Maor and Currie *International Journal of Educational Technology in Higher Education* (2017) 14:1
DOI 10.1186/s41239-017-0046-1

International Journal of Educational Technology in Higher Education

RESEARCH ARTICLE Open Access

The use of technology in postgraduate supervision pedagogy in two Australian universities

Dorit Maor* and Janice Kay Currie

* Correspondence:
d.maor@murdoch.edu.au
School of Education, Murdoch University, South Street, Murdoch 6016, WA, Australia

Abstract

The supervision journey is often a bumpy one. Students and supervisors should welcome making it smoother. This study investigated how the use of information and communication technology (ICT) and a more collaborative pedagogy could improve supervision. We interviewed eight supervisors and nine students in two Australian universities to explore the current use of ICT and its integration with supervision pedagogy. Recent literature demonstrated new forms of supervision pedagogy emerging that embraced the idea of creating communities, involving greater connectedness, collaboration and more intense relationships. Not all studies found movement away from the traditional form of supervision dyads. The students and supervisors in our study used email, mobile phones, Skype and Dropbox; some used social media like Twitter. Students reported their supervisors were competent in using ICT, sometimes initiating the uptake of new technologies. Overall, they identified the need for an increased use of ICT and its integration with supervision pedagogy.

Keywords: Supervision, Pedagogy, Technology, Social media, Communities

Introduction

How students communicate with their supervisors and the relationships that they develop have considerable impact on their research journey. In 2013 and 2014, we interviewed eight supervisors and nine students in two Australian universities to investigate the use of information and communication technology (ICT) and the type of pedagogy used in supervision. The universities were different in character: one was a large, technology university and the other was a small, research-led university. Our aim was to identify in what ways using ICT changed the student-supervisor relationship and whether new, participatory pedagogies using Web2.0 technologies were being used and could improve supervision.

In the past decade higher degree research supervision has changed to become more participatory in nature (Danby & Lee, 2012; Fenge, 2012) — a process where research students have greater autonomy in developing their research agenda and work collaboratively with their supervisor. This style of supervision is beginning to incorporate more ICTs (Carpenter, 2012; Le, 2012). Moreover, it involves the student and supervisor working together to achieve their goals, often within a community of researchers

(Parker, 2009). Parker found that by using Web2.0 technologies, research students could more easily be initiated into their scholarly communities.

Research studies also show that graduate students are increasingly enculturated into their disciplines (Lee, 2008). Lee raised the question: 'how much responsibility should the student or the supervisor take for arriving at the destination?' (Lee, 2008, p. 274). They have always been enculturated into their disciplines but, according to Carpenter (2012), the process is becoming more intense. Peer support has also developed as a part of group supervision in New Zealand (McCallin & Nayar, 2012). One form of peer support is the scholarly writing group, which has been shown to improve writing outputs (Aitchison & Guerin, 2014; Aitchison & Lee, 2010). To reduce the attrition of graduate students experienced in many countries (Taylor & Beasley, 2005), supervisors are creating communities of scholars and keeping students more socially and professionally active (Albion & Erwee, 2011; Danby & Lee, 2012; Fenge, 2012; Le, 2012).

In addition to becoming active members of their disciplines, higher degree students are encouraged to establish an online research presence. Changing the traditional supervision approach to a blended approach (de Beer & Mason, 2009), including a greater use of ICTs through the use of online forums, for example, may assist these students to become more active members in their scholarly and/or professional communities. This article looks specifically at how higher degree research supervision is changing to improve communication through the integration of participatory pedagogy and Web2.0 technologies to yield a more collaborative research process.

Literature review

A new type of supervision pedagogy emerged from the literature review that embraced the notion of creating communities of scholars and resulted in teamwork. This more participatory supervision involved the concepts of connectedness, more intense supervision, and group supervision. The group could be the team of supervisors and the student or a group of peers (fellow postgraduate students) that may or may not be combined with outside experts in the field. As noted above (Lee, 2008), central to many of the new approaches to supervision was the idea of enculturation into a disciplinary community (whether it was a single discipline or multi/transdisciplinary); this approach was integrated with emancipation in which graduate students found their professional 'voice' (Lee, 2008). In this instance, the term 'voice' refers to becoming active as independent researchers in their own right and not tied to their supervisor's reputation or research agenda.

A number of changes have affected the way graduate students undertake their research. Stubb, Pyhältö, and Lonka (2014) found that the research journey in Finland was shifting from a product-oriented (thesis production) to a process-oriented undertaking and from an individualistic to a community-centred approach where students were further developed as professionals in their field. The process has also moved towards a team approach in Australia (Green & Bowden, 2012; Hammond et al., 2010; Parker, 2009), which has existed in some disciplines, such as the sciences, but was largely absent from others until recently. According to Malfroy (2005, p. 165), in

nursing and midwifery in Australia, more flexible processes emerged that moved towards collective models of supervision with greater emphasis on 'collaborative knowledge sharing environments'. More universities use a co-supervision model of two or more supervisors, and the arts and humanities are increasingly taking up supervision within project-based groups, reducing isolation, which has been reported as one reason for high graduate student attrition rates (Bruce, 2009). The Group of Eight (2013) universities in Australia found an interesting trend that combines the team and project approach, teaching PhD students in groups rather than having them work with individual supervisors. This approach brings PhD candidates together in student cohorts to work on a specific area, such as chemical synthesis. *The Changing PhD* Discussion Paper (Group of Eight, 2013) argued that key 'soft skills' like communication, teamwork, planning, and organisation skills needed improvement in Australian doctoral students.

