

Evaluating the Impact of Dedicated Simulation Days on the Confidence of First-Year Diagnostic Radiography Students

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ABSTRACT

Introduction: From the use of phantoms to positioning software, simulation-based education (SBE) has become an integral part of radiography education. Evidence suggests that simulation is not only preferred by students but can substantially increase their clinical confidence¹. This study aims to explore student's confidence levels after undertaking a range of simulation-based activities.

Methods: First year diagnostic radiography students attended three dedicated simulation days prior to their first clinical placement block. The students were asked to complete a survey before and after their simulation days. This contained both qualitative and quantitative questions aimed at understanding the student's confidence level regarding clinical practice.

Results: A 13% response rate was obtained for the initial questionnaire. Clinical concerns included lack of experience, understanding radiation dose, and image evaluation. The second questionnaire showed increased confidence when communicating with patients, using the equipment and understanding how to apply radiation protection principles. An area that remained a concern was the positioning technique for some more complex examinations.

Conclusion: Results indicate an increase in reported confidence, with students able to give examples of specific areas where simulation had a significant impact, and where they perceived their abilities to be much improved. There were some lingering concerns regarding radiographic positioning of certain body parts, which could be due to the time limitations of the simulation sessions. Overall, the simulation days successfully increased student confidence prior to their first weeks of clinical placement.

Implications for practice: The inclusion of dedicated simulation time should be considered for all undergraduate diagnostic radiography programs to improve student confidence levels and increase their ability to link theory to practice.

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Introduction

Simulation-based Education (SBE) has become an established pedagogical approach that benefits undergraduate students in healthcare programs. There has been a large increase in SBE in the last two decades², and more recently the COVID-19 pandemic saw a rapid uptake globally, as educators sought ways to teach in a risk-free environment^{3,4}.

SBE is now commonly used in both pre- and post- registration education⁵, and in radiography it encompasses procedural skills,

image interpretation, communication, teamwork, and clinical decision making⁶.

The use of SBE in radiography education has been shown to increase students' radiographic knowledge and improve confidence levels in their clinical skills. A range of clinical skills are vital for radiographers, and by practicing these ahead of time, students can enter the workplace with enhanced confidence in their abilities. This has been shown to improve learning potential, with low confidence being cited by students as an obstacle to knowledge retention⁷.

First-year radiography students are exposed to many new experiences whilst on clinical placement and will encounter scenarios that are unfamiliar and stressful. SBE allows for a risk-free environment where students can prepare emotionally for what they may encounter⁸. In a study by Partner et al. (2022), a simulation week was perceived by students as highly useful in reducing

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feelings of anxiety and increasing their communication skills⁹. Students believed that this simulation was valuable enough to replace placement. This is disputed by some radiographers, as they reported that students who had undertaken SBE still require the same expected level of assistance in examinations, despite a noticed increase in clinical confidence¹⁰.

Simulation can be defined as a technique that creates a situation or environment that allows students to experience a representation of a real event¹¹. This can be applied to a spectrum of regularly used teaching activities, such as role-play or the use of anatomical models for practice². Advancements in technology are also changing the way simulation is viewed, with computer-based systems now widely implemented, and virtual reality (VR) becoming more common practice¹². However, it is apparent that students express higher confidence levels after undertaking more realistic scenarios¹.

The benefits of using more realistic scenarios are widely understood, however equipment costs, skilled educators, and time are all required, and these can easily become barriers to implementation. Despite improvements, such as decreasing costs and increasing educators' skills, simulation must still demonstrate its validity to prove its value¹².

Method

The aim of this study was to assess the effectiveness of three dedicated simulation-based learning days on the confidence of first-year diagnostic radiography students, prior to their first clinical placement. A confidence baseline was measured via survey and then a second survey was issued after the third full day of simulation. This looked to determine if these simulation days resulted in an increase in self-reported confidence levels. Finally, the students' perceptions of the simulation experience were explored to gain insight into their perceived value and how the sessions might be improved.

Research study design

Quantitative and qualitative methods were selected for this study to ensure that a comprehensive understanding of the students self-reported confidence levels could be achieved¹³. The JISC survey platform was used due to the simplicity of deployment and the palatability for respondents¹⁴. Likert style questions were asked to generate quantitative responses, with an additional section allowing free text answers (Appendix C).

