50
19	Cannulation/venepuncture training using virtual reality (VR)/immersive technology	23.8

Table 11: Years 3/4 – priority themes for simulation

The open-ended question highlighted one theme from a single survey response; however the project team felt that this area was already covered in the main questions asked in this round. The area was:

1. Machine management — managing a list, communication with other departments, understanding how to manage machine breakdown/ delays at chemo etc. (covered in communication — interactions with multidisciplinary team members, physicists, oncologists, nurses, other AHPs and advanced communication scenarios).

Across the four years of training, the priority areas were grouped into the eight topic areas in Table 12 and are shown in the main document 'Guidance for the use of simulation in enhancing pre-registration education and training of therapeutic radiographers', demonstrating the continuum of skills required within these topic areas across the duration of training programmes.

Topic areas
Communication
Imaging
Treatment techniques
Pre-treatment and planning
Professionalism and professional development
Patient pathways
Mandatory training
Interprofessional learning

Table 12: Priority themes for simulation across all year groups

Procedure

As mentioned previously, separate dual-moderator focus groups with the SCoR Patient Advisory Group (PAG) and with SoR student members were held following round two. An amendment to the original project ethical approval was obtained from the Institute of Life Course and Medical Sciences Research Ethics Committee at the University of Liverpool to facilitate conducting these groups (Appendix C).

PAG participants were recruited by advertising the focus group at PAG meetings and through emails via the PAG coordinator. Four participants took part in a recorded one-hour focus group.

Student members were recruited through the SoR Student Representative Forum, the professional officer for student members and targeted student member social media advertisements. Four students contributed to the recorded focus group.

Prompt questions for the focus groups can be seen in Appendices E and F. The responses for each group were transcribed before undergoing thematic analysis. The themes were then compared with and aligned to the Delphi survey results, as can be seen in the document *'Guidance for the use of simulation in enhancing pre-registration education and training of therapeutic radiographers'*. Key themes were primarily focused on communication and confidence, as illustrated in Table 13.

Theme

Communication

- Patient consultations (including delivery of first/last day discussions and information giving)
- Giving advice on side effects and their management
- Difficult conversations with patients and carers (e.g. dealing with anxious and claustrophobic patients, patients with additional communication needs, distressed patients)
- Professional development skills ie. confidence, resilience, interview skills, peer learning

Student focus group

"I thought the first day chats in 1st year and all the communication were most useful. Before placement I was a bit stressed about a patient asking me something on the first day and having no idea how to respond."

"I definitely think the communication tasks were very useful. I am certain I would've been more hesitant to start talking with patients if I had not had that simulation training and previous practice with the actors … The communication was definitely the most important thing."

"I found that the actors were so good! I feel like there should've been more of it. Obviously due to COVID this was not possible, but we only had it in the first year. You do see so many people who react very differently, so having the actors was definitely helpful."

" … The first few times I had been asked, it was clear to the patient that I was a bit taken aback because I didn't know what to say. However, the more I have been on clinical the more I have got used to hearing these types of questions. The responses eventually become routine."

"Nervous about saying the wrong thing – practice helped with this."

"Maybe a session on difficult questions and conversations could be useful."

" ... probably having some proper advanced communications simulation at some point would be useful, but also making people aware of some of the key things to say and to avoid saying."

" ... I think the actors made a big difference. If we had just practised on each other, I don't feel it would have been effective. It made it easier to get in the zone and to practise communication with the various emotions a patient may experience."

" ... communication, particularly around difficult conversations … would have been our number one choice."

"I have had patients express that they are struggling with their mental health, or with money, when I was in my second year. I think it would be useful to have a guide of talking points or basic responses."

"When you have a really bad week, it can be helpful to have reassurance and support from second or third year students, who have had similar experiences."

" ... because we are all students it can feel easier as a first year student to ask a third year student for help, as they may find it intimidating to ask another radiographer, particularly as they are very busy. I think a buddying system could be really nice."

Table 13: Key themes from student member and PAG focus groups

Patient Advisory Group focus group

"One thing I think you really need to emphasise with students is that they need to speak in measured tones … the communication can feel like a machine gun … It's all very, very quickly delivered … and therefore I'm sure they don't follow the instructions as they should do. It can make people quite nervous if instructions are delivered in that way. So, I think you need to practise with students how to deliver instructions in a measured way."

