Virtual Reality in Initial Teacher Education (VRITE): a reverse mentoring model of professional learning for learning leaders

Farrell, R., Cowan, P., Brown, M., Roulston, S., Taggart, S., Donlan, E., & Baldwin, M. (2022). Virtual Reality in Initial Teacher Education (VRITE): a reverse mentoring model of professional learning for learning leaders. *Irish Educational Studies*, *41*(1), 245-256. https://doi.org/10.1080/03323315.2021.2021102

Published in:
Irish Educational Studies

Publication Status:
Published (in print/issue): 22/02/2022

DOI:
10.1080/03323315.2021.2021102

Document Version
Author Accepted version

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Abstract

This small-scale design-based study describes a cyclical model of professional learning between three stakeholders in initial teacher education (ITE) namely: university-based educators (UEs), student teachers (STs) and co-operating teachers (CTs). This model promotes the development of digital learning leaders through an innovative mentoring process. This process started with university-based educators (UEs) mentoring their student teachers (STs) in the pedagogical use of Virtual Reality (VR) and the creation of re-usable learning objects (RLOs). STs were supported and encouraged to cascade this learning to their placement schools as digital learning leaders connecting the innovative practice from the university directly to their classroom practice. Through bi-directional reverse-mentoring the STs and CTs supported each other technically (with the VR) and pedagogical (through the links to the curriculum) to create additional subject-specific RLOs which the STs were able to demonstrate to the UEs on their return to university. Thus, providing the final link in the cycle of learning leaders across the triad of partners in ITE.

Introduction

During the past decade virtual reality (VR) has increasingly made inroads into education. However, much of its early use in schools was the non-immersive (computer-based) VR associated with virtual worlds such as Second Life, games or simulations. As smartphones became more pervasive, VR became more accessible via handheld devices using free apps such as Google Cardboard, Google Tour Creator and Google Expeditions, offering opportunities for young people to be creators of their own VR experiences. For many learners experiential learning using VR was motivating and engaging (Merchant *et al*., 2014) however small-scale studies have also revealed mixed effects with issues of user distraction from the intended learning outcomes due to the immersive experience emerging for some users (Bailey *et al*., 2016).

Despite the enthusiasm and associated benefits for VR as a tool for learning, Cooper & Thong (2019) also acknowledge “teacher self-efficacy, professional development opportunities, school leadership priorities, and the amount of access to VR in school” (p. 70) as potential inhibitors for the integration of technology into the classroom. Indeed, they state that “the implementation of virtual and mixed realities may be a considerable pedagogical shift for many in-service teachers” (*Ibid*., p. 70) making it all the more important to introduce these technologies in pre-service teacher education courses where support from university tutors can be provided. A second impacting factor on the use of VR in education relates to school policies on the use of linked VR devices (mobile phones) in the classroom combined with society's mixed perspectives on the role of VR as an acceptable tool for learning (Cooper & Thong, 2019, p. 71). As with any new technology, its acceptance and teachers' readiness to experiment lies at the heart of pedagogical innovations being adopted in the classroom.

Although there is a proliferation of research on the potential effectiveness of VR across a range of educational settings (Vaughan *et al*., 2016), little research exists on the island of Ireland examining how VR can support pedagogical innovation in Initial Teacher Education (ITE) programmes and in particular, what models of professional learning best support its implementation to all schools. This research study aimed to investigate the connections between university teacher educators, pre-service students and in-service teachers during a professional learning experience to create VR re-usable learning resources (RLOs) across a range of subjects. The focus of this paper is to discuss the emergent model of professional development for all the stakeholders involved.

