



## Exploring Connected Learning Spaces in Teacher Education

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This paper reports on outcomes from a study that explored how connected learning spaces, mediated by videoconference technology, enabled real-world engagement in pre-service teacher education. Student teachers in drama and science education participated in the study, which involved varied connections with school children and their classroom teachers. Key themes that emerged were underpinned by a consideration of authentic learning: student teachers' observations of teacher practices; enactment of multiple roles; and exposure to diverse and timely feedback. Implications for the design of discipline specific on-campus activities are considered in relation to how they inform effective integration of videoconference technology for real-world, professional engagement in teacher education.

Keywords: teacher education, videoconference, authenticity, learning spaces

### Introduction

This study contributes to a broader consideration of how connected learning spaces enable real-world engagement in teacher education. Focusing on drama and science education subjects in a Bachelor of Primary Education degree, it explored pre-service teacher learning in these contexts from the perspectives of student teachers, school teachers and teacher educators. Discipline-based ways of using the technology and associated pedagogical insights also were explored. Findings are underpinned by notions of authentic learning, and focus on opportunities for student teachers' observation of and immersion in professional practices, enactment of a range of roles, and exposure to spontaneous feedback from diverse sources.

## **Background**

### **Videoconferencing in education**

Videoconference (VC) technology has been available since the 1950's, most often located in corporate training, rural and remote schooling and post-secondary distance education. The term videoconferencing is used to describe a system where two or more participants in different locations interact using video cameras and other equipment through an Internet connection (Smith, 2003 cited in Kent & Simpson, 2010); while educational videoconferencing can be viewed as "people learning interactively by seeing, hearing, and sharing over distance in real-time..." (Tuttle, 2008, p. 200). VC has recently become a more significant teaching and learning tool in mainstream education, as fast, high bandwidth networks become commonplace in institutions, and equipment becomes affordable and more user-friendly (Anderson & Rourke, 2005). VC has traditionally been used in education using transmissive, didactic approaches such as the delivery of lectures between sites (Knipe & Lee, 2002) or the provision of guest speakers. However, the synchronous, interactive nature of VC can support more emancipative pedagogies, allowing interactive approaches that support more collaborative learning environments (Wright & Cordeaux, 1996). For example, VC offers potential to support discussion and collaboration and the "active exchange of knowledge and ideas which nurture critical thinking skills" (Bidjerano & Wilkinson, 2008, p.126).

### **'Connected Classrooms' in school education**

The present study was implemented in the context of unprecedented government investment in ICT in Australian schools. The Australian federal government launched a multi-million dollar *Digital Education Revolution* (DER) initiative in 2011 to support schools in embracing technology and effectively integrating the ICTs into the classroom (DEEWR, 2011). Similarly, the New South Wales (NSW) State Government announced its \$158 million *Connected Classroom Program* in 2007 that included amongst other initiatives, an 'interactive classroom' in every school. These 'connected classrooms' comprised an interactive whiteboard, video-conferencing facilities, a computer with internet connection and lesson creation and data collaboration software. In her evaluation of the *Connected Classroom Program*, Groundwater-Smith (2010) reported that school teachers had learned to function in new ways in these VC-mediated learning spaces, and exploit their ability to connect "to other schools, other places, and other colleagues" (p. 49). Amongst other benefits, the report gives evidence of enhanced opportunities for collaboration for school teachers and students, participation in virtual excursions or events, and access to specialist teachers and external experts.

A range of VC-mediated learning activity types have been explored in school settings, including virtual field trips, multi-class collaborative projects, cross-cultural exchanges and content-delivery; with many studies reporting the following benefits: participation, interaction, dialogue and collaboration (Anderson & Rourke, 2005). Videoconferencing allows opportunities for school students to enhance their learning experience across various subject and content areas. For instance, students can have access to various institutions such as museums, hospitals or astronomical venues, including 'live talks' from experts (Plonczak, 2010). The literature surrounding the use of videoconferencing within and between schools to facilitate collaborative learning in specific subjects is also well documented (Eales, Neale, & Carroll, 1999; Gage, Nickson, & Beardon, 2002; Smith 2010). Likewise, videoconferencing has played a significant role in supporting students with special educational needs who may be situated in rural areas (Donegan, 2002; Thorpe, 1998).