First-year undergraduate diagnostic radiography students were asked if they had attended any lab-sessions in the pre-simulation questionnaire. These are one-hour sessions that are already part of the curriculum, where students practice positioning each other for x-rays, and setting up the x-ray tube for exposure. It was important to understand the level of experience the students already held with the x-ray equipment.

The students participated in three dedicated simulation days, held at 3-4 week intervals, prior to their first clinical placement. These were timetabled as 'Simulation Week' and no other teaching was booked during this week. Each student attended four 90-minute sessions, totalling six hours of simulation per day. Sessions were designed to align with the Association for Simulated Practice in Healthcare (ASPiH) standards for simulation-based practice in health¹⁵ and the national toolkit to support the use of simulation in healthcare provided by Health Education England (HEE)¹⁶. Content was also planned to be cohesive with the student's module content, and all participating educators were appraised of the importance of preparation, briefing, activity and debriefing, and reflection. Whilst staff intensive, this was deemed

worthwhile to assist the students' clinical preparation and was supported by clinical stakeholders. An overview of the content can be found in Appendix A.

Data collection

The survey was deployed a week prior to the students first simulation session, then the subsequent survey was distributed after they had completed their three simulation days.

This was done via the student learning management system (LMS), ensuring all students received the survey at the same time. The students had a two-week time frame to complete the survey.

Data analysis

Two analytical methods are required for the survey analysis. Descriptive statistics were used to understand the quantitative answers. This allowed for simple, direct comparison of the Likert scale questions from before and after their simulation days¹⁷. For the open questions thematic analysis was used to establish patterns or themes to the participant responses¹³. Themes were extracted by experienced researchers and the use of direct participant quotes added authenticity to reporting and discussion¹⁸.

Ethics

Subjects received a participation information sheet prior to completing the survey outlining the study and their anonymity. Students provided their consent for their anonymised information to be utilised for this research. Local ethical approval for the study was obtained. Reminders were sent to improve response rate.

Results

The aim of the questionnaires was to provide the study with data that would assess student confidence in various areas of practice (see Appendix B).

Pre-simulation Questionnaire

The response rate for the first survey given prior to any simulation was 13% (n=14). A single participant reported having not attended any lab sessions, whereas 9 of the 14 stated that they had attended some one-hour lab sessions prior to undertaking this survey.

Quantitative data

Most of the participants reported feeling confident in their abilities to position patients, however three (23%) responded to the contrary. Six (43%) of the respondents felt that they were not yet comfortable operating radiographic equipment. There was a slight majority of eight respondents (57%) that felt they could accurately identify anatomical landmarks on radiographs.

Respondents indicated they were confident in ensuring patient safety during radiographic procedure, only three participants (21%) were less confident in this area.

None of the respondents felt that they had difficulty with communication skills with patients or the wider healthcare team.

Post-simulation Questionnaire

The second questionnaire received a lower response rate of just eight participants. Overall, seven of the eight (88%) respondents

felt that simulation had improved their confidence in radiographic practice, and 100% stated that they felt prepared for clinical placement after their simulation days. All participants noted that they had also attended seven or more one-hour lab-based sessions between simulation days. There was an increase of self-reported confidence in all areas, as seen in figure 1.

Qualitative Data

Thematic analysis was used to identify common elements within the free-text answers. Table 1. shows the themes described within this qualitative data, and the frequency of mentions.

Pre-simulation group

Challenges

Specific challenges were mentioned by 13 of the 14 participants. The most common was being able to link theory to practice, with students frequently stating concerns regarding retaining all knowledge learnt in the classroom. Dose optimisation and reduction was also mentioned regularly, with one student noting that *“One of the most challenging aspects of radiographic practice is ensuring optimal image quality while minimizing patient exposure to radiation”*.

Areas of Confidence

The areas that were reported the most can be summarised by one participant’s comment: *“Positioning the patients and use of the equipment are the areas of radiographic practice I feel most confident in”*. In total, six participants agreed that patient positioning was something they felt confident in, and four noted that they felt comfortable moving and handling radiographic equipment. Communication and knowledge of bony anatomy were other areas students reported feeling confident in.