Challenges to the use of VR in teacher education

According to McGarr (2020) "virtual simulations have many benefits in teacher education and their continued expansion into teacher education will likely continue" (p.167). Where teacher educators are 'early adopters' or even 'innovators' of technology (Rogers, 2003), the pre-service teacher will benefit. However it is widely acknowledged that not all pre-service course preparation addresses the issue of how to use technology effectively in the classroom (CEO Forum on Education and Technology, 2000) citing tutors' technological skills deficit and/or fear of technological problems (Eifler *et al.*, 2001), lack of access to new technologies or a mismatch between the tutor's own teaching philosophy and that of their institution (Dexter & Riedel, 2003) as reasons for the slow adoption of technology in the teaching profession. As Foulgar *et al.* (2013) assert "teacher educators must model appropriate technology integration strategies for teacher candidates in courses, so the candidates in turn can effectively teach with technology" as teacher educators acting as role models proved to be a significant influence on beginning teachers' readiness for the future embedding of digital technology in the classroom (Tondeur *et al.,* 2017). Readiness however does not guarantee action and so CTs in schools are also needed to mentor pre-service teachers in integrating technology in their subject teaching (Wetzel *et al*., 2017). Furthermore, both teacher educators at university level and experienced teachers in schools are needed to drive and embed innovative pedagogy in order to promote change agents or Learning Leaders (DENI, 2016) to share and lead innovative practice in the classroom.

Theoretical Framework

The cognitive apprenticeship model (Collins *et al*., 1988) focuses on cognitive and metacognitive skills and processes. The four dimensions of this model are context, methods, sequence, and sociology. The context refers to the application of the skills to a realistic problem (Figure 1) and in this case:

- modelling the use of VR in the classroom;
- methods are the coaching and mentoring by the expert (1-3);
- self-monitoring and correction by the novice (4-6);
- sequencing reflects the changing demands of the learning including complexity and diversity;
- sociology addresses the culture or community and the setting in which the expertise is situated.

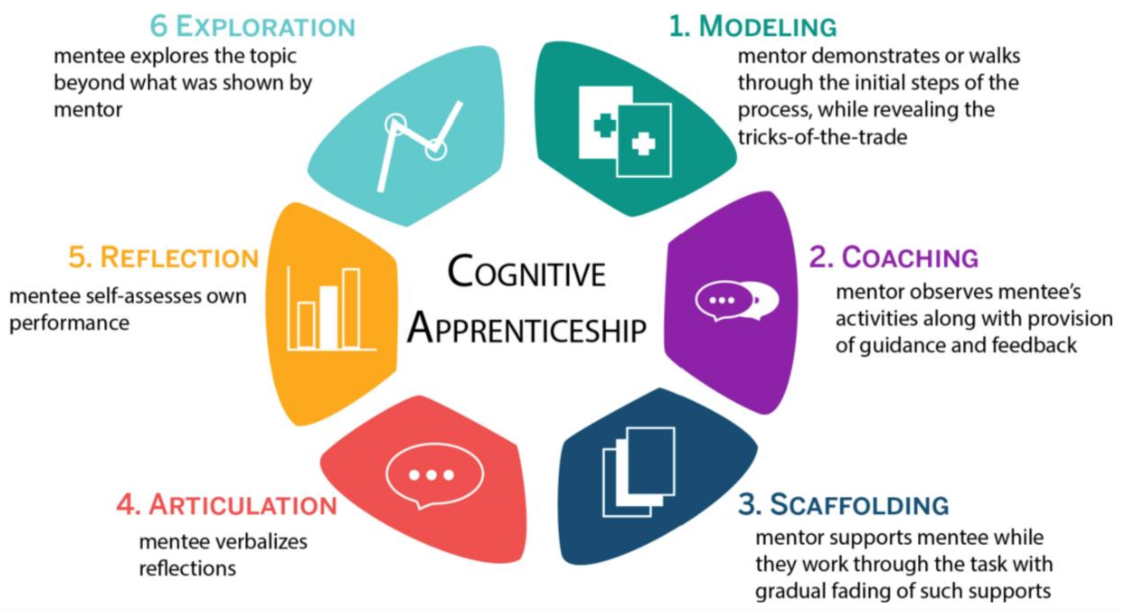

Figure 1: Source: Collins *et al*. (1988) Cognitive Apprenticeship Model .

