Radiography xxx (xxxx) xxx

Contents lists available at ScienceDirect

Radiography

journal homepage: www.elsevier.com/locate/radi

The impact of teaching experimental research on-line: Research-informed teaching and COVID-19

R. Higgins*, F. Murphy, P. Hogg

School of Health and Society, University of Salford, Salford, M5 4WT, United Kingdom

ARTICLE INFO

Article history:
Received 14 August 2020
Received in revised form
26 October 2020
Accepted 16 November 2020
Available online xxx

Keywords:
Online learning
Collaborative enquiry-based learning
Research-informed teaching experience
Task-value
Self-efficacy

ABSTRACT

Introduction: As part of the BSc (Hons) Diagnostic Radiography programme students learn and undertake research relevant to their development as first post radiographers (dose optimisation and image quality) within the Research-Informed Teaching experience (RiTe). Due to the COVID-19 pandemic, the delivery of RiTe to our year 2 students was moved to an online format using Microsoft Teams and Blackboard Collaborate and focused on a key area of current practice - COVID-19 and chest X-ray imaging. Within RiTe students are placed into collaborative enquiry-based learning (CEBL) groups to share tasks, but to also support and learn from one another.

Methods: An online survey was used to explore the year 2 student cohort task value and self-efficacy of this online version of RiTe.

Results: A 73% (32/44) response rate was achieved. Students found the online version of RiTe to be a positive learning and development experience. There was strong agreement that they not only found it relevant to their area of practice (task-value), but also strongly agreed that they understood and could master the skills taught (self-efficacy).

Conclusion: This online version of RiTe was effectively structured to help scaffold student learning and development of research data analysis skills despite the lack of face-to-face teaching. The students also valued the topic area (COVID-19 and chest X-ray imaging). A blended learning approach with RiTe will be used next year with a combination of collaborative online teaching and physical data collection and analysis in the university-based X-ray imaging laboratory. Further evaluation and data collection will also be undertaken.

Implications for practice: University-based empirical work in groups to learn about research can be replaced by an online mechanism whilst still maintaining task-value and acceptable self-efficacy.

Introduction and background

The Research-informed Teaching experience (RiTe) was developed in 2009 and integrates research and teaching within the Bachelor of Science Honours (BSc Hons) Diagnostic Radiography curriculum at a North West England Region University. RiTe was developed to help create a greater comprehension and appreciation of research at undergraduate level and to facilitate student understanding of key radiographic concepts and research methods using a Research-informed Teaching (RiT) model.[1–6] Within RiTe, students learn and undertake research relevant to their development as first post radiographers focusing on dose optimisation and image quality in collaborative-enquiry based learning (CEBL) groups which is commensurate with the Framework for Higher Education Qualifications of UK Degree-Awarding Bodies (FHEQ) level descriptors for years 1 (level 4) and 2 (level 5) set by the Quality Assurance Agency for Higher Education (QAA).[5]

Linking theory with practice, RiTe is delivered over a one-week period, and students learn to work interdependently via CEBL and explore the relationship between image quality and radiation dose optimisation to aid their practice-based learning and understanding of these key radiographic concepts. Each student works as a member of a CEBL group and this is facilitated by on-site lectures, staff supervision and by the students undertaking their own data collection using phantoms and analysis of their data in a university-based X-ray imaging laboratory.

* Corresponding author.
E-mail address: r.n.higgins@salford.ac.uk (R. Higgins).
(R. Higgins)

https://doi.org/10.1016/j.radi.2020.11.014
1078-8174/

Our year 2 student cohort were due to attend for RiTe in May/June 2020 as part of a module, but the ongoing COVID-19 pandemic meant that this was no longer possible, and RiTe would need to be delivered online. This presented the academic team with a significant challenge in adapting RiTe to this new format so that it still met the required student learning outcomes.