Further training

Seven students reported that they still wanted more training regarding patient positioning, with one student writing that they wanted *“More lab sessions on positioning”*. This was accompanied in

many cases by a request for training on image evaluation, one participant highlighted this; *“Gaining additional experience in recognising subtle abnormalities and improving my diagnostic accuracy would help boost my confidence in providing more precise and reliable evaluations.”*

Post simulation group

Areas of improvement

Most participants self-reported that after the simulation days their confidence had improved when positioning patients and using equipment, stating that they were more *“familiar with the basic positioning and the use of equipment [sic] with radiation protection in place”*. There was some recognition that students felt more confident in their communication skills, and that it had even improved their understanding of anatomy.

Areas of lower confidence

Students felt that they required more training in patient positioning (mentioned four times), and often this was mentioned regarding a specific anatomical area of concern. For example, one student stated that they would like *“More training in the positioning of the hips”*. There were several responses alluding to lower confidence in patient communication skills, one student noted *“During placements, we work with real patients, each with unique clinical conditions, so improving my interaction and communication skills is essential to handle these situations effectively”*.

Discussion

By comparing the pre- and post-simulation surveys, this study has demonstrated that dedicated simulation days improved student confidence in several areas of practice, from 3% to 43%. This aligns with the trend in radiography education which is focussing more on learning by experience⁴. Previous studies had demonstrated the benefits of low-realism simulation⁷, and the benefits of a single simulation week⁹, however this study asserts that in addition, dedicated time for more realistic scenarios throughout

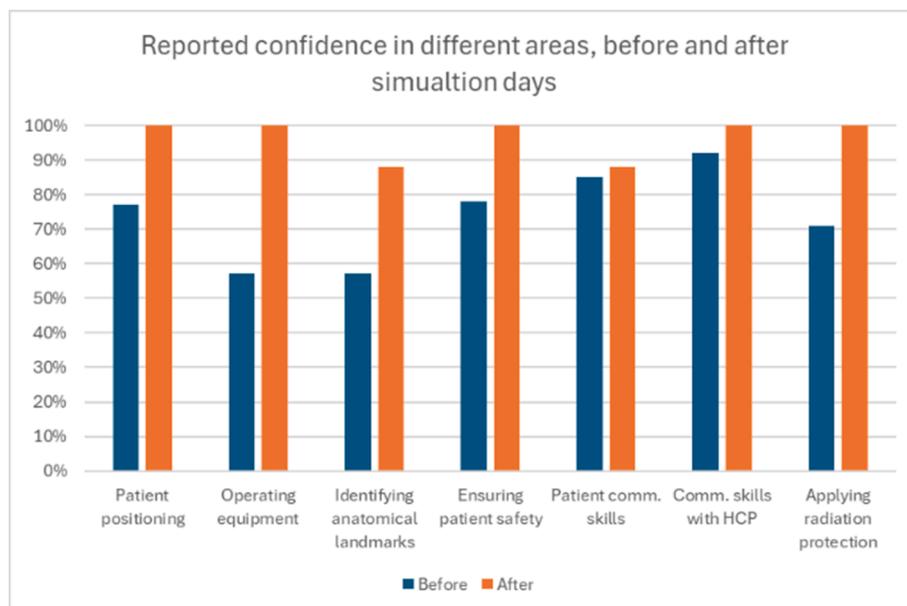


Fig.1. This graph shows the difference in reported confidence levels from before and after simulation days.

Table 1

Theme	Sub-theme	Number of mentions
Pre-simulation Challenges	Theory to Practice	6
	Dose optimisation and reduction	3
	Image evaluation	2
	Positioning patients	2
	Communication	1
	Handling equipment	1
	Modalities	1
Area's students felt confident	Patient positioning	6
	Knowledge of equipment	4
	Communication	3
	Bony Anatomy	2
	Safety measures	1
Areas that students wanted more training	Positioning	7
	Image evaluation	3
	Handling equipment	2
	Anatomical terminology	1
	Communication	1
	Critical thinking	1
Post-simulation Areas of perceived improvement	Patient positioning	3
	Using equipment	3
	Communication	1
	Identifying anatomy	1
	Radiation protection	1
Areas still requiring support	Patient positioning	4
	Specific examinations	3
	Patient communication	2
	Image processing	1

Table 1. shows the number of times each theme was mentioned within the qualitative data.

an academic block can have a real impact on students' clinical confidence.

