Education Research and Perspectives
An international journal

Volume 42, 2015, Pages 397-428

Engaging in Networked Learning: Innovating at the Intersection of Technology and Pedagogy

Grace Oakley† and Mark Pegrum

University of Western Australia

This paper reports on a case study of university lecturers' professional learning about digital technologies over four years, and their development of associated innovative teaching practices. During the first year, new hardware and software, as well as planned professional development (PD) opportunities, were made available to assist lecturers involved in initial teacher education in a Faculty of Education at an Australian university to integrate digital technologies into their teaching. Over the 2011-2014 period, some transformed their teaching practices substantially. It turned out that the provision of formal PD was only a trigger – much unplanned and unanticipated professional learning occurred through informal interaction, with lecturers co-learning with colleagues, and indeed with students, in an environment of enthusiastic experimentation. Formal learning was thus complemented by a networked model of the spread of knowledge and skills among colleagues, students, and wider educational communities. This paper, which focuses on the learning of two staff members who changed their practices considerably, suggests that educators benefit from a combination of formal and informal professional learning strategies when it comes to integrating digital technologies into their practices in pedagogically innovative ways.

Introduction

This study commenced under the auspices of the Australian Teaching Teachers for the Future (TTF) initiative. This nationwide project was implemented in 2011-2012 to support lecturers in teacher education – that is, teacher educators – in teaching with and about information and communication technologies (ICTs),

† Address for correspondence: Grace Oakley, The Graduate School of Education, The University of Western Australia, M428, 35 Stirling Highway, Crawley, WA, 6009. Email: Grace.Oakley@uwa.edu.au.

with an emphasis on pedagogically effective use of these tools (Romeo, Lloyd & Downes, 2012). The initiative was in response to a requirement in the Australian Curriculum, first implemented in 2012, that ICTs be taught across all school curriculum areas as one of seven 'general capabilities' (ACARA, n.d.). In addition, ICTs are interwoven in subject-specific ways into the curriculum documents in all learning areas covered by the Australian Curriculum.

At the same time, the Australian Professional Standards for Teachers (APST), introduced in 2011, mandate that all newly graduating teachers should be competent in using ICTs to support their teaching (AITSL, 2012). Among the focus areas which make up the seven standards, there are three that specifically reference ICTs: Focus Area 2.6 concerns knowing how to use ICTs to support teaching; Focus Area 3.4 concerns selecting and using resources, including ICTs; and Focus Area 4.5 concerns using ICTs safely, responsibly and ethically.

Thus, in order to prepare pre-service teachers to teach the Australian Curriculum, and ensure their attainment of the graduate stage of the APST, lecturers in Faculties of Education throughout Australia have been required to upgrade their own knowledge of, and skills in, the use of digital technologies, including developing strategies to keep abreast of rapid advances in this area.

The TTF initiative, which was designed to support this process, had Mishra and Koehler's (2006) TPCK, later renamed TPACK, framework at its core. TPACK focuses on teachers' integration of their Technological, Pedagogical And Content Knowledge to design learning experiences for students. The TPACK framework is often used in conjunction with Puentedura's (2011) SAMR (Substitution, Augmentation, Modification, Redefinition) model, which challenges teachers to integrate new technologies into their classrooms in increasingly transformational ways (Dudeney, Hockly & Pegrum, 2013). While SAMR was not officially endorsed by the TTF project, it offers teachers an intuitively

appealing way to put the TPACK principles into practice. Both TPACK and SAMR are described in greater detail below.

This case study of lecturers' professional learning and practice took place within a Faculty of Education at an Australian university. It focused on nine lecturers in a two-year Master of Teaching programme which prepares students, all of whom already have a degree in a relevant area, to become Early Childhood or Primary teachers. At the time of the commencement of the study, there were several new Faculty initiatives, including the introduction of wiki-based student e-portfolios (Oakley, Pegrum & Johnston, 2013); the installation of interactive whiteboards (IWBs) in the main teaching rooms; and the loaning of iPads to all lecturers and first year students in the Master of Teaching programme (Pegrum, Howitt & Striepe, 2013).