Moving the research-informed teaching experience (RiTe) online

The planned face-to-face delivery and development of student research skills with RiTe had to be altered to an online format. Students were allocated into four groups consisting of approximately 12 students per group. Each group was then further subdivided into 2 CEBL groups with 6 students in each group. Each CEBL group participated with RiTe for 1 week during May and June 2020. All CEBL groups were provided with a research scenario that required them to research and then provide advice on setting mobile x-ray unit exposure factors for performing chest x-rays (CXRs) on patients with COVID-19 in an Intensive Care Unit (ICU) setting. The exposure factors needed to have a high probability of giving a diagnostically acceptable CXR image to assess for COVID-19 along with a dose as low as reasonably practicable (ALARP) with a minimal chance of needing a repeat. The students were also required to identify CXR exposure factors that could be used at various source to image distances (SIDs). A relevant published paper on chest radiography that focused on dose creep as well as some of the underlying experimental data used to create this paper was provided to support to their research.[7]

The assessment associated with this version of RiTe required each CEBL group to prepare, submit and present a 20-min online presentation using Microsoft PowerPoint (PPT) linked to the scenario plus an oral discussion. In addition, each CEBL group member was also required to produce a single PPT slide and discuss their contributions during the week. Clear direction on the content required for the PPT presentation was included on the assessment brief, for example including background information about COVID-19, the value of personal protective (PPE) equipment, the considerations of performing chest radiography in an ICU setting and the use of descriptive statistics to support their data analysis and discussion based on their research linked to the scenario.

Both Microsoft Teams and Blackboard Collaborate Ultra (Blackboard Inc) were used for the online delivery of RiTe. Microsoft Teams allowed both synchronous and asynchronous online discussions between students and tutors and file sharing. Blackboard Collaborate Ultra was used for the delivery of an overview of RiTe, a questions and answers (Q&A) session and for the online assessment. Students were provided with a timetable of scheduled activities for the week. Resources were also provided on Blackboard to support self-directed learning and included videos on relevant research methods and statistical analysis. Previously, the research methods and statistical analysis session would have been delivered as a lecture, but it was decided, as the students would have some existing knowledge of this based on their learning with RiTe in year 1, that a self-directed learning activity using existing videos from another module would be appropriate instead along with tutor support later in the week. Resources on COVID-19 and chest x-ray imaging were also provided and the students were given access to a new COVID-19 e-Learning platform for radiographers. This had been created in partnership between the International Society of Radiographers and Radiological Technologists, European Federation of Radiographer Societies and the UK e-Learning for Healthcare.[8] Online tutor support was provided throughout using Microsoft Teams and included ensuring students understood the tasks involved and providing tutor support for statistical data analysis and presentation.

In this paper we report on a student evaluation of this online version of RiTe. An online survey was used to collect the value component (task-value) and activity expectancy component (self-efficacy for learning and performance) by a year 2 student cohort following their experience with RiTe.

Task-value and self-efficacy in education

According to expectancy-value theory students' beliefs concerning the degree to which they are confident in accomplishing an academic task (self-efficacy) and the degree to which they believe that the academic task is worth pursuing (task-value) are two key components for understanding students' achievement behaviours and academic outcomes.[9,10] Our research has explored the student group learning experience and reactions towards RiTe and found that this is seen as a valuable and relevant learning experience by students.[1–6]

An important lever on engagement with learning is through student motivation or reaction towards a learning activity. If students do not value the task or do not expect success, they may adopt low level surface strategies that may suffice to pass exams or assignments but may not meet the requirements of the workplace.[11] Understanding and evaluating the undergraduate student experience of teaching and learning activities is essential in understanding student development, motivation and engagement with learning activities.[12,13] Student engagement is generally considered to be among the better predictors of learning - the more students' study or practice a subject, the more they tend to learn about it and influence their future behaviour.[14,15]

Method

Data was collected using an online survey that measured task-value and self-efficacy responses of a year 2 student cohort who had participated with this version of RiTe. Currently there is no reported validity or reliability data available for this survey, but the questions used in the survey had gone through a process of face and construct validity as well as piloting. Ethical approval for this study was granted (HSCR1819-035) prior to approaching students.