Using this model ITE subject methods tutors who are adept in using VR for teaching and learning can highlight where VR is relevant to the learning process across a range of curricular areas. Student teachers, as apprentices, working alongside relevant ITE subject methods tutors may design and create their own VR RLOs enhanced by information hotspots, annotations, quizzes, sound, imagery and video. Student teachers who use innovative resources such as these during their school placement become more visible (Murphy, 2019) and are more likely to assume roles as "learning leaders" (DENI, 2016) in supporting schools to maximise the potential of technology enhanced learning. When STs learn new digital skills in the university setting, such as the use of VR technology, and transfer those skills to the school setting, they have the potential to topple the typical cooperating teacher/student teacher hierarchy (Farrell and Marshall, 2020; Farrell, 2021) and assume the role of "reverse mentor" (Zauchner-Studnicka, 2017). In so doing, while remaining the classroom teacher novice, they may emerge as the VR technology expert while their cooperating teacher may remain the pedagogy expert and VR technology novice. As a result, the cognitive apprenticeship model is bi-directional with the student teacher mentoring the experienced teacher's VR creation skills and the experienced teacher mentoring the student teachers' pedagogical skills to consider how to incorporate the VR immersive experience into the classroom most effectively. Through a dual process of demonstration and dialogic pedagogy, STs and CTs may support each other's professional learning both technically and pedagogically as required using a combination of cognitive apprenticeship and reverse-mentoring.

This approach to mutual learning is consistent with the notion of social constructivism whereby human development is socially situated and knowledge is constructed through interaction. This overarching theoretical framework is pertinent for investigating the collaborative and dynamic nature of professional learning relationships at the core of this study (Creswell & Creswell, 2018). Vygotsky suggests that people acquire new knowledge through interacting with a "more knowledgeable other" (Vygotsky, 1978, p. 86) working at or within their Zone of Proximal Development (ZPD). From this, Papert (1980) developed the concept of social constructionism asserting that learning comes from generating artifacts that are created through the social interactions of multiple stakeholders involved in a collaboration. As part of this designed-based research, student teachers collaborated with ITE subject methods tutors and CTs in the design, creation, implementation, review and improvement of a set of RLOs/artefacts of learning that modelled effective teaching and learning using VR. Illustrating how VR can be embedded into subject pedagogy with purpose and relevance and demonstrating the potential of VR technologies in supporting classroom learning across a range of subject areas and age groups is fundamental to a positive sense of usefulness and ease of use required for sustainable adoption of this innovative technology across the education system.

Methodology

This small-scale qualitative study draws on in-depth semi-structured interviews with a purposive sample of university-based teacher educators (n=20), co-operating teachers (n=20) and student teachers (n=20) across four ITE providers on the Island of Ireland, two each from north and south, and addressing the six post-primary subject areas of English, Languages, Mathematics, History, Geography and Science. A design-based (Brown, 1992) methodology was employed to evaluate the effectiveness of a collaborative cyclical approach to professional learning by university-based educators, co-operating teachers and student teachers using reverse-mentoring to connect the stages. Focus groups of 4-6 participants from each of these categories and connected to each institution allowed the data to be collected quickly, and more naturally than in individual interviews as participants reacted and built upon other group members' responses (Morgan, 1988).

Each interview lasted 30-45 minutes and was audio-recorded for transcription. To focus the participants' attention the broad definition that: **Virtual Reality** is *'a technology that immerses users in a completely virtual environment that is generated by a computer'* was provided at the outset followed by reflective questions related to the school situation including classroom management, resources, being a 'change agent', and subject-specific applications of VR now and in the future.

The same questions were used with co-operating teachers based on the subject-specific VR RLO. Co-operating teachers were also asked about their own feelings of readiness to adopt

VR in their teaching, their expectations of pupils' reactions to using VR for learning and not gaming purposes, departmental factors, and the level of support from the senior leadership team in school to facilitate VR in the classroom.

Interview data was initially coded according to participant type (see Table 1). For example, when referring to the code STN, the first two letters identify the participant as a student teacher [ST], and the third initial denotes if the ST is from the north [N] or south [S].

Table 1. Participant type and subjects

Participant	Code
University-based Educator - North	UEN
Student Teacher - North	STN
Cooperating/Experienced Teacher - North	CTN
University-based Educator - South	UES
Student Teacher - South	STS
Cooperating Teacher - South	CTS

Braun & Clarke's (2020) reflexive thematic analysis highlighted two main themes: VR as a catalyst for collaborative professional learning and secondly, VR as the vehicle for innovative pedagogy.