The pre-simulation quantitative data reveals an already high confidence level in the participants. Several reasons for this present themselves. Firstly, many respondents had already attended several 'lab sessions', which contain some simulation as the students practice their positioning on each other, and use software (MedSpaceVR) to position a virtual patient. This is backed up by one student "With all the lab sessions till date and the amount of help the lecturers are willing to provide and also the additional use of virtual technology i.e. medspaceVR, I have been able to learn". This, combined with the students lack of placement experience, could have contributed to an inflated sense of confidence. It may also indicate bias in the sample group. Age and previous work experience were not explicitly queried, however one of the respondents stated, "I feel most comfortable with talking with patients, as I have years of experience working with patients", indicating that this participant might have been a mature student.

The data supports previous literature in finding that simulation increases the student's self-perceived readiness⁹. The quantitative data provides evidence for this, with 100% of students responding that they either agreed or strongly agreed that simulations prepared them for clinical placement. By familiarising students with the concepts of workflow, communication strategies, and professional responsibilities, the transition from classroom to a real-world setting is improved.

Students reported the least improvement in their patient communication skills. Effective communication is a key component of patient focused care⁵, and the huge scope of patient facing scenarios can daunt students. Despite the quantitative results showing minimal improvement, the students reported in open questions that they felt that their communication skills were overall improved. One student noted that "The role play train [sic] me to communicate with patients". The main barrier to confidence in this area was a fear of the unknown. One student felt that the

simulation was not sufficient to gain practice when it came to patient communication, noting that they will "work with real patients, each with unique clinical conditions". Partner et al. (2022) shows students having similar concerns; however, these concerns diminished as the simulation progressed. When asked in the post-simulation survey where they require more training, 33% of participants mentioned communication with patients. This might indicate the need for longer simulation sessions practicing the various facets of patient communication, with more varied scenarios. Another potential barrier to improving these skills may be that no real patients or members of the wider healthcare team were involved. Therefore, the students were unable to gain sufficient practice of their communication in these areas, leading to their conclusion of minimally improved confidence.

The role of memory comes up as a common theme throughout the qualitative data. The students expressed a fear of not being able to remember their classroom learning or being able to apply it to real life scenarios. Simulation aims to improve the confidence students have but also helps to solidify some of the didactic teaching. Studies have previously found that test answers improved after a simulation intervention⁷. This is demonstrated by the responses regarding locating anatomical landmarks. Prior to simulation, only 43% of participants agreed that they could identify radiographic landmarks, after the intervention this increased to 63%. Despite this substantial increase, students still voiced concerns regarding specific projections, with a third of respondents mentioning hip projections in their open responses.

77% of students reported feeling overall confidence with their ability to position patients prior to simulation. After simulation, this rose to 100%. This is surprising when comparing this to the qualitative data, 50% of the students mention an anatomical area that they would like more positional training in. This may reflect on the question being too broad. This could be rectified in the future by breaking down this question into anatomical constituents.

Mastering imaging of complex anatomical regions presents a persistent challenge. Students noted that they wanted more teaching on areas such as shoulders and hips, which highlights the need for more targeted practice in these areas. Although simulation can help with this, the time limitations, mean that it would be impossible to focus on all anatomical areas equally. This is addressed in the curriculum by the students' 'lab sessions', which focus on a different anatomical area each week.

The students had a strong focus on image evaluation, dose optimisation, and patient positioning before their simulation sessions. This may be due to their own understanding of their future chosen career, and what this entails. They picked up on the practical aspects that will be required for clinical placement and mention 'soft skills' much less. After simulation there is a higher awareness of the other aspects involved in being a radiographer, and the 'soft skills' such as communication are mentioned more.