" ... I think empathy is very important for these situation ... I arrived at my appointment very stressed because I was worried ... However, I had a really nice experience with the sonographer, who was really empathetic and understanding of my situation."

" ... just somebody putting their hand on your shoulder means an awful lot to some people in these situations."

" ... There are conversations that take place as if you were not in the room and can leave you feeling as if you're a spare part."

"Conversations can also feel quite coded, which can be concerning."

"It's getting people to understand what it might be like if they were sitting on the other side as well."

" ... when it's not actually your duty to actually give them [the patient] news; I think one of the big issues is that you are often the person that the patient gets access to. While the person who is qualified to give you the news is often not as accessible as the people that you actually see in these situations."

"I think communication is critical … I think it's understanding that when people are frightened that you must be even more clear than normal."

"What about training in hiding emotions? I do think that if you're giving out, you know messages which people perhaps don't want to hear, or are difficult, not betraying your emotions is something that you really need good training in."

Table 13 (continued): Key themes from student member and PAG focus groups

Theme

Treatment and imaging

- Machine and equipment familiarisation
- General set-up principles (e.g. patient alignment, reproducibility, shifts to isocentre)
- Clinical interpretation and evaluation of 2D and 3D images
- Challenging scenarios and problem-solving (e.g. decision-making, dealing with errors, changes in patient contour/anatomy, medical emergencies, patients with diverse needs etc.)

Student focus group

"I liked the handset … it gave me a little idea of what goes on and a feel for the handset itself."

Masks

"The amount of patients who come in, especially head and neck patients. If you can tell them you've tried one of them before it can be a relatable talking point."

"Lining actors up felt 'low stakes' … get more involved because you're not worried about making mistakes."

"Practical and directional stuff"

Cone-beam computed tomography (CBCT) in particular

"... more for third years, but the interpretation and evaluation of 2D and 3D images"

"I think it would be good if there was a simulation with diverse people involved. For example, having someone blind, deaf, transgender or someone from the LGBTQ+ community come in so that we can experience how to approach and communicate effectively with diverse people."

Patient Advisory Group focus group

"I think some of the practical things … can sometimes feel like you're a slab of meat ... Some of these things are very intimate procedures. Also being respectful of their dignity … like not making them walk around with a gown … I understand you have to remain professional, but I think these things make a difference to the patient experience."

"I just wondered whether when you do these simulations, you do them on the whole spectrum. I mean, do the students get the opportunity to do simulations on really poorly patients, who are not mobile, patients who've got Alzheimer's, patients who are on the autistic spectrum."

Table 13 (continued): Key themes from student member and PAG focus groups

Theme	
Mandatory training • Infection control and correct use of PPE • Manual handling	
Student focus group	"Even pushing a wheelchair, which on my first placement block was actually very useful, as I feel I did quite a lot of taking patients to and from places in a wheelchair."
Patient Advisory Group focus group	" … do you have programmes which simulate how to deal with patients who got COVID because they've got to be dealt with in a totally different way, haven't they?"

Table 13 (continued): Key themes from student member and PAG focus groups

Discussion

The modified Delphi consensus method provided an appropriate technique, supported by focus groups, to identify areas of the radiotherapy curriculum that could be delivered via simulation and recommended timing of these activities within each year group. This was determined by stakeholders from both HEIs and clinical providers, supported by student SoR members and PAG members.

Response rates with a Delphi methodology often decrease as the rounds progress[3]; however, the response rates from HEIs and NHS radiotherapy providers were positive, with only a 7.2% reduction in HEI response rate between rounds and a 3.4% reduction for NHS radiotherapy providers. The main reason for the drop in response rates overall between rounds was the lack of responses from private radiotherapy centres in round two compared to one third of private centres replying to round one. It must be noted that this project was conducted during a period of major staff shortages due to COVID-19 sickness and isolation guidance, with many centres working under business continuity plans. However, the overall response rate for the final round was 47.7%, demonstrating the commitment of the radiotherapy profession to contribute to this guidance.