Findings

Theme 1: VR as a catalyst for collaborative professional learning

Faced with both opportunities and challenges when using VR as a teaching tool, the analysis of the focus group data revealed **VR as a catalyst for collaborative professional learning** when digital learning leaders existed amongst the triad of partners in ITE. As Dirin, Alamaki & Suomala, (2019, p. 100) note "adapting VR and AR applications to the educational context would require a special focus on technical support and ease of use." This requires expansive learning (Engeström, 2015) whereby industry specialists are co-opted into the training and development process as experts in areas such as maintaining the 'back-end' of the immersive

VR platform and providing the immersive 360-degree images and video clips.

> "You need support to know things like how to connect to WiFi and understand that you may need to connect to a router instead of school WiFi to effectively use VR programs." (STS)
>
> "Once I knew that the technical aspects were support by an expert, I felt more at ease about being involved in the use of VR in the classroom." (CTS)

Once the challenge of technical expertise has been addressed, the readiness to use the VR technology relies on the willingness and creative enthusiasm of the UE as indicated by the STs in this project:

> "On our ITE teacher training we are very privileged to have gained this training on VR. However, many other subject specialists do not have this training available to them" (STN).

Across the four ITE providers in this study, there was clear evidence that the first cycle of cognitive apprenticeship was effective as STs were ready and willing to use the VR experiences in the classroom, saying:

> "100% ready to use VR in the class and so are the pupils" (STS)
>
> "The first [training session] was very good for the exposure and understanding the VR technology, understanding its uses… when we got to apply it to our own subjects that definitely allowed me to feel very prepared and I felt like I could make something useful." (STN)
>
> "They would be willing to incorporate and introduce new experiences into the subject." (UES)

However when it came to cascading their VR training to teachers in their placement schools, there was awareness that the STs could be faced with a less positive response in placement schools: "Some schools are reluctant to get involved with modern technologies which hinders the growth in popularity of VR" (STS) and "Some senior subject departments may have a negative outlook towards innovative technology which they have yet to experience" (CTS). Reasons cited include VR is time-consuming in an already busy curriculum, too much bother booking the resources, not inclusive especially for pupils with SEN and the school's mobile phone policy.

From the ST's perspective, the dismissal of the idea of using VR in the classroom and lack of support from the Head of Department (HOD) was disheartening:

> "As soon as I mentioned, we need to use mobile phones it was: "we can't do it, there's no chance, drop the idea". And that it's very discouraging obviously when we're trying to bring this new technology to the school. It's very limiting." (STN)
>
> "In terms of support, I don't feel as if he was going to be able to provide me with any support at all" (STN)

And it was viewed as preventing other interested departmental members from experimenting with the VR technology:

> "It is very important for the HOD to support the use of VR and it allows pupils to be creative and think outside the box. Backing of the HOD would show the other teachers that this is an effective technique to use with the pupils." (STN)

The final barrier to be overcome is the school context or 'sociology' dimension. For many STs the placement school savours the ideas and innovation they bring to the classroom context, viewing the presence of a ST as an opportunity to update their teaching skills and to gain insights into evidence-based approaches from the educational literature discussed in ITE programmes: "schools are always going to be delighted with these new technologies that are coming out that they maybe don't have experience of using" (UEN) and "many co-operating teachers view their student teachers as rich sources of learning" (UES). Consequently, for STs using reverse-mentoring to encourage the adoption of innovative practice in VR, it is relatively easy when the school staff matches the readiness and willingness of the ST to pilot and trial new ideas:

> "I think it is important for the student teacher to promote VR as it shows their willingness to explore different avenues of teaching and shows that they can be versatile in the classroom using different teaching methods. It will also encourage other teachers outside of ICT to think about using VR." (STS)
>
> "As pre-service teachers, it is important to be open minded and to try these innovative methodologies to enhance student learning. Furthermore, younger teachers may have more experience with the VR devices and thus would be more confident to showcase the VR potential and educate more senior staff who are new to such technology." (STN)

From these collaborative partnerships the dialogic insights can be realised in the classroom teaching by the process of reverse-mentoring:

> "Pre-service teachers have the role of showing older members of staff, upper and middle management that VR is the future of education. By showcasing the fact that a younger member of staff is broadening their mythologies and accepting modern digital education strategies, the older members of staff will be more willing to change." (STS)

> "This peer-to-peer experience is invaluable and sharing it could act as a real example that VR can and does work in the class." (CTS)

Once trained by the student teacher, continued professional development and the roll-out of these skills to the wider teaching staff was suggested: "More confident and experienced teachers using VR may take a leading role with the upskilling of fellow staff and pupils with the use of VR and other cutting-edge technology" (UES). More targeted training and follow-up support, both in person and virtually, was requested for the sustained adoption and continued use of VR preferably through the sharing of ready-made curriculum specific resources:

> "Professional development needs to be embedded in schools. Teachers need to know that **it will work in the context of their school and their pupils** *[our emphasis].* Establishing a group of teachers that would receive sustained support in the use of the technology and come together to discuss their experiences as a professional learning community would enable it to become embedded in their practice. These teachers can then provide professional development to their colleagues and on-going support in the form of Teach Meets." (CTS)

In summary, when reliable internet access, technical equipment and a change responsive mindset are all present, learning leaders emerge in all three partners in ITE programmes, and teachers gain unexpected professional development opportunities using the bi-directional cognitive apprenticeship model: "As a young teacher, it is important to support fellow staff with innovative technology and help showcase how it can be used to enhance pupils' learning" (STS) and through collaborations with the teachers, the new subject-specific RLOs created during these ST-CT partnerships can be fed back into the university ITE programmes to complete the cycle of reverse-mentoring between the ST and the UE as shown in Figure 2.