Stelma (2011) used a network of Web pages inserted into a learning management system (Blackboard) to explore resources and develop an online discussion forum in the UK that encouraged ongoing reflection. Another study in the UK (Fenge, 2012) discovered that group supervision in the UK supported peer learning and enabled the supervisor to complement the learning process by enriching different perspectives offered by individuals in the group. Overall, the strongest pedagogical supervision approach throughout this literature was the dialogue between the students and supervisors and the emphasis on being part of a community to achieve collaboration.

Australian graduate students have become increasingly aware of the need for greater knowledge and skills in ICT to achieve high-quality research outputs (Phelps, Fisher, & Ellis, 2006). However, a longitudinal study in the UK found that 'Generation Y doctoral students were not keen users of new technology applications in their research and preferred those that do not challenge existing research work practices' (Carpenter, 2012, p. 3). Furthermore, according to the doctoral students in Carpenter's study, the majority worked alone and not in research teams and shared research information only with their peers.

In contrast, one Australian study (Cumming, 2010, p. 36) advocated for more 'open and flexible' approaches 'enabling candidates to exercise greater autonomy with regard to when, where and how they learn.' He conceptualised the research process as an ecosystem with a myriad of stakeholders that would use online technology to develop a more participatory and less traditional pedagogy that would help students meet 21st century skill requirements. Another Australian and international study (Danby & Lee, 2012) developed a new online network space which included discussion forums, chats, video conferencing, linked homepages and collaborative writing spaces to combine technology with pedagogy as practice-in-action to improve the supervision relationship. Halse (2011, p. 565) argued for a change from an intense personal relationship to a more professional one as a 'necessary survival strategy' for Australian doctoral students. de Beer and Mason (2009) employed a storyboard technique in South Africa to schedule events in the hope that students would complete their dissertations on time.

A wide variety of technologies are now being used in supervision: Skype, Elluminate, Wimba, Second Life, telephone, MSN messenger, Wikis, Microblogging, Social Bookmarking, email, ePortfolio, Microsoft Office Share-Point for collaborative writing and WebCT. There are also technology changes that are rapidly affecting research techniques, including predictive analytics, software and data management tools (such

as Nvivo, CAQDAS, QDA Miner and MAXQDA). In the use of these new forms of technology, students may actually be defacto in the role of tutor to their supervisors and speed up the process of dissemination of their research results. These are areas that will have to be explored in further research.

Two groups of researchers (one in Australia and one in France) developed new network spaces: *Doctoralnet* (Danby & Lee, 2012) and *Form@doct* (Malingre, Serres, Sainso, & Men, 2013). Others (Le, 2012 in Australia; Manathunga & Lant, 2006 in Australia; Rockinson-Szapkiw, 2011 in USA) used ePortfolios or other collaborative website workspaces to facilitate communication between research students, their peers and their communities. These researchers found these participatory forums to be highly interactive.

Thus, these studies in many different countries demonstrated that the collaborative-based technology in which students and supervisors interacted delivered a sense of connectedness and promoted social and academic achievement. In an Australian study, the result was a supervision relationship that was more reciprocal and less hierarchical (Green, Bowden, & Andrew, 2012), involving a shift from the master apprentice model to one in which the supervisor facilitates and negotiates rather than directs or instructs. Bruce (2009) explored what these changes mean for supervisors and their pedagogy and found three distinct approaches they implemented during supervision: a direction setting approach, a scaffolding approach, and a relationship approach. The key strategies she advocated for effective supervision were: negotiating expectations; creating a structure; generating outputs; focusing on the big picture; and creating space where groups could interact. The supervisors interviewed in our study adopted many of these roles and strategies, moving towards a participatory pedagogy and a more collaborative and project-based approach to the supervision process.

Not all the studies, however, revealed that supervision was changing towards a more participatory process. In South Africa, de Beer and Mason (2009) claimed that relationships did not alter as a result of using technology: the supervisor still maintained the role of advisor and mentor and provided support and quality control, but with the advantage of better communication. As noted above, Cumming (2010) in Australia found that the supervision relationship was not changing enough and suggested that there was mounting pressure to implement a more open and flexible type of supervision. In a 2012 review of supervision practices in New Zealand, McCallin and Nayar found that there were a number of changes in how research supervision was conducted, mainly due to external changes caused by economic conditions and subsequent policy enactments. However, most supervision remained in the traditional model. They found that different models were needed for different students and identified three types of supervision: traditional (dyadic relationship between supervisor and student); group (supervisor and multiple students); and mixed (mixture of the two previous plus new technologies). They argued for a mixed model for the current New Zealand conditions, which would allow for multiple supervisor student relationships that incorporated learning technology to support the development of research students. To implement a mixed supervision model with online programs and emergent technologies, they concluded that graduate students and their supervisors would need to have additional research training.