A total of 15 areas of the curriculum reached consensus on importance and desirability to deliver via simulation after two survey rounds. A ranking is provided for both importance and desirability; however, it must be noted that ranking of the topics is based on the mean score for importance and desirability. Higher mean scores may reflect greater consensus within the group of participants that scored that topic, meaning that the lower-ordered topics may reflect a wider diversity of opinion among the respondents.

Conclusion

The Delphi process, alongside the focus groups, has provided a robust method for identifying areas of the radiotherapy curriculum that are a priority to be delivered via simulation. Recommendations have been provided for topic areas where simulation could provide the most benefit within each of the three or four years of training. Finally, multi-professional case studies have been collated to demonstrate how areas of the curriculum can be delivered via simulation, with the expectation that these are used as a guide and tailored to meet the learning outcomes of course programmes.

Appendices

Appendix A: steering group terms of reference

Radiotherapy simulation champions Delphi project
Steering group terms of reference

1. To meet at each stage of the Delphi process — prior to each of the three rounds of the survey and following the final round.
2. To monitor and guide the progress of the project against the agreed milestones.
3. To provide independent feedback to the research team on appropriate aspects of the project surveys and evaluations.
4. To ensure that stakeholder perspectives are embedded in all aspects of the Delphi process.
5. To advise on dissemination and public engagement activities related to the project.

Appendix B: ethical approval

Institute of Life Course and Medical Sciences Research Ethics Committee

28 February 2022

Dear Ms Ketterer,

I am pleased to inform you that your application for research ethics approval has been approved. Application details and conditions of approval can be found below. Appendix A contains a list of documents approved by the Committee.

Application details

Reference: 10926

Project Title: The use of simulation in pre-registration training and education for Therapeutic Radiography students: Establishing consensus guidelines

Principal Investigator/Supervisor: Ms Sarah-Jane Ketterer

Co-Investigator(s): Ms Nicky Hutton

Lead Student Investigator: —

Department: School of Health Sciences

Approval Date: 28/02/2022

Approval Expiry Date: Five years from the approval date listed above

The application was **APPROVED** subject to the following conditions:

Conditions of approval

Please note: any research ethics approval granted will be subject to the University's policies on research during the pandemic.

Please ensure you are familiar with the latest guidance on conducting research during the pandemic. The guidance is available on the research ethics webpages.

All serious adverse events must be reported to the Committee (**ethics@liverpool.ac.uk**) in accordance with the procedure for reporting adverse events.

If you wish to extend the duration of the study beyond the research ethics approval expiry date listed above, a new application should be submitted.

If you wish to make an amendment to the study, please create and submit an amendment form using the research ethics system.

If the named Principal Investigator or Supervisor changes, or leaves the employment of the University during the course of this approval, the approval will lapse. Therefore it will be necessary to create and submit an amendment form within the research ethics system.

It is the responsibility of the Principal Investigator/Supervisor to inform all the investigators of the terms of the approval.

Kind regards,

D Prescott
Institute of Life Course and Medical Sciences Research Ethics Committee

Appendix — approved documents

(Relevant only to amendments involving changes to the study documentation)

The final document set reviewed and approved by the committee is listed below:

- Participant Information Sheet 21/01/2022 1
- Participant Consent Form 21/01/2022 1
- Questionnaire Round 1 Survey V1 21/01/2022 1
- Advertisement Email Invitation 21/01/2022 1

Appendix C: amendment to ethical approval — to include focus groups

UNIVERSITY OF LIVERPOOL

Institute of Life Course and Medical Sciences Research Ethics Committee

6 May 2022

Dear Ms Ketterer,

I am pleased to inform you that the amendment to your study has been approved. Amendment details and conditions of approval can be found below. If applicable, Appendix A contains a list of documents approved by the Committee.

Amendment details

Reference: 10926 (amendment)

Project Title: The use of simulation in pre-registration training and education for Therapeutic Radiography students: Establishing consensus guidelines

Principal Investigator: Ms Sarah-Jane Ketterer

Co-Investigator(s): Ms Nicky Hutton

Student

Investigator(s): —

Department: School of Health Sciences

Approval Date: 06/05/2022

The amendment was **APPROVED** subject to the following conditions:

Conditions of approval

Please note: any research ethics approval granted will be subject to the University's policies on research during the pandemic.