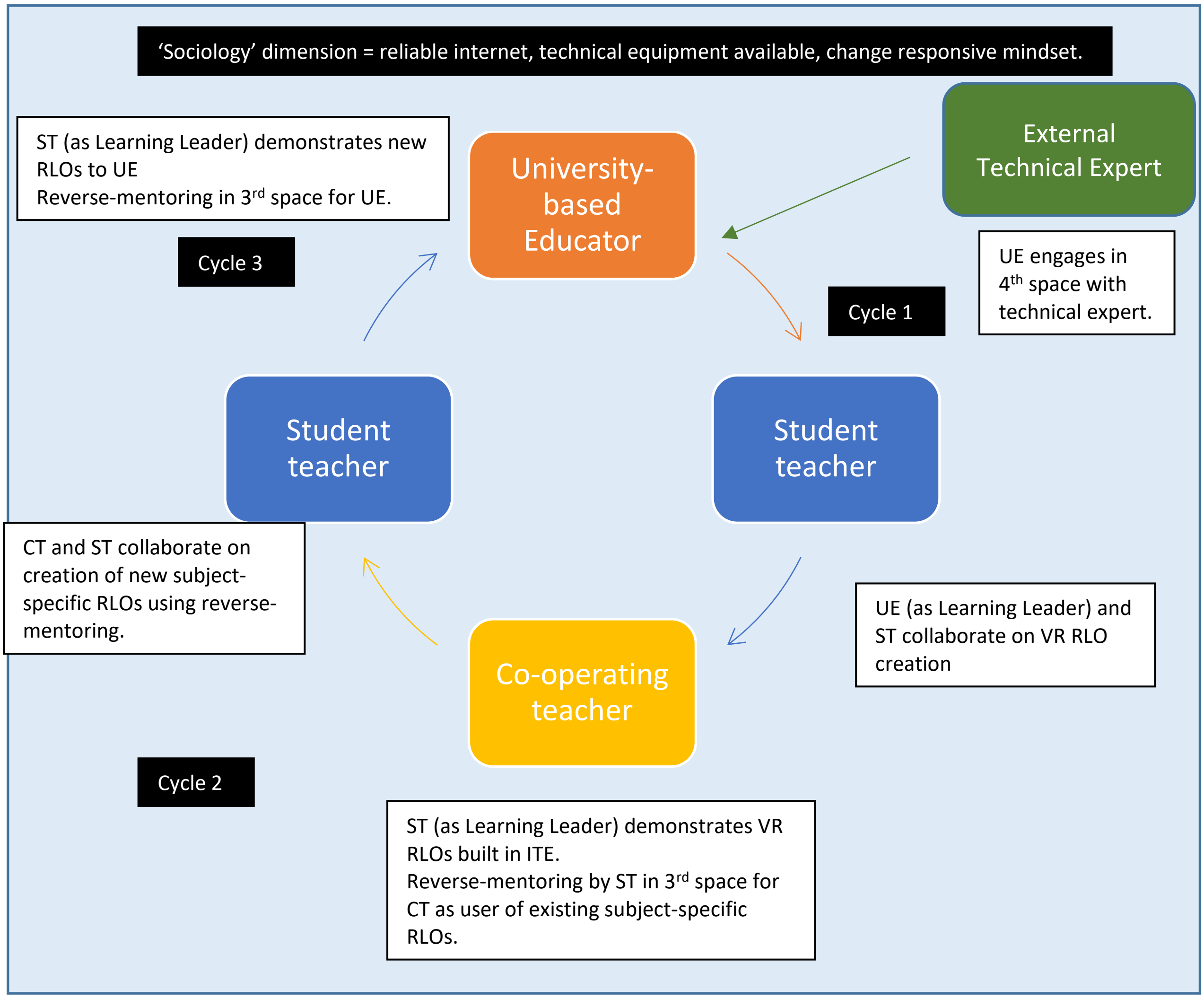

Figure 2. Reverse Mentoring Model of Professional Learning for Learning Leaders aligned to Cognitive Apprenticeship Cycles (in black).

Theme 2: VR as a vehicle for innovative pedagogy

The second theme emerging from the analysis was **VR as a vehicle for innovative pedagogy**. The UEs, who were early adaptors of VR, used their methods modules to highlight the affordances of VR by "demonstrating the simplicity of the use of VR at an introductory level" (UEN) and by

> "Using variety of practical activities within the immersive experiences I created allayed fears that VR is a distraction or a gimmick and it convinced the students in my module that it can be used to facilitate teaching and assessing subject content." (UES)

Having role models who provided guidance and concrete subject-specific examples cultivated a culture of calculated risk-taking in the STs and motivated them to experiment with innovative VR approaches in their practice. Moreover, by embracing a constructivist pedagogical orientation (DES, 2015) STs became more engaged in creating their own immersive learning experiences and less dependent on using external sources that may not always be aligned to their curriculum or available to use in the long-term.

Although the initial training was completed using Google Expeditions as a 'user' and Google Tours as a 'creator' of the VR experiences, the skills learnt in these environments were transferrable to other VR platforms such as SchooVR which was used later with the CTs. The creativity and enthusiasm of the STs demonstrates their capabilities as learning leaders:

> "Google Tours definitely inspired me to create resources. In my first placement I implemented a lesson in VR for a Year 10 class. We used Google Tours and cardboard camera App and created their own Google Tours." (STN)

> "Google Tours has inspired my use of creativity as it has showed me how VR can be used not just for ICT but other cross-curricular subjects such as religion. We created a Google Tour for places of worship which would allow students to virtually visit the famous religious landmarks worldwide". (STN)

STs who embraced this growth mindset (Dweck, 2006) created an array of RLOs, one example for each subject is summarised below:

Subject	**Examples created in UE-ST or ST-CT partnerships**
English	Students take a virtual visit of Shakespeare's Globe Theatre when studying their Shakespearean text. Students work in pairs to engage in descriptive writing whereby one student is immersed in a learning experience ad describes this to their peer and then the roles reverse.
Languages	VR is inclusive as it enables all student regardless of social background of physical impairment to immerse themselves in language and culture of any location worldwide free of financial and pandemic constraints.
Maths	VR empowers students with numeracy difficulties to comprehend shape, space and size by providing them immersive learning experiences and tangible real-

	life examples. VR enables students to engage in fun, interesting and stimulating problem solving scenarios.
Science	VRs may be used in biology to tour inside the human body and understand functions of specific organs such as the respiratory system. VR in physics enables students to orbit space.
History	VR may be used in History to help students visualise and comprehend the space and place of a range of historical moments in time e.g. being dug in the trenches of WW1, travelling on a ship during the Age of Exploration or living inside a monastery in Early Christian Ireland.
Geography	VR is useful in Geography for case studies. Students may witness an erupting volcano, see the effects of coastline erosion or explore the devastating impacts of plastic being dumped into the ocean by humans.