In our study, we first explored how much technology was used in the supervision process and the impact it had on supervisors' pedagogy. Second, we wanted to investigate if this research had changed their perceptions and practices regarding the use of technology. (This question we were able to determine through follow-up interviews a year later.) A third question was about any barriers they perceived to the use of technology. (This question was asked only of the supervisors.)

Research design

Our study used qualitative methods to investigate whether technology was in the process of transforming postgraduate supervision pedagogy in two Australian universities. According to Denzin and Lincoln (2005), qualitative methods allow researchers to "study things in their natural settings, attempting to make sense of, or interpret phenomena in terms of the meanings people bring to them" (p. 3). Through semi-structured questions, the students and supervisors were able to identify how new technologies were emerging in their world.

Research knowledge is never value-neutral. Rather it is created by inquiry through a dynamic interaction between the investigator and the investigated (Guba & Lincoln, 2005). In this sense, findings are value-mediated. One of our underlying values that mediated our findings is the notion that supervision should be more participatory. This was based on participatory learning theory and the idea of creating communities of practice (Bandura, 1977; Wenger, 1999). By utilising social learning Web2.0 tools and participating in developing their own and others' knowledge, the supervision process becomes one where students and their supervisors are co-creators of knowledge rather than consumers of knowledge created by experts (Jenkins, 2006). This is consistent with transforming higher degree research training through the incorporation of appropriate technologies for the 21st century context because these technologies allow greater interaction among participants and ideally produce more collaboration.

Even though we had a small sample of participants, the study allowed us to describe the changes taking places in supervision in these two universities based on the rich narratives gained through in-depth interviews. Small sample sizes are not necessarily a limiting factor in qualitative research since the aim is to gain perspectives from a range of participants. "The rigor of a qualitative study should not be judged on sample size. When sampling is appropriate, the objectives and theoretical basis of the research should determine the size of the sample and the sampling strategy" (National Health and Medical Research Council 2007, p.27).

In deciding on the sample, we chose deliberately to look at areas outside of the sciences where team approaches were not traditionally used. This yielded more of an exploratory study in one field, education, with extended areas, engineering education and education psychology. In further research, it may be of benefit to look at science areas and other social science disciplines to see if the team approach exists in these areas or as in the case of the sciences is still prevalent and how ICTs have changed the way teams interact and disseminate their findings.

Data collection

We carried out in-depth interviews with students and their supervisors in 2013 and 2014 in two phases. The supervisors responded to an email asking for expressions of

interest and then the supervisors recommended their students. A separate expression of interest email was sent to their students. The supervisors and students who volunteered to participate in the study signed the relevant consent forms. We ensured confidentiality and anonymity and kept the two groups of participants separate.

In the first interview, some of the supervisors had not thought in depth about how they were using ICT. In a subsequent follow-up interview, they were better able to reflect on the use of ICT and whether as a result of their involvement in the study, there were any changes in how they used technology during that year.

In phase one, the in-depth interviews were conducted using semi-structured questions with eight supervisors and nine students. In phase two, audio reflections were gathered from five students who indicated that they were willing to have a second interview to provide reflections about their experiences and perceptions following Skype or face-to-face meetings with their supervisors.

The interviews and audio reflections were transcribed, coded and thematically analysed both deductively (set questions) and inductively (based on the literature themes) in NVivo 10 for Windows. Following Creswell's (2013) research methods, an 'inductive, emerging' analysis shaped the themes selected. Two independent researchers identified the emerging themes and then they compared and contrasted these to selected themes from the literature.

Participants

All the academics had supervised doctoral students and their supervision experiences ranged between 4 and 20 years. Some reported supervising as many as ten doctoral students at one time. Supervisors were from the fields of teacher education, educational psychology, and engineering education. All but one of the supervisors indicated that they were co-supervising students. One supervisor was supervising his/her doctoral students while working in another country (i.e. all distance supervision).

The research students were either in their first or second year of studies. Seven of the nine students were doctoral students and the other two were doing Masters by Thesis. Three were enrolled full-time and six part-time; all had family and/or career commitments; and there was a mix of funded and self-funded enrolments. Two students were in other countries, and one was in regional Western Australia, yielding three distance students.

Both supervisors and students had a high level of technology competence. They had already begun integrating these technologies into their supervision process.

Qualitative findings

Two researchers independently undertook the data analysis and identified the major findings. They used an iterative process to identify the main themes in the transcribed interview data. First we discuss the findings on the range of technology the participants used and how it altered their supervision process. Then we describe the changes they perceived after a year of reflection and finally supervisors identified some barriers they felt might limit the use of technology in supervision.