Instrument design

The survey was based on reviewed published literature[16–22] and the authors previous research findings[1–6] which helped to establish a theoretical framework from which to construct the task-value and self-efficacy questions. The creation phase included question item identification, generation and appropriateness. Face and construct validity were performed via a focus group (FG) which included a radiography academic involved with research and RiTe, and three academic staff from outside the diagnostic radiography programme (Schools of Nursing, Business and Psychology). These participants had the range of experience and knowledge necessary to assesses the survey items. A list of 20 question items, with 10 questions each for the activity value component (task-value) and activity expectancy component (self-efficacy for learning and performance) were generated. All FG participants contributed to the discussion and no questions were added or deleted to either construct domain in the survey. All participants agreed that respondents would be able to comprehend the questions in both constructs. Five participants took part with a piloting FG of the survey and consisted of a recently qualified radiographer who had undertaken RiTe as student and four third year student radiographers who had recently undertaken RiTe in years 1 and 2. No issues were raised following piloting.

Closed ended questions were used in the survey (apart from the general comments section at the end which was open ended only).

The closed ended questions used a six-point Likert scale, ranging from 1 strongly disagree to 6 strongly agree for each item, with four gradations between the two extremes. A Likert scale was used as it can measure qualitative qualities (e.g. attitudes, experience and opinions) and participant's responses to these in a numerical format.[23–25] A free-text open-ended further comments question at the end of the survey complemented the quantitative analysis by providing a further perspective of student experience of RiTe in its new online format.

Data collection, sampling and recruitment

The survey was distributed via an online survey (https://www.onlinesurveys.ac.uk) (see Fig. 1). A purposive sampling technique was used to collect data by administering the survey to the whole year 2 student cohort following each of the groups one-week attendance with RiTe and remained open for a further 3 weeks during which two e-mail reminders went sent out. Student participation was voluntary and good ethical practice for survey administration and analysis was followed, with consent assumed to be implied with completion of the survey. Students could withdraw at any time by exiting the survey. Any data arising from incomplete surveys was excluded from the results. Students were assured of confidentially and anonymity during and following the survey.

Results

Data was collected over 7-week period. Out of a year 2 cohort of 44 students, 32 student respondents completed the scale giving a response rate of 73%. A good response rate for an unsolicited online survey has been found to be 23%–47%.[26] There were no incomplete surveys.

Survey responses were converted into numerical scores by equating the responses with the corresponding scores. Scale items that had negative wording (e.g. “I lack confidence”, “I do not believe”) were reversed for scoring purposes so that all responses were unidirectional (i.e. a score of 6 reflected a high level of task-value or self-efficacy). Cronbach alpha coefficient was calculated to assess the internal reliability of the survey as this would indicate whether the survey items were consistent in measuring what they have been designed to capture. An acceptable reliability value has been suggested as 0.7 and above.[27] The Cronbach alpha coefficient for the survey items was found to be 0.942, indicating a very good level of internal reliability. Descriptive statistics are used to further analyse the data using aggregated results.

Construct domain 1: activity value component (task-value)

There was strong agreement by 68% of respondents to question 3 with 78% also strongly agreeing to question 10. Similarly, there was strong agreement by 78% of respondents to question 1. There was strong disagreement by 78% of respondents to question 2 and question 9 (72%) (see Fig. 2).

Therefore, despite RiTe being moved to an online format, students indicated that this did not negatively affect their learning experience. Key to this was the fact that the scenario and research undertaken was linked to COVID-19 and chest X-ray imaging which the students saw as relevant and helpful for placement:

All answers are given using a 6-point Likert scale using one of the descriptors: 1 = strongly disagree, 2= disagree, 3 =slightly disagree, 4 =slightly agree, 5= agree, 6= strongly agree.
Activity value component: Task value
1. I think I will be able to use what I have learnt with this research activity in other areas
2. I cannot see the benefit of research as part of my learning experience within the programme
3. I think the teaching and learning materials in this research activity are useful for me to learn
4. I do not believe research is essential for the future development of my profession
5. I do not believe it is important to encourage students to be involved with research
6. I expect to make use of research in my future career
7. I do not believe developing an understanding of research skills is important
8. I believe that it is important to be able to change practice based on research evidence
9. I do not believe working as a part of a group has helped with my learning and research skills development
10. I like the subject matter of this activity
Activity expectancy component: Self-efficacy for learning and performance
11. I am confident I understand the basic concepts taught in this activity
12. I lack confidence with my ability to think logically and solve problems
13. I try to work with other students to help with my learning and development (group working)
14. I would lack confidence if asked to apply my research skills
15. I expect to do well with the assessment in this activity
16. I lack confidence in my abilities to communicate findings to others
17. I am confident that I can master the skills taught
18. I am not confident in my ability to learn further research skills and apply these
19. I am convinced that as time goes by, having research skills will benefit me as part of my learning and professional development
20. I lack confidence in my ability to change practice based on research evidence
Any comments you wish to add?