Please ensure you are familiar with the latest guidance on conducting research during the pandemic. The guidance is available on the research ethics webpages.

All serious adverse events must be reported to the Committee (**ethics@liv.ac.uk**) in accordance with the procedure for reporting adverse events.

If it is proposed to make further amendments to the study, please create and submit an amendment form within the research ethics system.

It is the responsibility of the Principal Investigator or Supervisor to inform all the investigators of the terms of the approval.

Kind regards,

D Prescott
Institute of Life Course and Medical Sciences Research Ethics Committee

Appendix — approved documents

If applicable, the final document set reviewed and approved by the committee is listed below:

- Default Focus Groups — Participant Information Sheet 23/03/2022 1
- Default Focus Groups — Participant Consent Form 23/03/2022 1

Appendix D: round one supplementary question responses

Goals of simulation	Current simulation delivery	Future vision	Value of simulation to radiotherapy curriculum	Value of simulation to therapeutic radiography students	Value of simulation to patient experience	Challenges with implementation	Barriers to wider adoption
Safe, controlled, unpressurised environment	Technical skills	Learning resources and equipment • Access to training on linear accelerator (LINAC) • Virtual environment for radiotherapy training (VERT) • Simulated patients • Communication and empathy • Image matching • Treatment planning • Dedicated staff • Simulation education centre • Advanced scenarios and techniques • Computed tomography (CT) • Technical skills confidence • Time • Access • Anatomy • Immersive environment • QA equipment • Surface guided radiation therapy (SGRT) • Artificial intelligence (AI) • Electron practice • Palliative scenarios • Student education • Treatment pathways	Practical application of theory	Unpressurised environment	Communication • Instilling confidence • Effective communication • Rapport • Team communication	Resources • Time • Equipment • Staff • Dedicated space • Training • Access • Outdated equipment/ practice	Resources • Time • Staff • Equipment • Dedicated space • Training • Access • Capacity • Equity

Goals of simulation	Current simulation delivery	Future vision	Value of simulation to radiotherapy curriculum	Value of simulation to therapeutic radiography students	Value of simulation to patient experience	Challenges with implementation	Barriers to wider adoption
Confidence	Communication	Preparation for clinical	Unpressurised environment	Confidence and engagement	Patient experience	Cost	Cost
Optimise/ supplement clinical experience	Planning	Promote profession	Optimise clinical placement and prepare for placement	Technical skills	Technical confidence	Perceptions/ awareness	Perceptions/ awareness
Preparation for clinical • Familiarisation • Practical application of theory • Professional skills • Transition to placement • Imaging • Improve efficiency	Imaging	Student support	Problem-solving and decision-making	Communication	Patient care	Lack of evidence and evaluation	Lack of evidence
Aid to learning	VERT		Imaging	Practical application of theory	Efficiency	Ethics	Limited sharing of practice/ standardisation
Problem-solving	Mandatory training		Communication	Problem-solving and decision-making	Improved student performance	Lack of realism	COVID (linked to staffing)
Patient safety	Anatomy		Capacity	Imaging	Reduce anxiety	Requires partnership	Lack of hands-on experience
Equity	Clinical skills		Equity	Optimise clinical placement	Problem-solving	National variations	Not used as intended/genuine
Capacity/reduce pressure on clinical placement	Machine QA		Planning	Peer learning	Expansion of learning opportunities		None
Realism	Personal and professional development		Teaching aid/explain complexity	Equity	Imaging		

Goals of simulation	Current simulation delivery	Future vision	Value of simulation to radiotherapy curriculum	Value of simulation to therapeutic radiography students	Value of simulation to patient experience	Challenges with implementation	Barriers to wider adoption
Debriefing	1st year teaching activities		Anatomy	Preparation			
Improve clinical skills in the workforce	Assessment		Linked to learning outcomes	Understanding of underlying principles			
	Professionalism		Patient set-up	Capacity			
	Radiotherapy physics		Confidence	Linked to learning outcomes			
	Surface guided radiation therapy (SGRT)		Patient education	Research and leadership			
	CT lab sessions		Patient safety	Team working			
	Error analysis		Student safety	Time management			
	Interprofessional learning (IPL)						
	Patient care						
	Peer learning						
	Use of phantoms						
	Radiotherapy workflows						
	Support for students not meeting learning outcomes						
	Team working						