Use of technology

All participants were using what they considered to be basic ICT, such as email and mobile phones for communication and exchange of information, iPads, laptops and applications such as Twitter, video communications, audio recording and editing software. Most were also using Skype for meetings when unable to meet face-to-face or if distance supervision was involved. All supervisors reported the use of Word documents using 'track changes' and exchanging these via email, Dropbox or during Skype meetings, for sharing written drafts. All participants used the Internet for information seeking and sharing, as well as research databases and university specific software. Some used social networking mediums such as Twitter and Google Hangouts, which support web conferencing. Some supervisors were branching out into using other software, such as, iAnnotate (software for annotating PDFs on an iPad): '*One instrument that I use when I read my students' work and give them feedback is iAnnotate. It's very good, so you open it, you put everything in Dropbox and you open with iAnnotate and you can highlight and you can put comments in. I also use Skype a lot*' [SUP5].

Only two supervisors reported having recently encountered some students who had very little technology background (unable to format Word documents, for example). This was related to groups of students from particular countries, though it was also noted, in terms of technology competencies among graduate students, '*those gaps are narrowing now*' [SUP4] and increasingly research candidates had sufficient technology experience to be able to easily adapt to new technology requirements. At the other end of the scale, some reported their students were advanced users of technology and could teach their supervisors aspects of technology they found useful. For example, one student reported that he had taught his supervisor how to access and use Twitter, and the supervisor reported subsequently developing an academic Twitter community following, with supervisor and student recounting the way in which their Twitter engagement involved several overlapping academic discipline communities sharing research, disseminating new research findings, and exchanging other useful information such as writing and research methodologies.

Some graduate students were perceived as particularly proactive in technology use, such as recording meetings with their supervisors on their mobile telephone for later reference, using social networking sites to seek out others studying in similar areas, and videoconferencing from other countries for their research proposal presentations to university panels. With respect to overseas students who presented their proposals using the electronic software Prezi, their supervisor noted '*The two students who presented this way, they really loved it, and they made a lot of effort to create something that looked really quite impressive…and they were competent…confident*' [SUP8].

According to responses from all participants about communication, it was not uncommon for communication to occur several times a week by email. It was noted by one long-term supervisor that this was in stark contrast to 20 years ago, when she was doing her PhD and there were only two or three meetings per year. This supervisor also commented on a colleague's experience of undertaking a PhD some years ago: '*He met his supervisor maybe six or eight times throughout the whole degree*' [SUP8], noting that supervision had since become a much more participatory process.

In one case, communication also occurred via Twitter two to three times a week, which was reported as serving the function of answering quick questions, referring one

another to research or other resources, and also contributing to relationship building. They were also very active in referring one another to online blogs of academic communities that dealt with aspects of their research areas. The supervisor fed links to relevant blogs via a Tweet, which was reported as a quick and relatively non-intrusive form of communicating by the supervisor and the student. This supervisor reported that those students who were not on Twitter did not regularly get the benefits of being fed links to topic-relevant academic blogs, given that they were not active in this form of social media. With respect to using Twitter to communicate and share information, his student reported that it was '*by a light year the most useful*' [STU2]. She had to convince her supervisor of this:

> *At first he's 'oh no, a waste of time' and now he's on it more than me! [Laugh], which is great, and I benefit from it as well. He disseminates a lot of information through it and we have quick exchanges that would be awkward over email. It would be too formal* [STU2].

Most supervisors with distance students reported that they believed Skype was very useful for ensuring regular meetings and for relationship building. For example, one supervisor reported, '*He and I did not actually meet in person until the middle of the first year. So to actually meet and have that connection, then it was easy to pick it back up again through the technology*' [SUP8].

Some also reported using Skype to meet with prospective research candidates prior to making a decision as to whether they would be willing to supervise them, for example: '*I have used Skype with some prospective students, so some international students where I felt I want to meet this person before saying yes or no to a supervision…*' [SUP1]. And '*I just see it as a fantastic tool when it comes to supervising students who are not in the same geographical space as you are*' [SUP1]. Similar sentiments were reported by all but the one supervisor who expressed disinterest in distance supervision, and most reported anecdotes about successful relationship building and successful completions with candidates in different locations. The role of technology in facilitating a sense of community among students isolated by distance was acknowledged as a step forward: '*that sort of sense of community can be…a potential positive…absolutely*' [SUP2].

Supervision pedagogy

The project team was interested in exploring supervisors' perceptions of their supervision pedagogy, particularly in relation to aspects such as whether they saw the supervision process as a participatory partnership and a professional relationship and the extent to which they perceived technology could facilitate or inhibit these relationships. In relation to pedagogical discussions, the sub-themes of community and relationships emerged. Supervisors also pointed out that individuals differed and that to an extent, personalities and other individual factors, such as work and family commitments, contributed to the way supervisor-supervisee relationships and pedagogical approaches were negotiated.

Some supervisors explained the importance of developing initiative in their students to take control of their work and adopt a professional approach to the research process.

For example, '*One big issue is to enhance their initiative and accountability in the process…the more they show the ability to self-direct the process, the more I withdraw*' [SUP1]. Another supervisor mentioned the desire to have more strategies to motivate students and would like to have advice from more experienced supervisors about how to influence students who are difficult to manage, '*…more into strategies to actually make PhD students (not all of them again) a bit more focused and I think more the level of influencing them and stimulating them a bit more*' [SUP5].