Despite initial high confidence, the post-simulation survey does show a clear increase in overall confidence. Following the simulation days, 50% of the participants strongly agreed that they were confident operating radiographic equipment, compared to 14% in the pre-simulation survey. This reflects previous studies findings⁷ that simulated examinations allow practice and mastering of aligning the X-ray tube, without the pressures of time restraints and ensuring patient care. Students cited the hands-on experience as being integral to building confidence, with one reporting: *"During simulation week, we had the opportunity to position each other using an X-ray tube and operate X-ray equipment. This experience helped us become familiar with the process and prepared us for actual placements"*. It is also notable that when asked about radiation safety, there is an increase from 71 % agreeing or strongly agreeing, to 100 % of surveyed students feeling prepared to apply radiation protection measures. This reflects the effectiveness of these simulations in embedding safety behaviours; critical when working with ionising radiation.

Limitations

This study aims to contribute to the understanding of a simulation's role in radiography education. However, there are some limitations to consider. Firstly, this study was conducted in a single institution, with a modest sample size (n=14 pre, n=8 post). This will limit the generalizability of the results. Secondly, there is a strong possibility of self-report bias, which has caused inflated initial confidence levels. Finally, the curriculum also played a role in limiting what was possible to include within the simulation sessions and limited the length of time available for the sessions.

Conclusion

These findings add to the growing evidence base for the use of simulation in radiography education. These simulation days were found to be particularly helpful in several areas. The improvement

in confidence mirrors previous research, however it is hard to distinguish if the spread of dedicated days were an improvement on Partner et al. (2022)'s single simulation week. There were some discrepancies around communication skills, which suggests additional communication sessions would be beneficial. As virtual reality and artificial intelligence advance², the options available for simulation increase in scope and number, however it is important to keep patient care as the primary focus of the simulation activities, a factor that was articulated by many of the students. Further research into knowledge retainment, post simulation sessions, could help guide the curriculum for future iterations.

Ethics approval and consent to participate

Ethical approval for this study was obtained from the Health, Science, Engineering and Technology Ethics Committee with Delegated Authority (ECDA) (Protocol number HSK/SF/UH/05789).

Students received a participation information sheet prior to completing the survey outlining the study and their assured anonymity. They indicated on the survey that this information was understood and gave consent for their anonymised information to be utilised for this research.

Availability of Data

Data required for this study may be made available by the authors upon reasonable request.

Author contributions

SS: Conceptualisation, Formal Analysis, Investigation, Writing – Original Draft, Project Administration

GLJ: Methodology, Validation, Writing – Original Draft

JG: Validation, Writing – Review & Editing

PX: Formal Analysis, Writing – Review & Editing

Generative AI use

Not applicable

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Conflicts of interest statement

The authors declare that they have no competing interests.

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Appendix A

Simulation Activities

Week 1

Week 2

Week 3

Type of simulation	Aim	Content
PC-based	To evaluate X-ray images of the upper limb	Students were asked to work in pairs as if they were the radiographer, evaluating X-ray images that showed an array of different pathologies.
Lab-based	To explore the radiation protection regulations within a radiography lab	Scenario based application of radiation protection requirements
Role-play	To enhance some basic communication skills	Students role-played taking phone calls from patients and colleagues and practiced sending a return email.
Role-play	To understand the professional behaviours expected	Students role-played through how they would greet and initiate an examination with a patient. Afterwards, there was discussion on professional behaviours that included how to appropriately use social media.

Type of simulation	Aim	Content
PC-based	To evaluate X-ray images of the lower limb	Students were asked to work in pairs as if they were the radiographer, evaluating X-ray images that showed an array of different pathologies.
Lab-based	To simulate adaption of radiographic technique	Students worked as the radiographer, positioning a patient with a splinted limb and talking through their decisions with regard to exposure settings.
Role-play	To enhance patient care skills	Considerations for imaging patients with diverse needs – roleplay using equipment such as vision impairment goggles, bariatric and geriatric simulation suits.
Scenario	To understand how radiographers triage patients	Students worked in pairs to look through a set of image requests and put them in a working order. This was followed by some discussion on why they chose this order.