Table 2. Examples of VR RLOs from the six subject areas.

Conclusions

This study aligns with the view that novice teachers need role models for using digital technology on two levels: UEs modelling how technology can be used effectively in subject teaching and CTs acting as role models and mentors for STs by integrating technology in their subject teaching (Admiraal *et al.,* 2017). While research generally highlights the lack of ITE tutors being adept in innovative technology-enhanced learning, the data emerging from this study suggests a growing number of university-based teacher educators are capable of acting as role models (Ananiadou & Rizza, 2010) in the use of VR.

In addition, STs' propensity to transfer VR skills acquired in the university setting to the school setting using reverse mentoring, whereby the STs were learning leaders (DENI, 2016) in using innovative pedagogical approaches in collaboration with CTs during school placement, was more prevalent in digitally well-equipped schools. Schools with less reliable networks and limited hardware presented challenges for the STs acting as reverse mentors as it restricted their pedagogical innovations in the classroom.

The findings also suggest that to implement a professional learning initiative in an innovative digital application such as VR, there needs to be a bank of subject-based exemplars to illustrate the affordances of learning by pupils and to convince subject teachers to invest the time and energy in adopting novel digital learning models into their existing use of technology-enhanced pedagogy. Consequently, this SCoTENS funded initiative resulted in a portfolio of artefacts of learning or reusable learning objects that are mapped to the local subject specifications and are freely available to the wider education community at https://vriterlos.ie/ and a professional learning MOOC available at https://bit.ly/3ATKKLv. This initiative is timely given that Covid-19 lockdowns may also be a catalyst for the use of transformative educational experiences offered through VR especially where teaching resources tailored to the curriculum already exist for use.

Acknowledgement

The authors wish to acknowledge the financial support provided by the Standing Conference on Teacher Education, North and South (SCoTENS) for this project (September 2019 to April 2021).

References

Admiraal, W., van Vugt, F., Kranenburg, F., Koster, B., Smit, B., Weijers, A., & Lockhorst, S., (2017). Preparing pre-service teachers to integrate technology into K–12 instruction: evaluation of a technology-infused approach, Technology, Pedagogy and Education, 26:1, 105-120.

Ananiadou, K. & Rizza, C., 2010, July. ICT in Initial Teacher training: first findings and conclusions of an OECD study. In *Conference Proceedings: L. Gomez Chova, D. Marta Belenguer, I. Candel Torres, IATED (eds.), Proceedings of EDULEARN10 Conference* (pp. 5-7). Retrieved from http://woulibrary.wou.edu.my/weko/eed502/ICT_in_initial_teacher_training.pdf

Bailey, J. O., Bailenson, J. N., & Casasanto, D. (2016). When does virtual embodiment change our minds? *Presence: Teleoperators & Virtual Environments, 25*(2), 222–234. https://doi.org/10.1162/PRES

Barton, R. and Haydn, T. (2006) Trainee teachers' views on what helps them to use information and communication technology effectively in their subject teaching. *Journal of computer assisted learning*, *22*(4), pp.257-272.

Braun, V. & Clarke, V. (2021) One size fits all? What counts as quality practice in (reflexive) thematic analysis? *Qualitative Research in Psychology*, 18:3, 328-352, DOI: 10.1080/14780887.2020.1769238

Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *The Journal of the Learning Sciences*, 2(2): 141-178.

CEO Forum on Education and Technology. 2000. *Teacher preparation StaR chart: A self-assessment tool for colleges of education—Preparing a new generation of teachers.* Retrieved January 16, 2018, from https://files.eric.ed.gov/fulltext/ED437382.pdf

Collins, A. (1988). Cognitive Apprenticeship. In R. Keith Sawyer (2005) *The Cambridge Handbook of the Learning Sciences*, Chapter 4, p.47-60. Cambridge University Press.

Cooper, G., & Thong, L. P. (2019). Implementing virtual reality in the classroom: Envisaging possibilities in STEM education, an emerging field of enquiry. Leiden: Brill.