### **Teacher education contexts**

Much of the literature on VC in teacher education focuses on the nexus between university and schools and strengthening the link between theory and practice. BECTA (2003) highlighted three benefits of VC for teacher education: observation of school classrooms without being present in the school, sharing of ideas and teaching resources, and mentoring whilst on professional experience. Virtual field experiences, observing classrooms, cyber-mentoring, cyber-teaching, and supervision on professional experience were emphasised by Smith (2003,

cited in Kent & Simpson, 2010, p. 13). Tuttle (2008) outlined several types of VC uses in teacher education, including: accessing experts, university-to-school connections, peer-to-peer student teacher collaborations, peer-to-peer Faculty collaborations, mentoring and observing student-teachers on professional experience, and professional networking.

There is a strong emphasis in the literature on the use of VC in professional experience contexts (e.g. Barnett et al, 2008; Crawford et al, 2002; Stansberry & Denker, 2012). For example, Sharpe et al. (2003) found that student teachers on professional experience that used videoconferencing as a collaborative learning tool between themselves and university supervisors, benefited through 'sharing of ideas' and reduced stress levels through peer support. Similarly, Melville et al. (2011) found that videoconferencing can play a role in supporting student teachers' reflection processes and identity formation during professional experience.

Student teachers and teacher educators can also link with school teachers from campus-based classes through videoconferencing to observe scenarios, discuss phenomena and reflect in real-time with participants (Marsh et al, 2010). Such a redefinition of classroom boundaries is providing a way to enhance the initial teacher education experience through the use of VC (Wiesemes & Wang, 2010). By employing other kinds of technologies with videoconferencing, student teachers can benefit from non-lecture based interactive sessions such as brainstorming, role-play, simulations and demonstrations. However, there has been less emphasis on discipline-specific uses of VC in campus-based teacher education classes.

Strategies associated with campus-based pre-service teachers' observation of real-world K-12 classrooms via videoconferencing have been recently explored. In a study by Kent and Simpson (2010), pre-service teachers on campus were given the opportunity to observe reading instruction in schools through videoconferencing and then interact with the classroom teacher, thereby creating exposure and experience for pre-service teachers to develop their conceptual understanding of research-based, best teaching practices in reading. Similarly, pre-service teachers used videoconferencing technology to observe literacy being taught in a classroom and then reflect on the lesson "by conversing with the teacher via distance learning" (Barnett et al., 2008, p.1). Additionally, in language education, pre-service Spanish teachers watched and analysed a drama production before further exploring their analysis with the production's director and actors through videoconferencing (Tuttle, 2008). The integration of video-conferencing in a social studies methods course was explored by Good, O'Connor, Greene and Luce (2005). Their findings revealed that pre-service teachers' content and pedagogical learning was enhanced through being exposed to different perspectives from outside of the university, sharing of resources, as well as engaging with guest speakers and future social studies professionals from other regions.

In summary, research on the use of VC in discipline-specific, 'method' classes in teacher education is in its infancy and further research is needed in this area (Kent & Simpson, 2010). This study contributes to this literature base by exploring the use of VC in science and drama teacher education. This focus also fits well with the research agenda informed by the TPACK model of teacher knowledge (Koehler et al., 2011), calling for further studies on the nuanced, discipline-specific integration of technology in the curriculum.

## **The study**

This qualitative study is set in the contexts of pre-service science and drama education at an Australian university. These discipline areas provided the focus for the study as a result of the particular academic staff members that were teaching these subjects sharing an interest in integrating VC technologies. Attentive to the reciprocal relationship between educational technologies and pedagogical approaches (Salomon & Almog, 1998), it develops an understanding of the qualities of the experiences in two distinct disciplinary subjects, created when student teachers interact with emerging VC technologies. The study employed an interpretive methodology (Erickson, 1986; Lincoln & Guba, 1985) to explore the use of VC in pre-service teacher education, investigating the key research question: *How can connected learning spaces enable real-world engagement in teacher education?*