Supervisors reported that some of their students were already professionals in their own fields and that these relationships were more collaborative than hierarchical. For example, '*I have one student…who is completely self-motivated…works best at a more collegial kind of, you know, sit beside the supervisors as an equal, right?*' [SUP2]. Some supervisors referred to the apprenticeship model: '*They're sort of an apprentice — almost; it's almost an apprenticeship in becoming an expert in a field. And in one sense, you are a mentor to them*' [SUP3].

Participants felt that there were different ways that technology facilitated their academic collaborations within their area of research. One supervisor reported that using online communications technology was '*absolutely critical*' to '*feel that you're a part of that community of researchers*' [SUP1]. Another supervisor reported that an online presence was instrumental in their academic work, '*I run my own website, I'm on Twitter…I've got over 1300 followers…which has been really useful for me as a strategy to both connect with other academics and other institutions*' [SUP2]. This supervisor also reported using social media to generate awareness of, and voluntary participation in their research, and to be part of online social media professional forums. This ensured their research findings could be disseminated to reach those for whom it was intended to make an impact in a timely manner rather than remaining in academic circles: '*The research should make an impact on…the sort of field in which you work…if it's not, it's a waste of time…If you're only writing for academics…a big 'who cares'*!' [SUP2].

Some students identified spouses or peers who had withdrawn from PhDs due to feelings of isolation, either social isolation due to being in remote Western Australia, or though city-based isolation due to a particularly unique research topic. The evidence we saw of academic uptake of online social media forums may help to arrest such attrition in the future.

Changes in perceptions and practices

Some supervisors reported the interview had prompted them to reflect on how they interacted and developed relationships with their students, in particular how they provided feedback. It heightened their awareness of the use of technology and the impact it could have on the research process. As a result of the first interview, one pair had initiated technological changes to make their relationship a more participatory one:

> *It made me aware…self aware of what I'm doing, and looking into the questions you asked. Starting Wiki was the outcome of this interview. Had you not interviewed me that day I don't think I would have thought of starting this Wiki with students* [SUP4].

This supervisor saw the value of *Wikispac*e for students, in creating a community of researchers who were sharing methodologies for researching and writing, and having ongoing discussions. It had become *'a learning space for these students'*, as well as a motivational space, for example, '*One student saw that student number two was progressing, and they started talking to each other. It proved to be a motivational factor for other students as well*' [SUP4]. According to this supervisor, the *Wikispace* provided a non-confrontational means through which students could be honest and open in a way that some would find difficult face-to-face. The supervisor also saw this virtual space contributing to the university's listed graduate attributes about '*interpersonal skills, people skills, or values-based skills*' [SUP1]. Another supervisor reflected on '*the pedagogy of feedback…and whose work it is…how much is co-constructed…and how much is correcting*' [SUP3] with research students. This reflection prompted the supervisor to provide more feedback to students.

Supervisors reported on the changes they had experienced in the process of supervision due to the use of technology and their own progress in adapting to emergent technologies both for teaching and for research supervision and collaboration with colleagues. Some supervisors noted that, as universities were changing their teaching delivery increasingly towards online offerings as well as ongoing technological changes in administration and governance, there was no choice but for staff to adapt to changes in the supervision context as well. As one supervisor noted, '*At the university level they are changing systems all the time which requires flexibility to learn different ways of putting your units up*' [SUP1]. Supervisors also reported very recently (in the past 12 to 24 months) they used social media platforms such as Google Hangouts, which provided space to write collaboratively with colleagues internationally. One participant observed that, while there is a growing international academic Twitter community in Australia, it is currently somewhat patchy: '*In states like NSW, there is a very healthy Twitter community…less so in WA…although it's starting…*' [SUP2].

Most participants had daily or at least weekly contact and made comments such as, '*We decided to increase the frequency of the supervision to make it a more continuous process…to have Skype sessions between the face-to-face sessions*' [SUP6]. What's more, there was an expectation among students that their supervisors would be readily available, at least via technology. It is now taken for granted, as the following representative quote indicates: '*Technology's really important because you can't meet up face-to-face all the time*' [STU1].

Students often spoke of contacting their supervisors by telephone, texting or email for a quick response to questions, day or night, and supervisors reported the need for boundaries in the context of technological communication.

Several students mentioned how enthusiastic their supervisors were to use technology and try new programs: '*Oh, she's great, really receptive, yeah*' [STU5]; and '*I think she's quite keen. If I wanted to use more technology, she would be more than willing to*' [STU4].

One student described how technology had facilitated her supervision by making contact more consistent:

> *The supervision process, as far as I am concerned is good via Skype. What we have done is to lock in regular Skype appointment times and that forces me to hold myself*

> *accountable, so as to have progress in my research. And also, during the discussion, my supervisor gave me suggestions for the next step, pointing me in the right direction for resources or suggesting reading to refine my thinking, or suggesting reading for me to develop the next stage of data collection for writing* [STU8].