Figure 1. RiTe survey with activity value component (task-value) and activity expectancy component (self-efficacy for learning and performance).

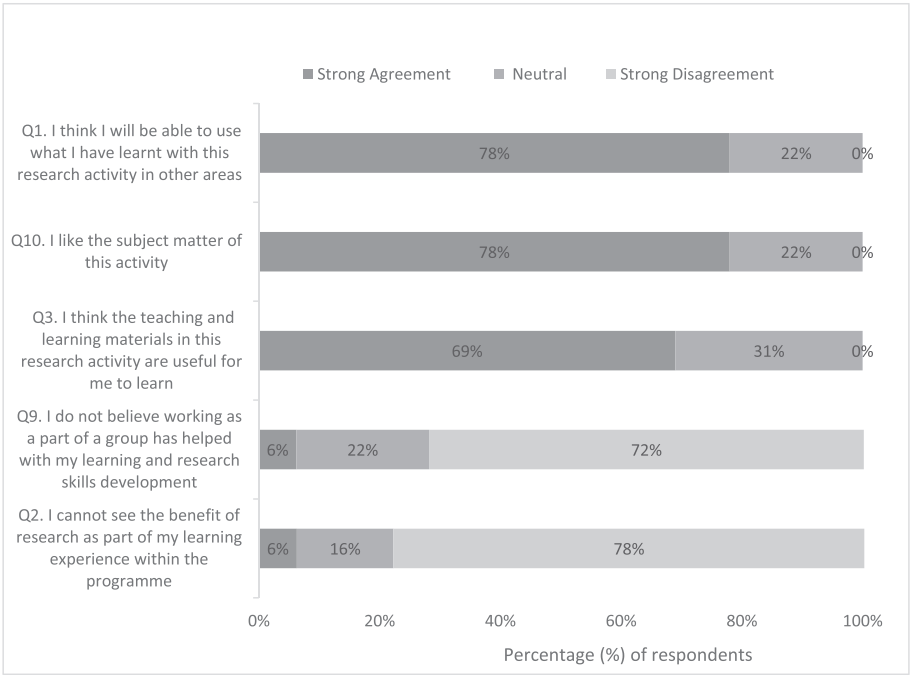

Figure 2. Aggregated stacked bar chart for student task-value having undertaken the online version of RiTe. (Note the last two items are intentionally negatively worded).

"*I enjoyed the scenario being on current situations as it was a developing topic and increasing my knowledge in COVID-19 has benefitted me for when I attend placement.*"

Respondents strongly disagreed (88%) to the question 5 and 91% of respondents also strongly disagreed to question 7. There was strong agreement to questions 8 (91%) and 6 (78%), whilst 91% of respondents strongly disagreed to question 4 (see Fig. 3).

Construct domain 2: activity expectancy component (self-efficacy for learning and performance)

There was strong agreement (91%) by respondents to questions 11 and 15 (91% and 84% respectively). 78% of respondents also strongly agreed to question 17 with 87% strongly disagreeing to questions question 18 and 14 (87% and 63% respectively) (see Fig. 4).

Respondents strongly disagreed (78%) to the question 12, whilst 69% strongly agreed to question 13. There was also strong disagreement by 75% of respondents to questions 16 and 20. Finally, 84% of respondents strongly agreed to question 19 (see Fig. 5).