## Participants and procedures

Teacher education staff and student teachers involved in two drama education elective subjects and two science and technology education core subjects participated in collaborative VC-mediated activities with school-based teachers and children in Sydney primary schools during 2011 and 2012. All student teachers were studying in the four year Bachelor of Education (Primary) program. The VC-mediated spaces acted as a 'test-bed' environment for the student teachers to test their ideas and emerging professional competencies. The VC equipment used in the study consisted of a permanently installed 'room system' (or 'connected classroom') at the university, connected via a fast, high bandwidth network to similar rooms in the six participating NSW public schools.

The two drama education subjects involved 3rd and 4th year student teachers (total of 35 student teachers) in a creative process of exploring, building, rehearsing and performing for primary school children via the connected classroom technology. VC activities included conversations with children and school teachers in preparation for, and reflection on, VC mediated drama performances, rehearsal performances gathering feedback from peers, rehearsal opportunities utilising the self-feedback capacity of the VC setup, as well as the live performances themselves. Assessment was tied into the VC-based work of each class.

There were two science and technology education subjects in which student teachers participated: one 2nd year subject (137 student teachers in 5 classes) and a 4th year subject (77 student teachers in 3 classes). VC activities for science were also varied. For 2nd year student teachers, this included a connected session between student teachers and a panel of classroom teachers from the same school, to learn more about how they approached planning and teaching science and technology. The 4th year student teachers experienced a facilitated connected session with a panel of children from Kindergarten to Grade 6 to hear what they had been learning and to support preparation for a subsequent face-to-face school-based science day. As with the drama subjects, VC activities related to class-based assessment.

## Methods

The qualitative research methods employed in the study were designed with the purpose of gathering triangulated data from the adult participants in the VC sessions, who also shared their impressions of children's participation. There were four methods used: student teacher (coded S in findings) and school teacher (coded T in findings) written reflections on their experiences in the VC spaces (guided by broad focus areas), student teacher focus groups, collaborative peer observation (Pressick-Kilborn & Te Riele, 2008), discussion and written reflection amongst academic staff (coded A in findings). The two academic staff engaged in teaching the subjects (authors 1 and 2), along with the third author of this paper, engaged in the collaborative peer observations and critical collaborative reflective discussion (Bullough & Gitlin, 1991) after each session. Participant written reflections included student teachers' responses to stimulus questions from academics; school teacher written reflections and notes from conversations with academic staff; academic written reflections, including notes made during collaborative discussion; and email messages exchanged between academic staff following the VC sessions.

Data were analysed using qualitative methods and sorted (Coffey & Atkinson, 1996) in multiple ways to allow themes to emerge, but also for the experiences of individual students to be respected (Connelly & Clandinin, 1988; Perry, 2006). Key themes and patterns from initial drama-based data were identified (Coffey & Atkinson, 1996). Preliminary thematic analysis of responses then guided the ongoing data collection in both drama and science subjects. Themes were again placed as a lens over the new data with additional themes emerging. The establishment of preliminary themes allowed for broad focus areas to be developed that guided the ongoing data collection. As these broad focus areas were applied across all methods (written reflections, focus groups and observations), triangulation could take place considering the various participant groups and sources.

## Findings

Three key themes emerged in analysis of the data. The themes relate to how VC technology enhanced student teachers' 1) observations of teaching practices, 2) enactment of multiple roles, and 3) receipt of immediate feedback from diverse sources.

### Enhancement of student teachers' observation of teaching practices

VC connections enabled student teachers in both drama and science to witness classroom teachers interacting with primary children, and in science with other school-based teaching colleagues. Connections provided a window into the real worlds of the school classroom, extending beyond passive, 'fly-on-the-wall' observation to simultaneously involve a variety of interactions and questioning by student teachers. Opportunities were created for student teachers to: 1) observe school-based teacher practices in drama or science, including classroom teachers' professional interactions with children and colleagues; and 2) observe their lecturers as teachers interacting with children and classroom teachers.