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative & mixed methods approaches* (5th, International Student Ed.). Sage.

Department of Education Northern Ireland (2016)*. Learning Leaders: A Strategy for Teacher Professional Learning*. DENI: Rathgael House, Bangor.

DES (2015). *Digital Strategy for Schools 2015 to 2020*. Dublin: Department of Education and Skills.

Dexter, S, & Riedel, E. 2003. Why improving preservice teacher educational technology preparation must go beyond the college's walls. *Journal of Teacher Education*, *54*(4)*,* pp. 334–346.

Dirin, A., Alamaki, A. & Suomala, J. (2019) Gender Differences in Perceptions of Conventional Video, Virtual Reality and Augmented Reality. International Journal Information Management, 13, 6, 93-103.

Dweck, C. S. (2006). *Mindset: The new psychology of success*. New York: Random House.

Eifler, K., Greene, T., & Carroll, J. 2001. Walking the talk is tough: From a single technology course to infusion. *The Educational Forum*, *65*(4), pp. 366–375.

Engeström, Y. (2015). *Learning by Expanding: An Activity-Theoretical Approach to Developmental Research*, (2nd Ed). Cambridge, MA: Cambridge University Press. https://doi.org/10.1017/CBO9781139814744

Farrell, R. (2021). Covid-19, A Catalyst for Sustainable Change: The Rise of Democratic Pedagogical Partnership in Initial Teacher Education in Ireland. *Irish Educational Studies.* (ahead-of-print), 1-7. https://doi.org/10.1080/03323315.2021.1910976

Farrell, R., & Marshall, K. (2020). The interplay between technology and teaching and learning: Meeting local needs and global challenges. In Jillian Fox et al. (Eds.), *Teacher Education in Globalised Times: Local Responses in Action* (pp. 41-52). Singapore: Springer. https://doi.org/10.1007/978-981-15-4124-7_3

Foulger, T.S., Graziano, K.J., Schmidt-Crawford, D. and Slykhuis, D.A. (2017) Teacher educator technology competencies. *Journal of Technology and Teacher Education*, *25*(4), pp.413-448.

Merchant, Z., Goetx, E. T., Cifuentes, L., Keeney-Kennicutt, W. and Davis, J. (2014) Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education: A meta-analysis. Computers & Education, 70, 29-40.

McGarr, O. (2020). The use of virtual simulations in teacher education to develop pre-service teachers' behaviour and classroom management skills: implications for reflective practice. *Journal of Education for Teaching*, *46*(2), pp.159-169.

Morgan, D. L. (1988) *Focus groups as qualitative research*. Newbury Park, CA: Sage.

Murphy, G. 2019. Exploring Principals' Understandings and Cultivation of Leadership at All Levels During Initial Teacher Preparation School Placement. *International Studies in Educational Administration* 47 (2): 88–106.

Papert, S. (1980). *Mindstorms: Children, Computers and Powerful Ideas.* Basic Books: USA.

Rogers, E.M. (2003). Diffusion of innovations (5th ed.). New York: Free Press.

Tondeur, J., Pareja Roblin, N., van Braak, J., Voogt, J., & Prestridge, S. (2017). Preparing beginning teachers for technology integration in education: ready for take off?, *Technology, Pedagogy and Education*, 26:2, 157- 177.

Vaughan, N., John, N. and Rees, N. (2019). *CPR Virtual Reality Training Simulator for Schools*. 2019 International Conference on Cyberworlds (CW), Kyoto, Japan, pp. 25-28, doi: 10.1109/CW.2019.00013.

Vygotsky, L., S. (1978). *Mind in Society.* Cambridge, MA: Harvard University Press.

Wetzel, K., Buss, R., Foulger, T., and Lindsey, L. (2014). Infusing educational technology in teaching methods courses: Successes and dilemmas. *Journal of Digital Learning in Teacher Education*, *30*(3), 89–103.

Zauchner-Studnicka, S. (2017). 'A Model for Reverse-Mentoring in Education'. World Academy of Science, Engineering and Technology, Open Science Index 123, *International Journal of Educational and Pedagogical Sciences*, 11(3), 551 - 558.