Students found the use of online learning platforms to be a benefit rather than barrier to their learning and assessment:

"… Microsoft Teams experience enhanced my confidence in future online learning. The group communication has been much easier and we (as a group) worked really well together"

Interestingly some students commented that they preferred presenting online as a group rather than face-to-face:

"*Even though it was audio recorded I did not feel pressured as I did not have examiners staring at me, which made me more confident.*"

The use of both synchronous and asynchronous in the delivery of RiTe helped to create a community of learning by the students in their CEBL groups. Some students also preferred the online format as they could work on things at time that suited them best:

"*I also like the fact that this was done online as it's less time consuming as we are not travelling into the university. Microsoft Teams was very helpful and made communicating easier.*"

Analysis of the survey findings indicates that the students valued content topic and activities with this online version of RiTe. Students' motivational beliefs and emotions play a significant role in their academic achievement and engagement with learning activities and highlights the importance of including content or tasks that students see as being directly relevant to their learning which in turns motivates the learning process.[15] Similarly, students expressed a sense of high self-efficacy in demonstrating what they had learnt with the assessment process and applying this as part of their future behaviour in practice. Students with a sense of high self-efficacy are more likely to be motivated to succeed when faced with potential failure.[15,28,29] Individuals can develop self-efficacy beliefs in relation to set clear, specific and challenging goals.[30]

One of the most significant barriers to online learning identified by Muilenburg, & Berge[32] was a perceived lack of social interaction. This could be considered either student–student interaction, student–instructor interaction or "instructor presence". The use of CEBL groups helped students to share tasks, but also allowed them to support and learn from one another (student–student interaction). The use of online platforms such as Blackboard Collaborate Ultra and Microsoft Teams also helped to facilitate and encourage discussions, which gave the students the opportunity to ask questions and receive support (student–instructor interaction). These 'real-time' online sessions were found be effective and helped us as tutors to keep connected with the students and their progress with RiTe.

Anecdotally we found that all CEBL groups had good engagement with this version of RiTe and the level of content and discussions presented were of a high standard. All CEBL groups were successful in that they passed the summative assessment. However, this

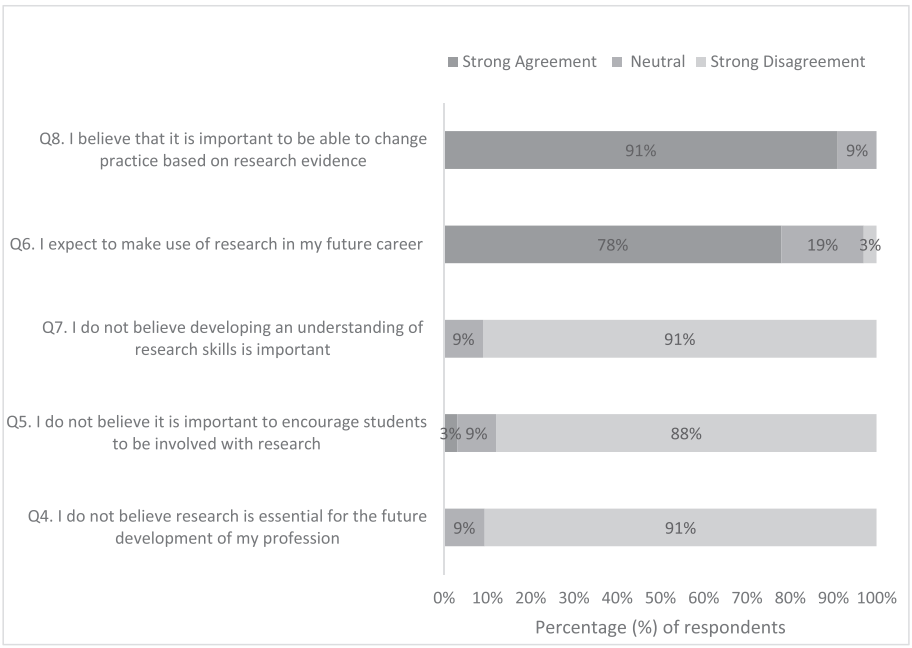

Figure 3. Aggregated stacked bar chart for student task-value having undertaken the online version of RiTe. (Note the last three items are intentionally negatively worded).