Firstly, VC connections engaged the student teachers in observing how school-based teachers mediated children's engagement in the connected space, in both the context of the drama performances and their interaction between children when planning for the science day activities. The practising teachers either engaged directly with student teachers or played a mediating role between children and the student teachers. The pivotal role of the classroom teacher made an impression with student teachers in both contexts—many of them highlighting the importance of observing this role, particularly for initiating more dialogic interactions (Beauchamp & Kennewell, 2010) in these connected spaces: "I think to do it without having a [school] teacher being there... prompting them, it would have been much harder. Like she was really helpful being like "It's ok". Getting them started off, "Tell them where the rainbow fish is!" (Focus Group, 2012 drama). Another student said:

It [having classroom teacher facilitating response] was really helpful for me in the interaction thing. I could look at the kids and she could get them to react back to me. 'Cause I didn't have to look at the screen to choose someone, she did that for me so I was able to maintain that contact with them. But that was, I think, was pretty vital for the interaction. (Focus Group, 2011 drama)

These perceptions were reinforced by one of the science lecturers, who noted in her reflective notes:

T [classroom teacher] played an active role in engaging and focusing the children on relevant aspects of their learning, which prompted the children's reflection and provided student teachers with insight into the children's understanding and enjoyment of the science ... T was playing a dual role - teacher and teacher educator. Her questioning of the children was very strong and provided a role model for the student teachers in how a skilled teacher can elicit students' ideas." (A2 reflection, 13/8/12 science)

The communication between the key collaborators at each site prior to the VC sessions was important to ensure that the class teacher's questioning of children was focused and purposeful, as a peer academic observer noted in science: "The classroom teacher ... effectively mediated the first half of the session. She skillfully probed the children's thoughts and asked them pertinent questions, obviously well-informed by previously set goals and directions negotiated with academic staff" (A3, Peer observation 13/8/12 science).

Student teachers also had opportunities to observe classroom teachers engaging professionally with colleagues through the VC connections. In science, student teachers connection with a panel of school teachers provided an opportunity for modeling for the pre-service teachers, who observed how practising teachers engage collaboratively in professional discussion. The drama students noted a similar benefit, with one stating: "So you

really see that in that kind of scenario, the teacher needs to be a collaborator in the process” (Focus Group, 2011 drama). It also gave student teachers the chance to test their own skills in contributing to such conversations. Student teachers reflected positively on the experience of interacting with the practising teachers: “I loved being able to talk to new [school] teachers and draw from their knowledge. I feel that it is one of the best ways to gain knowledge, is through people living life every day” (S15 science); and “Yeah, but just that collaborative learning is just so, it makes it so real” (Focus Group, 2011 Drama). Another science student mentioned: “I thought it was a great opportunity to connect to school teachers. I am finding that it is important for my development as a teacher to get as many differing views on teaching ideas and practice as possible” (S1 science).

Secondly, student teachers observed their lecturers actively engaging with primary children and school-based teachers during the VC connections in both subject areas. Student teachers rarely see their teacher education lecturers modelling the role of primary teachers. The importance of this modeling was noted: “A1 giving student teachers guidance related to asking more responsive questions, building from children’s responses” (A2 peer observation notes 29/3/12 drama); and “Good team teaching between A2 and NN teachers - bounced off each other to share and discuss” (A1 reflection, 5/4/12 Science). The student teachers also required prompting from their lecturers to engage productively with the children during the VC connections: “Student teachers needed a fair bit of prompting to ask questions. Maybe a confidence issue - students not knowing how to phrase [questions]” (A1 reflection, 5/4/12 science). In this way, the VC connections provided an opportunity for the lecturers to model professional engagement with children and school-based colleagues. The connections also supported student teachers in taking on multiple roles during campus-based classes.