This student also talked about Skype as a motivating factor: '*To me Skype is a great way to stay in touch with my supervisor to ensure that I am making progress. I have found it is not only putting a name to a face, but having the ability to bounce off ideas or discuss challenges and maintain some degree of motivation towards my research*' [STU8].

Three other students talked about the importance of technology to improve their research work, ending with a working mother who saw it as essential:

> *I want to embed more virtual work with my supervisor and probably if I look at the amount of time that the supervisor is investing in me, then being able to reduce that face to face and supporting virtual, not just email – I think email is probably not deep enough – a video conference whether it's a Skype call or something like that, just adds that personal piece that my personality probably needs* [STU9].
>
> *So we talked about the data I'm using, which was helpful, and then she reiterated that she's happy to talk any time, Skype or through email, and that's basically how we've been going along. I email her where needed. I'm pretty focused on working steadily on my project so I don't need any constant checks on what I'm doing but what I do need is to submit work when I've done it and get quick feedback, which she's been good at, and over the next few months when I really get into the writing that's going to be the most important thing* [STU7].
>
> *The use of technology for someone who is working is paramount – I couldn't do it otherwise* [STU4].

Barriers perceived

One supervisor reported that people are generally '*quite nervous and scared and apprehensive*' about technology and *'about the whole PhD process. I think if you force them to…do it online, I think you're adding another complexity to an already complex relationship*' [SUP2]. This supervisor expressed concern that, if a policy was introduced about taking up a particular technology for the doctoral process, it may prove counterproductive.

Another issue raised by supervisors was the potential for working longer hours and the perception of being always available to respond to students' questions via technology, and the extra vigilance required to maintain a work-life balance. Supervisors spoke of their students sending text messages late in the evening expecting prompt answers to questions, and having to create boundaries around appropriate times for Skype meetings and other requests. The students regularly expressed how important it was for them to receive quick responses in the context of having full-time careers, families, and limited hours to work on their research. Increased accessibility of supervisors as a result of technology was viewed as both positive and negative. For example, '*…on the one hand, while that accessibility can be great for the student…it can also be kind of a double-edged sword, can't it*?' [SUP2].

Another concern raised was in relation to research students using social media to discuss their research, and the potential problems this could create in the case of people not yet experts in a particular field being quoted as experts in the media, for example, and *'being seen to speak with authority on things they don't actually know much about'* [SUP2].

Some supervisors reported sensitivity on the part of their graduate students in receiving feedback, and that written feedback could appear not only more harsh, but also overwhelming to see many revisions and comments, and importantly, demotivating. It was perceived that this could be managed better face-to-face, though it was also acknowledged that increasingly, at both undergraduate and graduate levels, academics are required to provide written feedback of online assessment submissions and that becoming more accustomed to adapting to this form of feedback is a necessity.

Finally, poorly implemented institutionalised use of technology was reported as a commonly experienced barrier and often influenced negative attitudes towards technology. One example that was repeatedly cited was to do with mandatory administrative forms of research supervision, in the form of templates online, which were reported as difficult and time consuming. The following quote represents several complaints of this nature, '*The problems we have are more with stupid forms – that's where people see aaah, frustration rather than useful technology*' [SUP3].

Discussion

Supervisors reported that the range of technological competence among their students was no longer so great as most students were adept at using new technologies. Most were high users of ICT in their every day lives so they tried to integrate these into their supervision process. The vast majority used email and Skype, which increased the frequency of contact between supervisors and students creating a more intense relationship. A few supervisors and students used online social media like Twitter, mainly to disseminate their research findings. Nevertheless, supervisors and their students identified the need for an increased use of ICT and an integration of that technology with supervision pedagogy. The students needed more frequent communication and an accommodation of their family and work commitments.

As a result of the study, a more intensive relationship developed through increased contact between supervisors and their students that was facilitated by Web2.0 technologies. The supervisors began to change their supervision pedagogy by developing more participatory relationships through greater collaboration and communication using new technologies and increased their use of social networks such as Twitter for disseminating their research findings.

The findings that emerged from the interviews and reflections aligned with most of the findings of the literature review. For example, supervisors and supervisees were aiming to form communities of researchers and learners and less hierarchical and more participatory relationships (e.g. Albion & Erwee, 2011; Fenge, 2012; Green et al., 2012). Several concepts that were present in the literature (Green et al., 2012; Lee, 2008), such as the increased connectedness among supervisors and supervisees and the more intensive supervision, were also evident in the interview data. Similar to the established yet few collaborative online communities of researchers that were found in the literature review (Danby & Lee, 2012; Malingre et al., 2013), some individual supervisors from

this study were initiating their own online academic communities that included their students, without institutional or departmental support.

Hamilton, Carson, and Ellison (2014) described the idea of self-reflection to change practices in supervision. They also identified the need for learning communities for supervisors, similar to those enacted for students and their supervisors. This would enable supervisors to enter into dialogues about supervision practices and to exchanges ideas between new and experienced supervisors. Built into the methodology for this project was reflection on the supervisors' practices and as seen above this type of self-reflection yielded changes within the practices of some of the supervisors over the course of our study.