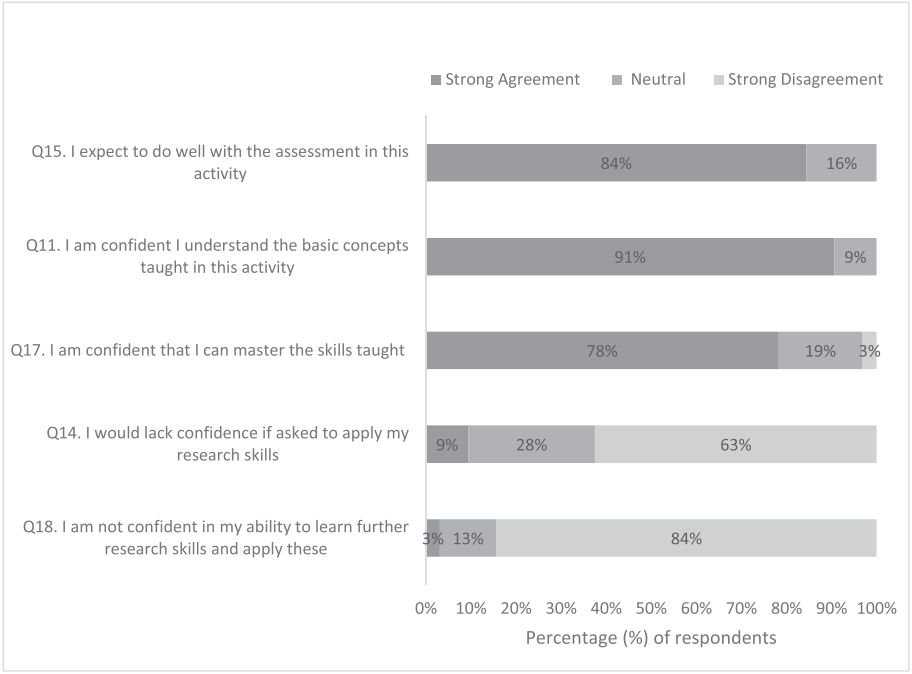

Figure 4. Aggregated stacked bar chart for student self-efficacy (learning and performance) having undertaken the online version of RiTe. (Note the last two items are intentionally negatively worded).

cannot be compared with previous iterations of RiTe in year 2 as the format and final assessment weighting were different.

Nonetheless from an educator's perspective there are potential barriers that exist in implementing this approach into educational practice. These including resistance to using technology, additional time required to acquire new skills to effectively interact with the technology, and the time taken to construct new content material.[33]

Further work

Currently no survey exists that measures self-efficacy or task value for research skills development within undergraduate Diagnostic Radiography programmes. The survey used in this paper demonstrated a high level of internal reliability (Cronbach Alpha 0.942), but further work is needed to validate its use. Further data is planned to be collected to fully validate this survey.