Type of simulation	Aim	Content
PC-based	To evaluate X-ray images of the appendicular skeleton	Students were asked to work in pairs as if they were the radiographer, evaluating X-ray images that showed an array of different pathologies.
Lab-based	To simulate the use of in-bucky exposures	Students acted as the radiographer in preparing a phantom for an examination that requires the bucky. They then discussed the use of various settings, and the use of automated exposure devices. Images taken with phantom intentionally positioned incorrectly in relation to the AED.
Scenarios	To understand how consent is applied in different situations within the radiography department	Groups of students were provided with scenarios and were asked to discuss what consent issues they might encounter and how that would impact how they gain consent.
Role-play	To understand the methods of patient identification in complex situations	Students acted as the radiographer and were instructed to go through ID checks with a range of role-played patients (increasing in complexity).

Appendix B

Initial Questionnaire Quantitative results

	Strongly Agree	Agree	Neither agree or disagree	Disagree	Strongly disagree	Total no. of responses
1 I feel confident in my ability to position patients correctly for radiographic procedures	1 (8 %)	9 (69 %)	2 (15 %)	1 (8 %)	0 (0 %)	13
2 I am comfortable operating radiographic equipment	2 (14 %)	6 (43 %)	5 (36 %)	1 (7 %)	0 (0 %)	14
3 I can accurately identify anatomical landmarks on radiographs	2 (14 %)	6 (43 %)	4 (29 %)	2 (14 %)	0 (0 %)	14
4 I feel confident in ensuring patient safety during radiographic procedures	3 (21 %)	8 (57 %)	2 (14 %)	1 (7 %)	0 (0 %)	14
5 I am confident in my communication skills when interacting with patients	3 (21 %)	9 (64 %)	2 (14 %)	0 (0 %)	0 (0 %)	14
6 I can effectively communicate with other healthcare professionals	3 (21 %)	10 (71 %)	1 (7 %)	0 (0 %)	0 (0 %)	14
7 I feel prepared to apply radiation protection measures for patients and staff	1 (7 %)	9 (64 %)	3 (21 %)	1 (7 %)	0 (0 %)	14

Second Questionnaire Quantitative results

	Strongly Agree	Agree	Neither Agree or disagree	Disagree	Strongly disagree	Total no. of responses
1 I feel confident in my ability to position patients correctly for radiographic procedures	1 (13 %)	7 (88 %)	0 (0 %)	0 (0 %)	0 (0 %)	8
2 I am comfortable operating radiographic equipment	4 (50 %)	4 (50 %)	0 (0 %)	0 (0 %)	0 (0 %)	8
3 I can accurately identify anatomical landmarks on radiographs	2 (25 %)	5 (63 %)	1 (13 %)	0 (0 %)	0 (0 %)	8
4 I feel confident in ensuring patient safety during radiographic procedures	5 (63 %)	3 (38 %)	0 (0 %)	0 (0 %)	0 (0 %)	8
5 I am confident in my communication skills when interacting with patients	2 (25 %)	5 (63 %)	1 (13 %)	0 (0 %)	0 (0 %)	8
6 I can effectively communicate with other healthcare professionals	5 (63 %)	3 (38 %)	0 (0 %)	0 (0 %)	0 (0 %)	8
7 I feel prepared to apply radiation protection measures for patients and staff	4 (50 %)	4 (50 %)	0 (0 %)	0 (0 %)	0 (0 %)	8
Additional post-simulation questions						
8 I feel that simulation improved my confidence in radiographic practices	2 (25 %)	5 (63 %)	1 (13 %)	0 (0 %)	0 (0 %)	8
9 I feel that simulation prepared me for clinical placement	2 (25 %)	6 (75 %)	0 (0 %)	0 (0 %)	0 (0 %)	8

Appendix C

Qualitative Questions

Initial Questionnaire Qualitative Questions

10. What aspect of radiographic practice do you find most challenging, and why?

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11. What areas of radiographic practice do you feel most confident in, and why?

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12. In what areas do you feel that you need more training or support to improve your confidence?

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13. Any additional comments:

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Second Questionnaire Qualitative Questions



14. How did the simulation weeks impact your confidence in clinical skills? Please provide examples.

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15. In what areas do you feel that you need more training or support to improve your confidence?

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16. Any additional comments:

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