### **Opportunities for student teachers’ enactment of multiple roles**

The connected classroom experiences in drama and science created opportunities for student teachers to actively participate in the VC scenarios adopting multiple roles, some of which are only usually possible enacted in the field. Some of these were expected, including that of student teacher (‘teacher-learner’) to actual teachers through their interactions with children in both subjects. Others were less expected, including those of facilitator, actor, performer, theatre designer, writer and director for the drama students and inquirer and collaborative investigator for science. The VC experiences offered students the opportunity to enact and switch between these roles spontaneously while located on the university campus. Staff noted this benefit: “So much is dislocated from the classroom and professional experience can be also quite separate in their minds. Bringing the two together in this style of learning experience gives authenticity of purpose” (Peer discussion, A1/A2 9/3/12). These experiences functioned as a springboard for student teachers to enact their own VC-mediated plans and associated teaching roles in their own classrooms.

The intimate relationship between metaphors and teacher identity has been long recognised (Bullough & Stokes, 1994, Pullias & Young, 1968) with roles such as professional and researcher discussed (Goode et al., 2004). While not explicitly questioned regarding the roles they adopted, students alluded to role adoption in their reflections through references to opportunities such as walking in the shoes of the children, “seeing it [drama performance] from the perspective a child audience will be watching it” (S5 reflection, 2011 drama) as well as a consideration of the teacher as actor (student reflections, 2011 drama). The opportunity to position children as collaborative and self-guided learners was also considered emphasising again the teacher role of a ‘non-intrusive’ facilitator (S3 reflection, 2011 drama).

There was evidence of several student teachers enacting their VC plans during their subsequent professional experience in schools. For example, one drama student teacher modelled the process she experienced at university with a Grade 5 class. This engagement clearly demonstrated understanding gathered through her experiences of the unique nature of performance via VC, with her stating “we ran through things like focusing on the camera and not the screen, and adjusting voice projection according to where they were standing, and keeping background noise to a minimum” (S11 reflection, 13/10/11 drama). Other student teachers who planned and enacted VC-mediated lessons at their school reported positive children responses. Their own school students

appreciated the authenticity of their VC experiences. For example, one student teacher reported on a recent VC class session with NASA during her professional experience: “Most said it [video conference hookup] was cool that we heard from a real person that is doing the training rather than just reading from a book.” (S10 17/10/11 drama). Another student teacher incorporated VC into her English lesson:

The kids loved using it and allowed them to participate even though they were 8 hours away from the other candidates. They got to participate in real time with real officials - great because regional schools could participate and not have to travel. (Regarding participation in National Spelling Bee) (S12 17/10/11 drama)

These reports affirmed the student teachers’ own notions of connected classrooms as a conduit for real-world engagement.

### **Engendering immediate, diverse and authentic feedback**

Another theme that emerged from the data was the role that VC technology played in enabling student teachers’ exposure to spontaneous, valued feedback from diverse sources that would not usually be available to them on campus. Three sources of feedback allowed student teachers to ‘test ideas’ and were evident in the data gathered: self-feedback, feedback from children and practising teachers. The immediate, synchronous nature of the feedback was a feature of the VC scenarios for student teachers: “Live and interactive... I think that is the unique feature of the Connected Classroom. That is what it really brings to teaching and learning” (Focus Group, 2011 drama) and “It’s all about live and real time. You can ask questions, you can have access to anything that is available” (Focus Group, 2011 drama).

Firstly, the drama student teachers commented in their focus groups that rehearsing in front of the camera, and then performing via VC provided them with useful self-feedback on their performance. The dual screen view of the VC (see Figs. 1 & 2) enabled the student teachers to see what the children in the audience would see, and some made observations of the affordance of the technology in providing ‘real-time’ feedback that contributed



**Figure 1. Dual screen view of the VC facilities in drama context (school audience on RHS )**



**Figure 2. Dual screen view of the VC facilities in science context (school audience on RHS )**

to refining their own performance: “Without meaning to sound egocentric, even just the experience of seeing ourselves acting was useful for me to notice/correct things in my own acting. Even just switching in the camera can be useful for children acting” (S1 2012 drama); and “I found it [seeing self on screen] helpful actually because if you knew you were on screen then you knew that they could see you and you had to always keep looking at it, not in a distracting way” (Focus Group 2012 drama). Similar benefits were noted by one of the observers:

The student teachers were comfortable using the technology, but did tell me at the end of their rehearsal period that they had to rethink their blocking based on the technology (they had worked the week before on the basic structure). They found that being able to see what children view opened up new possibilities. (A1 reflection, 22/3/12 drama)

The timely feedback helped the student teachers to develop their use of acting techniques more broadly, but for the nuances of performing using this hybrid theatre/film medium more specifically. As they drew on the ability to see themselves as afforded by this particular technology, they used what they viewed as a source of development. In contrast, the nature and purpose of the science connections did not afford the same possibilities for self-feedback for student teachers.