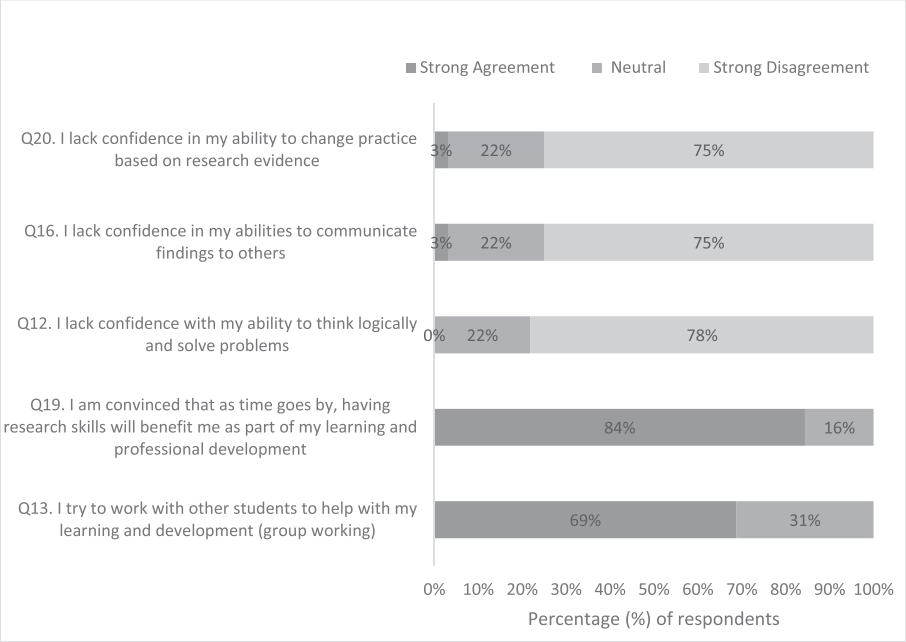

Figure 5. Aggregated stacked bar chart for student self-efficay (learning and performance) having undertaken the online version of RiTe. (Note the first three items are intentionally negatively worded).

Participant sample size is an important element in scale validation, because of the relationship to the number of random errors that arise; the impact of random error can be minimised using large sample sizes or power calculations to determine sample sizes. Reliability assessment, item and factor analysis (the statistics used for scale validation) require a minimum sample size and Spector[31] recommends a sample size of at least 100 participants. Despite a larger sample size being needed to provide more reliable results, the sample did meet the aims set out in evaluating this version of RiTe.

Conclusions

Based on survey findings, students valued both the task and content of this online version of RiTe. It was found to effectively scaffold student learning and development of research skills as well as being applicable to their practice with COVID-19 and chest x-ray imaging as well as well as facilitating student–student and student–instructor interaction.

Based on these initial findings it is planned to take to a blended learning approach with RiTe next year by using a combination of collaborative online teaching and learning supported by students performing and collecting data in the university's X-ray imaging laboratory. This approach to RiTe will then be further evaluated.

Given the current COVID-19 pandemic is continuing and there is no clear endpoint, this blended learning could also be taken forward into other areas on the programme, for example with clinical skills to include the delivery of a theoretical session and the opportunity to practice in social distanced simulation.

Conflict of interest statement

None.

References

1. Higgins R, Hogg P, Robinson L. Towards a research informed teaching experience within a diagnostic radiography curriculum: the level 4 (year 1) student holistic experience. *Radiography* 2013;**19**(1):62–6.
2. Higgins R, Hogg P, Robinson L. Integrating research-informed teaching within an undergraduate level 4 (year 1) diagnostic radiography curriculum: a pilot study'. *J Vocat Educ* 2013;**65**(3):351–68.
3. Higgins R, Robinson L, Hogg P. Developing undergraduate diagnostic student radiographers' research skills using research-informed-teaching. *Imaging and Therapy Practice* 2013:May 27–9.
4. Higgins R, Robinson L, Hogg P. Integrating research-informed teaching within an undergraduate diagnostic radiography curriculum: results from a level 4 (year 1) student cohort. *Radiography* 2014;**20**(2):100–6.
5. Higgins R, Hogg P, Robinson L. Constructive alignment of a research-informed teaching activity within an undergraduate diagnostic radiography curriculum: a reflection. *Radiography* 2017;**23**:S30–6.
6. Higgins R, Hogg P, Robinson L. Research informed teaching experience in diagnostic radiography: perspectives of academic tutors and clinical placement educators. *J Med Imag Radiat Sci* 2017;**48**(23):226–32.
7. Ma WK, Hogg P, Tootell A, Manning D, Thomas N, Kane T, et al. 'Anthropomorphic chest phantom imaging – the potential for dose creep in computed radiography'. *Radiography* 2013;**19**(3):207–11.
8. Hogg P, Holmes K, McNulty J, Newman D, Keene D, Beardmore C. Covid-19: free resources to support radiographers. *Radiography* 2020;**3**:189–91.
9. Eccles JS, Adler TF, , With the assistance of, Futterman R, Goff SB, Kaczala CM, Meece JL, et al. Expectancies, values and academic behaviors. In: Spence JT, editor. *Achievement and achievement motives*. San Francisco: W.H. Freeman; 1983. p75–146.
10. Wigfield A, Eccles JS. Expectancy-value theory of achievement motivation. *Contemp Educ Psychol* 2000;**25**:68. 8.
11. Biggs J. Teaching for better learning. *Leg Educ Rev* 1991;**2**(1):8.
12. Aziz S, Mahmood M, Rehman Z. Implementation of CIPP model for quality evaluation at school level: a case study. *Int J Educ Dev* 2018;**5**(1):189–206.
13. Krause K-L, Coates H. 'Students' engagement in first-year university'. *Assess Eval High Educ* 2008;**33**(5):493–505.
14. Brown SC, Stevens Jr RA, Troiano PF, Schneider MK. Exploring complex phenomena: grounded theory in student affairs research. *J Coll Student Dev* 2002; March/April;**43**(2):1–11.
15. Bandura A. *Self-efficacy: the exercise of control*. New York, NY: Freeman; 1997.
16. Imafuku R, Takuya S, Kawakami C, Suzuki Y. How do students' perceptions of research and approaches to learning change in undergraduate research? *Int J Med Educ* 2015;**6**:47–55.
17. Carini RM, Kuk GD, Klein SP. Student engagement and student learning: testing the Linkages. *Res High Educ* 2006;**47**(1):1–32.
18. Boswell SS. 'Undergraduates' perceived knowledge, self-efficacy and interest in social science research'. *J Effect Teach* 2013;**13**(2):48–57.
19. Earley MA. A synthesis of the literature on research methods education. *Teach High Educ* 2014;**19**(3):245–53.
20. Kitching JJ, Cassidy SF, Eachus P, Hogg P. Creating and validating self-efficacy scales for students. *Radiol Technol* 2011;**83**(1):10–9.
21. Pintrinch PR'A. Manual for the use of the motivated strategies for learning questionnaire (MSLQ)'. *National Center for Research to Improve Postsecondary*