It was within this context that staff members were asked to engage in an ongoing PD programme, structured around the TPACK and SAMR frameworks. It comprised presentations and workshops by Faculty lecturers who were more experienced in using ICTs in teaching and learning, as well as one-on-one development sessions facilitated by an ICT Pedagogy Officer (ICTPO), a seconded school teacher who was highly accomplished at using ICTs in the classroom. All academic staff members in the initial teacher education programmes in the Faculty were involved in this upskilling process. This included the authors, who delivered or facilitated a number of the PD sessions and who, as members of the teaching team, were also involved in regular interaction with colleagues in the process of reflecting on and seeking to further develop their own teaching with digital technologies. The authors were thus participant researchers as they were an integral part of the learning community.

Literature Review

Digital technologies and learning

The ways in which people can access, engage with and communicate ideas and knowledge are expanding thanks to new types of hardware, such as smartphones and tablets; new types of software, such as social media platforms and mobile apps; and improving wired and wireless connectivity. Educators around the world have begun to harness and repurpose these ICTs, using them as tools that can enhance and transform teaching, learning and assessment (Puentedura, 2011).

However, it has been argued that lecturers in higher education are often resistant to changing their teaching practices (Ellis & Goodyear, 2010) for a variety of reasons, including the inhibitive 'traditions, values and infrastructure' of universities (Laurillard, 2002, p. 3). Furthermore, when lecturers employ ICTs in their teaching, the underlying pedagogical strategies are frequently unchanged, except that they operate in digital formats (Laurillard, 2006). While this generally represents a restricted use of new technologies by lecturers, it is of particular concern when it comes to lecturers in education. The latter are tasked with preparing future generations of teachers and therefore need to be able to model pedagogically effective uses of ICTs in meaningful contexts (Lim, Chai & Churchill, 2011; Steketee, 2005). This involves teaching through as well as about the use of ICTs, a point which has become all the more salient in the Australian context, thanks to the Australian Curriculum and the APST. The use of ICTs to further learning is often referred to as e-learning (electronic learning), while the more recent use specifically of mobile technologies is known as m-learning (mobile learning).

There are varying conceptualisations of e-learning (e.g., Haythornthwaite & Andrews, 2011; Horton, 2012; Mason & Rennie, 2006; Pachler & Daly, 2011), with an emphasis being placed in recent years on socially constructed learning through the use of ICTs (Garrison, 2011). Yet, as Haythornthwaite and

Andrews (2011) observe, e-learning is dynamic and constantly changing. This is even more the case with m-learning, which can take education outside the boundaries of traditional learning spaces and schedules (e.g., McCaffrey, 2011; Sharples, Taylor & Vavoula, 2010). This means that educators must be flexible and innovative, always keeping abreast of new technological developments and their pedagogical possibilities. This has implications for PD, which must be ongoing and customised to educators' needs, as well as allowing scope for educators to customise their use of ICTs to their students' changing needs. Traditional models of PD are no longer always relevant.

TPACK and SAMR

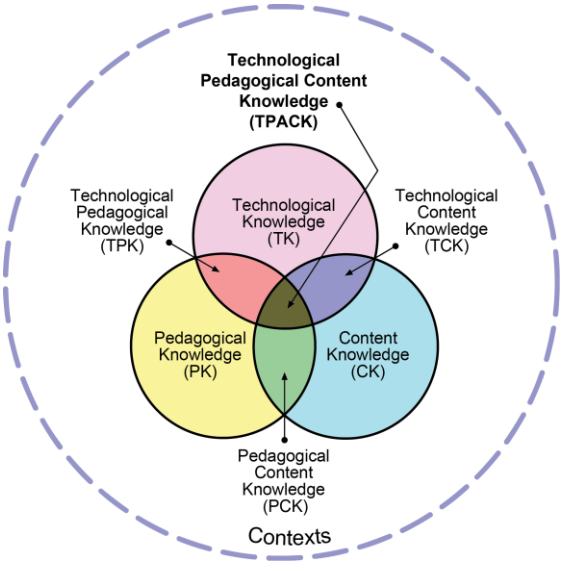

Figure 1. The TPACK framework. Source: tpack.org, © 2012, reproduced by permission.

Perhaps the best-known teacher development model involving ICTs is Mishra and Koehler's (2006) TPACK framework, which consists of interlocking circles representing teachers' technological knowledge (TK), pedagogical knowledge (PK) and content knowledge (CK), as seen in Figure 1. Used to underpin the work of the Australian TTF project, it advocates integrating understanding of technology with understanding of content and pedagogy, which have long been regarded as teachers' core competencies. Placing equal importance on all three areas, it suggests that the most effective teaching may occur in the areas of overlap between the circles, with technology being an integral part of TCK, TPK and, of course, TPACK as a whole.