Secondly, feedback from children was highlighted by both student teachers and academic staff members as being of particular value. Children's participation in conversations with student teachers informed planning in both the science and drama contexts prior to the science day and performances respectively. Constructive feedback and the potential for audience inquiry were features that drama student teachers experienced. They were initially concerned about receiving the crucial response central to, and characteristic of a Children's Theatre performance. However, these concerns were alleviated as they experienced spontaneous feedback from the audience. One student teacher mentioned: "They [children] are rethinking...critiquing, however basic what you're doing and thinking about it in terms of what they're reading and learning, so it adds a whole other level of analysis ... " (Focus Group, 2011 drama). Another student appreciated the supportive nature and spontaneity of the feedback: "This is another avenue to collaborate about acting/theatre with people you would not necessarily be able to access. It could help reduce anxiety about the audience viewing. They can encourage immediate feedback and question from performer or audience" (S5 2012 drama).

Science lecturers also reflected on the value of children's feedback for student teachers' planning of relevant school-based science day activities. This authentic feedback source was perceived as purposeful, meaningful and adding enjoyment to the planning process: "They had been generating ideas for possible design and make tasks, that they would actually be planning and teaching with children at the school. The video conference gave them the opportunity to test their ideas with the children" (A2 reflection, 13/8/12 science). Another lecturer mentioned:

The student teachers commented that they really enjoyed hearing from the children about what they had learnt ... One other thing was how important it was for the students to pitch their lesson plans as stage/age appropriately as possible and seeing children from all stages K-6 [during the VC connection] and the children's ability to articulate scientific learning and ideas facilitated that fine-tuning of the student teachers' expectations and ideas for the preparation of the design and make task. (A4 reflection, 13/8/12 science)

Thirdly, student teachers valued the feedback they received within VC connections from school teachers in the partner schools. In science, this was evident when classroom teachers drew on examples from lessons they had just taught in the responses that they gave to student teachers' questions: "This was a great experience and opportunity to speak to teachers who are currently involved in teaching, particularly science and technology. It was great to ask more practical questions and get 'real' responses" (S4 2012 science). The answers that the practising teachers gave during the VC exchange were appreciated by this student teacher, who believed that she could trust the experience of these school teachers to inform her own future practice.

However, many pre-service teachers critiqued the potentially impersonal, less intimate nature of the 'connected classroom' and children's possible perception of VC as a passive medium. They mentioned in focus groups that they perceived face-to-face environments as easier to elicit feedback. For example, one drama student mentioned:



At first the kids were a little bit tentative to respond...and perhaps that's because they're used to screens being a passive thing, like they're used to watching movies on TV and they're not used to having to respond to it. Where they're used to responding to people face to face I guess. (Focus Group 2012 drama)

Another school teacher whose class was participating in the drama activities reflected that:

I found it interesting that the quieter students (who had valuable information to share) did not feel comfortable speaking up in this forum while they would have in class. They were overwhelmed perhaps? It will be interesting to see if they speak up next time. (School Principal reflection, 9/3/12 drama)

These comments highlight that the VC medium may have been inhibiting for some children and raises a broader issue, in relation to the importance of children being prepared for *how* to participate as an audience through VC. It was more likely that the children didn't know *how* to respond, not having previous experience as an audience to draw upon. This points to the value of designing opportunities for repeated engagements through VC, so that all participants become familiar with the medium and more comfortable engagement with one another, leveraging effective feedback.