Where the interviews and reflections diverged from the literature, however, was that all of the students reported that their supervisors were competent and willing to use technology, sometimes initiating the uptake of new technologies, and at other times learning and adopting new technology from their students. This was in contrast to a large longitudinal research project (Carpenter, 2012; Carpenter et al., 2010, 2011) in the literature review that, according to most of the Gen Y doctoral students in the study, found their supervisors were not very interested or competent in using Web2.0 technologies. There may be two reasons for this anomaly: 1) the study's small sample from a limited range of disciplines; and 2) supervisors who volunteered to participate in the study may have had greater confidence and interest in the use of technology.

Conclusion

In most professions, individuals are expected to be competent in the use of technology and to adapt to emerging technologies. This is the case for universities as they become more international and competitive in a global environment. Universities are also making continuous changes in technology in administration, governance and teaching. Thus there is an increasing necessity for supervisors to adapt to emergent technologies with their students. This study showed that this process is already underway with many innovative ways of creating research communities through the use of ICTs.

There were some participants who felt that universities would be ill advised to 'force' research students into using technology even though it is increasingly a requirement for professional practice and for those seeking a career as academics. However, as more students take up distance and part-time research opportunities, supervisors will have to meet their needs with more online resources to match the opportunities provided to those on campus. Additional training with emergent technologies could encourage supervisors and their students to keep abreast of the latest innovations. Forums where these new technologies are shared among supervisors would facilitate this transfer of knowledge.

As more international students seek research degrees in Australia, participants suggested institutions should respond to their language and academic writing needs. Some supervisors recommended the creation of software that would address the needs of research writing, including showing revisions in a more efficient way than the current 'track changes' in MS Word software. They also wanted institutions to develop online resource repositories with links to community research forums that would give them exposure to professional publication and administrative forms, such as ethics, milestones and project management tools.

A major change in using Web2.0 technologies is that the learner participates by becoming a co-creator of knowledge. This can happen in the research process as students utilise Web2.0 technologies to collaborate with their supervisors and communities of researchers. This study demonstrated that as supervisors and their students adopted Web2.0 technologies, supervision became more participatory in nature and lead to greater connectedness and collaboration. In the future, students could be encouraged to share their work through collaborative technologies, such as YouTube and websites that would allow public scrutiny of their work.

New technologies may play a vital role in transforming traditional, dyadic forms of supervision towards a more collaborative group process. What is needed when creating a community of research students is to sustain this community for the duration of their journey. New technologies when combined with participatory pedagogy may provide the context to sustain such a community with ongoing dialogue, reflection and the ability to co-create knowledge.

Acknowledgment
This work was supported by a grant from the Office for Learning and Teaching, Higher Education Division, Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education, Australia [Grant number SD12-2447].

Authors' contibutions
Both authors read and approved the final manuscript.

Competing interests
The authors declare that they have no competing interests.

Received: 24 August 2016 Accepted: 5 November 2016
Published online: 06 March 2017

References

Aitchison, C., & Guerin, C. (2014). Writing groups, pedagogy, theory and practice: An introduction. In C. Aitchison & C. Guerin (Eds.), *Writing groups for doctoral education and beyond: Innovations in practice and theory*. London: Routledge.

Aitchison, C., & Lee, A. (2010). Writing in, writing out: Doctoral writing as peer work. In M. Walker & P. Thomson (Eds.), *The Routledge doctoral supervisor's companion: Supporting effective research in education and the social sciences* (pp. 260–269). London: Routledge.

Albion, P., & Erwee, R. (2011). Preparing for doctoral supervision at a distance: Lessons from experience. In Maddux, C. (Ed.), *Research highlights in technology and teacher education. Society for Information Technology and Teacher Education (SITE), Chesapeake, VA* (pp. 121–128). SBN 1-880094-88-6.

Bandura, A. (1977). *Social learning theory*. New York: General Learning Press.

Bruce, C. (2009). *Towards a Pedagogy of Supervision in the Technology Disciplines*. Australian Government Office for Learning and Teaching Project. Final Report. Retrieved from: www.olt.gov.au/resource-towards-pedagogy-supervision-qut-2009.

Carpenter, J. (2012). Researchers of tomorrow: The research behaviour of generation Y doctoral students. *Information Services and Use, 32*(1), 3–17. doi:10.3233/ISU-2012-0637.

Carpenter, J., Tanner, S., Smith, N., & Goodman, M. (2011). *Researchers of tomorrow: A three year (BL/JISC) study tracking the research behaviour of 'generation Y' doctoral students: Second Annual Report 2010–2011*. London: Education for Change.

Carpenter, J., Wetheridge, L., Smith, N., Goodman, M., & Struijvé, O. (2010). *Researchers of tomorrow: A three year (BL/JISC) study tracking the research behaviour of 'generation Y' doctoral students: Annual Report 2009–2010*. London: Education for Change.

Creswell, J. W. (2013). *Qualitative inquiry and research design: Choosing among five approaches*. Thousand Oaks: Sage Publications.

Cumming, J. (2010). Doctoral enterprise: A holistic conception of evolving practices and arrangements. *Studies in Higher Education, 35*(1), 25–39. doi:10.1080/03075070902825899.