Teaching and Learning (NCRIFFAL) and the School of Education at the University of Michigan 1991.
22. Schroderus-Salo T, Hirvonen L, Henner A, Ahonen S, Kaariainen M, Miettunen j, et al. Development and validation of a psychometric scale for assessing healthcare professionals' knowledge in radiation protection. *Radiography* 2019;**25**(2):136–42.
23. Rattray J, Jones MC. Essential elements of questionnaire design and development. *J Clin Nurs* 2005;**16**:234–43.
24. DeVon H, Block M, Moyle-Wrigth P, Ernst D, Hayden S, Lazzara D, et al. A psychometric toolbox for testing validity and reliability. *J Nurs Scholarsh* 2007;(39):155–64.
25. Drennan J. Cognitive interviewing: verbal data in the design and pretesting of questionnaires. *J Adv Nurs* 2003;**42**(1):57–63.
26. Nulty DD. The adequacy of response rates to online and paper surveys: what can be done? *Assess Eval High Educ* 2008;**3**:301–14.
27. Crocker L, Algina J. *Introduction to classical and modern test theory*. Belmont, CA: Wadsworth Group; 1996.
28. Rowbottom M, Schmitz GS. Development and validation of a student self-efficacy scale. *J Nurs Care* 2013;**2**:126. https://doi.org/10.4172/2167-1168.1000126. 2013.
29. Schunk DH. Self-efficacy and education and instruction. In: Maddux JE, editor. *Self-efficacy, adaption and adjustment: theory, research and application*. New York: NY: Plenum Press; 1995. p281–303.
30. Anthony R, Artino Jr AR. Academic self-efficacy: from educational theory to instructional practice. *Perspect Med Educ* 2012;**1**(2):76–85.
31. Spector P. *Summated rating scale construction: an introduction*. California: Sage Publications; 1992.
32. Muilenburg LY, Berge ZL. Student barriers to online learning: a factor analytic study. *Dist Educ* 2005;**26**(1):29–48.
33. John-Matthews J, Gibbs V, Messer S. Extending the role of technology enhanced learning within an undergraduate radiography programme. *Radiography* 2013;**19**(1):67–72.