## Discussion

This study was conducted within a higher education climate where a consideration of 'spaces' for learning is an increasingly prominent issue resulting in implications for the role and place of technologies such as videoconferencing. Teacher educators in Australian universities are engaged in looking into ways of including and incorporating videoconferencing as a teaching and learning tool in their own classrooms, not only to leverage opportunities provided by recent infrastructure investment and to innovate their own teaching practices, but also to educate and equip future teachers to the possibilities of videoconferencing across the school curriculum. They seek to develop their own connected classrooms, partnering with schools, other universities and content providers such as cultural institutions, museums and professional organizations.

The deconstruction of traditional classroom boundaries between the university and school contexts allowed for the real-world engagement, providing opportunities for observation of and immersion in teaching practices with multiple roles to be played by student teacher participants. The breaking down of boundaries supported the provision of 'real-time' authentic feedback in the drama context, enabled by the nuances of the technology itself (e.g. self-feedback via the dual screen). This allowed for adjustments to be made, enhancing student teachers' understanding of the unique features of the connected classroom 'stage'. Similarly, valued and timely feedback was provided by children and school teachers in science to inform the student teachers' final tasks for the subsequent science day at the school.

The connected classroom is a unique environment, for example, for structuring performance and as a result engagement in drama education. The study raised important implications in regard to developing student awareness of the nuances for drama performance as experienced on this hybrid 'virtual stage', and what this meant practically for the performers and performances themselves. Many drama student teachers in the study welcomed the connected classroom as a suitable space for novice actors, and perceived the VC-mediated audience as less intimidating and a possible way to reduce anxiety. The VC activities, particularly in drama, became a 'deep play' experience (Koehler et al., 2011) for the pre-service teachers, enabling them to explore creative ways of using the VC facilities and develop more nuanced understandings of the technology for their own teaching. Further research into implications for performance more broadly, opportunities for performance where 'actors' work simultaneously across spaces, along with what drama learning through the use of VC technology means for school-based pedagogical design in drama education should be considered.

Collaborative learning mediated through the VC technology was witnessed in both discipline areas through the engagement of student teachers with school children and their teachers. This constitutes a move toward “the students doing the learning rather than the teacher doing the teaching” (Willey & Gardner, 2010, p. 2). Such a student-centred perspective on student learning is crucial when considering future discipline-specific opportunities for VC, and should guide an understanding of the kind of activities that can be designed for enabling effective real-world engagement in teacher education. Such real-world engagement is consistent with a perspective that professional learning is not just confined to the “tangible boundaries of a physical classroom ... but involves a diverse range of spaces enriching the learning and teaching experience of both academics and students” (Keppell & Riddle, 2012, p.1). Subject-specific nuances and opportunities for application of VC in future teaching practice and associated pedagogical understandings should be considered.

This study adds to the growing research literature on the use of learning technologies and new learning spaces in teacher education. It responds to calls for more discipline-specific research in this area (Koehler et al., 2011), by emphasising ICT-supported, discipline-specific pedagogy in drama education and performance allowing alternative forms of theatre to be explored, as well as inquiry-based science teaching. While common themes emerged as relevant to both discipline areas, the way they played out were unique and this reinforces the need identified by Kent and Simpson (2010) and Koehler et al. (2011) for further discipline-specific research to be conducted. VC activities in the two subjects considered in this study brought together university and school-based learning in a hybrid of time and place, using VC between teacher education students and staff, and school-based teachers and children.

## Conclusion

Use of VC technologies facilitated discipline-specific professional engagement for the pre-service teacher participants in this study. The connected classroom facilities enhanced observation of and immersion in school-based teacher practices, and leveraged unique opportunities for the student teachers to receive authentic feedback from children and practising teachers on their drama performances and science inquiry projects. In this way, the VC-mediated spaces acted as a ‘test-bed’ environment for the student teachers to refine their teaching ideas and notions of professional practice, and develop their emerging professional conversation and performance competencies.

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**Please cite as:** Perry, R.M., Pressick-Kilborn, K.J. & Kearney, M. (2013). Exploring connected learning spaces in teacher education. In H. Carter, M. Gosper and J. Hedberg (Eds.), *Electric Dreams. Proceedings ascilite 2013 Sydney*. (pp.694-705). <https://doi.org/10.14742/apubs.2013.1438>

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