Danby, S., & Lee, A. (2012). Researching doctoral pedagogy close up: Design and action in two doctoral programmes. *Australian Universities Review, 54*(1), 19–28.

de Beer, M., & Mason, R. B. (2009). Using a blended approach to facilitate postdoctoral supervision. *Innovations in Education and Teaching International, 46*(2), 213–226. doi:10.1080/14703290902843984.

Denzin, N. K., & Lincoln, Y. S. (2005). *The Sage handbook of qualitative research* (3rd ed.). Thousand Oaks: Sage.

Fenge, L.-A. (2012). Enhancing the doctoral journey: The role of group supervision in supporting collaborative learning and creativity. *Studies in Higher Education, 37*(4), 401–414.

Green, P., & Bowden, J. (2012). Completion mindsets and contexts in doctoral supervision. *Quality Assurance in Education, 20*(1), 66–80. doi:10.1108/09684881211198257.

Green, P., Bowden, J., & Andrew, M. (2012). Supervising doctorates at a distance: Three trans-Tasman stories. *Quality Assurance in Education, 20*(1), 42–53. doi:10.1108/09684881211198239.
Group of Eight. (2013). *Discussion Paper: The Changing PhD*. Retrieved from: https://go8.edu.au/sites/default/files/docs/the-changing-phd_final.pdf.
Guba, E. G., & Lincoln, Y. S. (2005). Paradigmatic controversies, contradictions, and emerging confluences. In N. K. Denzin & Y. S. Lincoln (Eds.), *The Sage handbook of qualitative research* (3rd ed., pp. 191–215). Thousand Oaks: Sage.
Halse, C. (2011). 'Becoming a supervisor': The impact of doctoral supervision on supervisors' learning. *Studies in Higher Education, 36*(5), 557–570. doi:10.1080/03075079.2011.594593.
Hamilton, J., Carson, S., & Ellison, E. (2014). *Building distributed leadership for effective supervision of creative practice higher research degrees*. Sydney: Australian Government Office for Learning and Teaching. Final Report.
Hammond, J., Ryland, K., Tennant, M., & Boud, D. (2010). *Building research supervision and training across Australian universities*. Strawberry Hills: Australian Learning and Teaching Council.
Jenkins, H. (2006). Confronting the challenges of participatory culture: Media education for the 21st Century. White paper for MacArthur Foundation, 2006. Retrieved from https://www.macfound.org/media/article_pdfs/JENKINS_WHITE_PAPER.PDF.
Le, Q. (2012). E-Portfolio for enhancing doctoral research supervision. *Quality Assurance in Education, 20*(1), 54–65. doi:10.1108/09684881211198248.
Lee, A. (2008). How are doctoral students supervised? Concepts of doctoral research supervision. *Studies in Higher Education, 33*(3), 267–281. doi:10.1080/03075070802049202.
Malfroy, J. (2005). Doctoral supervision, workplace research and changing pedagogic practices. *Higher Education Research and Development, 24*(2), 165–178. doi:10.1080/07294360500062961.
Malingre, L. In collaboration with, Serres, A., Sainso, A., & Men, L. (2013). Form@doct: Designing innovative online tutorials for PhD students in France. *IFLA Journal, 39*(1), 45–57
Manathunga, C., & Lant, P. (2006). How do we ensure good PhD student outcomes? *Education for Chemical Engineers, 1*(1), 72–81. doi:10.1205/ece.05003.
McCallin, A., & Nayar, S. (2012). Postgraduate research supervision: A critical review of current practice. *Teaching in Higher Education, 17*(1), 63–74. doi:10.1080/13562517.2011.590979.
National Health and Medical Research Council. (2007). *National Statement on Ethical Conduct in Human Research*. Canberra, Australia
Parker, R. (2009). A learning community approach to doctoral education in social sciences. *Teaching in Higher Education, 14*(1), 43–54. doi:10.1080/13562510802602533.
Phelps, R., Fisher, K., & Ellis, A. (2006). Organisational and technological skills: The overlooked dimension of research training. *Australasian Journal of Educational Technology, 22*(2), 145–165.
Rockinson-Szapkiw, A. (2011). Improving doctoral candidates' persistence in the online dissertation process. *Proceedings of Global Learn Asia Pacific Conference* (pp. 1162–1166). Melbourne, Australia
Stelma, J. (2011). An ecological model of developing researcher competence: The case of software technology in doctoral research. *Instructional Science: An International Journal of the Learning Sciences, 39*(3), 367–385. doi:10.1007/s11251-010-9132-7.
Stubb, J., Pyhältö, K., & Lonka, K. (2014). Conceptions of research: The Ph.D. student experience in three domains. *Studies in Higher Education, 39*(2), 251–264. doi:10.1080/03075079.2011.651449.
Taylor, S., & Beasley, N. (2005). *A handbook for doctoral supervisors*. London: Routledge.
Wenger, E. (1999). *Communities of practice: Learning, meaning and identity*. Cambridge: Cambridge University Press.