Appendix E: prompt questions for SoR student member focus group

Student forum focus group schedule

Study title: The use of simulation in pre-registration training and education for therapeutic radiography students: establishing consensus guidelines — Stakeholder focus group

Principal investigators: Sarah-Jane Ketterer, Nicky Hutton

Contact details: sarah-janek@sor.org, nickyh@sor.org

1. Introductions
2. Opening questions:
   - What experience, if any, have you had of simulation?
   - What did you find most helpful/useful?
   - Was there anything that you did not find useful?
   - What would you have liked more of?
   - Summary of topic areas –
     - do you agree with priority areas?
     - anything missing?

Appendix F: prompt questions for SCoR patient advisory group focus group

PAG focus group schedule

Study title: The use of simulation in pre-registration training and education for therapeutic radiography students: establishing consensus guidelines — Stakeholder focus group

Principal investigators: Sarah-Jane Ketterer, Nicky Hutton

Contact details: sarah-janek@sor.org, nickyh@sor.org

1. Introductions
2. Opening questions:
   - Is there anything that you remember from your experience related to students on placement that you can share?
   - Summary of priority areas — some of these will be more technical based, but related to comms etc. — do you think anything is missing here?
   - What do you think should be the priority areas for preparing students for interacting with service users?
   - What skills would you like to see students demonstrate while on placement/interacting with service users?

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Simulation models

Appendix 2 — September 2022

Models

Simulation models

The implementation of successful simulation initiatives is based on recognising the intricacies of simulation activities and adopting a validated process model to ensure that associated learning outcomes can be met[36].

As per Nestel and Bearman's process model for the 'phases in simulated-patient based simulation' (Figure 1), a simulation consists of six phases: preparation; briefing; simulation activity/intervention; debriefing; reflection; and evaluation[20].

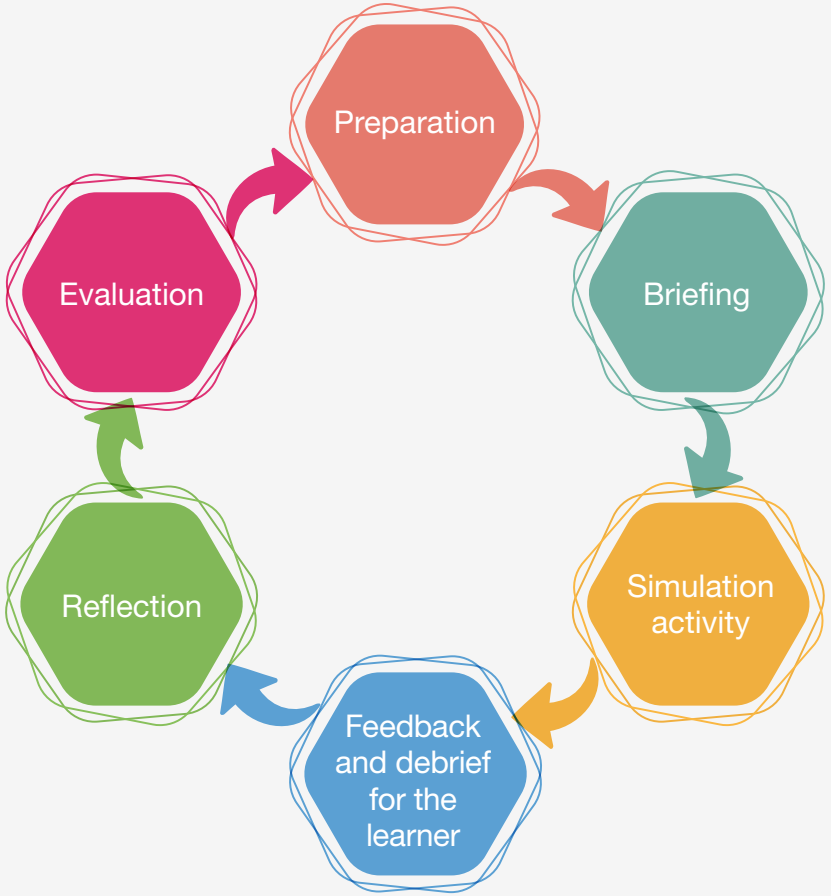

Figure 11: Simulation process model[20]

Preparation

The construction process for any simulation begins with careful consideration of the purpose of the simulation[37]. This should be targeted towards the specific curriculum/module learning outcomes to be achieved and the level of the learner[36]. Well-designed scenarios can be adapted, as required, to the appropriate learner level and/or individual learning objectives. Case studies that fit a foundational level learner can be modified in complexity as learners gain experience[36].

Using a template allows for standardisation of approach and, once implemented, can facilitate increased efficiency and consistency in scenario development[36]. The literature highlights the fact there is no universally accepted template that must be used, but that accessible templates such as the Association of Standardised Patient Educators (ASPE) case development template (**aspeducators.org**) can act as a useful guide, and be readily modified to suit the needs of individual institutions[36].

Briefing

Briefing can be defined as "information or an orientation session held prior to the start of a simulation-based learning experience in which instructions or preparatory information is given to the participants"[38]. Appropriate briefing can help to ensure learners are clear on the objectives of the exercise, promote safety and alleviate learner anxiety that may be associated with undertaking simulated activities, especially for those completely new to the experience[37]. Continued exposure to simulation interventions encourages more comfortable engagement and therefore has a more positive impact on practice[37].

Simulation activity/intervention

Simulation activities or interventions will vary widely but, as indicated in the main guideline recommendations, should be clearly targeted towards specific learning outcomes. High-fidelity, and sometimes higher-cost, simulations can provide a realistic and immersive experience for students, but the current work reinforces the evidence to indicate that low-fidelity, lower-cost interventions, such as communication scenarios involving information giving, can also have a significant impact on skills acquisition and student confidence[39].

Feedback and debriefing

Debriefing is recognised as an essential component of healthcare simulation to aid the transformation of experience into learning through reflection and allow the learner to consider alternative approaches[40,41]. There is a range of approaches that can be used to facilitate this and practice varies widely[42]. One example in the literature is the Promoting Excellence and Reflective Learning in Simulation (PEARLS) blended framework[40]. This integrates three recognised educational strategies used during debriefing: learner self-assessment; facilitated focused discussion; and providing information through directive feedback and/or teaching. This particular framework incorporates scripted language to guide the debrief, depending on the specific approach, to support those healthcare educators who are new to simulation debriefing. Although the framework provides structure, it is easily adapted to fit a variety of simulation-based education scenarios, including clinical decision-making, technical skills, teamwork and interprofessional learning[40].

Reflection

There is a range of models that can be adopted to facilitate reflection post-simulation. The key elements ensure that the student has an opportunity to work through the experience. Kim's critical reflective inquiry (CRI) model refers to three stages: descriptive; reflective; and critical[41]. The descriptive stage asks the students to talk about what happened in the simulation and how this aligned with or deviated from their expectations and to consider what the key moments were. In the reflective phase students are asked to think about how they felt, what influenced their decisions during the intervention and what went well or not so well. This phase helps students to develop self-awareness around knowledge gaps and individual beliefs that may have influenced decision-making. The critical phase offers an opportunity for reflection on insights gained that can be taken forward into clinical practice[41].

Evaluation

The evidence base around the use of simulation in AHP education is continually expanding as provision grows and new resources are developed. However, much of the current evidence base related to simulation in therapeutic radiography education relies heavily on data from student self-assessment of perceived learning and confidence levels[39]. There is a need for ongoing qualitative and quantitative research to supplement this, and collaboration across institutions is encouraged to promote sharing of practice and wider dissemination.

Evaluation is also key to revising and updating simulations[37]. Improvements can often be identified after the initial pilot of an intervention, so that future iterations can be appropriately amended and updated[37].

Dissemination of these evaluations will afford greater opportunities for colleagues across institutions to learn from each other in what is a continually evolving field[37].

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