The TPACK framework, as noted earlier, can be usefully complemented by Puentedura's (2011) four-level SAMR model, as seen in Figure 2. When teachers and teacher educators first begin to work with ICTs, they are likely to start on the lowest level, substitution, where, for instance, they might simply ask students to type up and submit essays by email instead of submitting them on paper, leading to efficiency gains but no learning gains. Small learning gains begin to appear at the next level, augmentation, as ICTs are used to add functional improvement. To transform rather than simply enhancing learning, however, teachers need to work at the upper two levels of the SAMR model, involving modification or redefinition of learning tasks. The latter might entail, for example, replacing an essay task with a digital video task where students' work is subject to peer feedback and editing before being publically shared; thus, ICTs can facilitate an increase in multimodality, collaboration and co-construction of understanding, with a real-world target audience lending the task greater significance. (For a fuller discussion of the SAMR levels, see: Pegrum, 2014.) Puentedura (2012) estimates that a full-time teacher might need around three years of experience with ICTs to move from tasks which simply involve substitution to tasks which involve some redefinition.

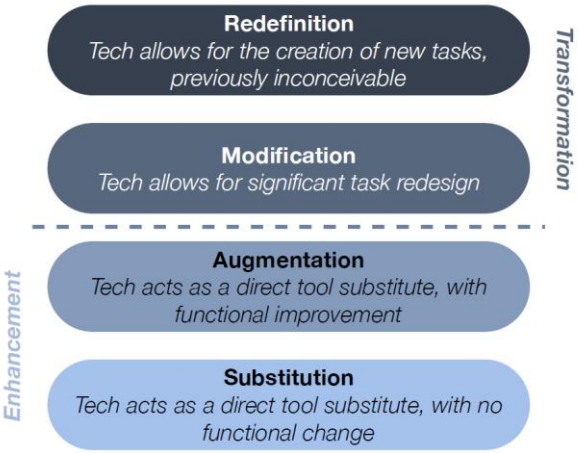

Figure 2. The SAMR model. Source: Puentedura (2011), under CC BY-NC-SA 3.0 licence.

In the current study, both TPACK and SAMR were introduced in presentations, and discussed in workshops, in order to give lecturers theoretical frameworks to help contextualise and guide their thinking about, and integration of, ICTs in their classes. The seconded ICTPO was also available to help lecturers improve their TK and consider how it might be integrated with their PK and CK, as well as how they might shift their technology usage towards the higher SAMR levels.

Professional learning and changing practices

There is no guarantee that PD in educational settings will lead to real change in either teachers' practices or attitudes. In fact, Guskey (2002) has pointed out that it can be extremely difficult to design and implement PD that results in educators changing their teaching practices, unless they see clear benefits for their students' learning. In the context of ICTs, one barrier to change could be that the PD typically emphasises the teaching of skills (how to use

new hardware or software packages) rather than the meaningful embedding of ICTs into the curriculum (Pachler, Preston, Cuthell, Allen & Pinheiro-Torres, 2010). Ward and Parr (2010) have suggested that there is, in fact, no one best way of providing ICT-related PD for educators because of their diverse needs, and because of the varying ways in which ICTs can be used in teaching and learning. Indeed, traditional PD in this area is often ineffective (Brinkerhoff, 2006) and it appears that new modes of professional learning are required to enable educators at all levels to cope with constant changes in the available technologies and their associated pedagogical potential.

As in many other PD initiatives, staff development in the area of ICTs often takes the form of presentations, sometimes accompanied by hands-on workshops where participants can receive guidance as they begin to experiment with new technologies, and it may also involve one-to-one coaching. This largely reflects a top-down 'training' model of knowledge building and upskilling, which may be supported by a 'coaching/mentoring' model (Kennedy, 2014). In recent years, increasing attention has been paid to alternative, but complementary, development models which focus on bottom-up rather than top-down learning. In the well-known 'community of practice' model (Wenger, 1998), community members 'share a concern or a passion for something they do and learn how to do it better as they interact regularly' (Wenger, n.d.). A related model with a specific educational focus is the 'community of learning', which may be defined as a 'group of people working together to facilitate the learning process' (Hill, 2012, p. 269); a community of learning may be either 'bounded' (having a limited lifecycle associated with a specific learning need, and often being directed by a person in a position of authority) or 'spontaneous' (emerging when a group of people with a common learning interest work together to improve their knowledge and practices) (Wilson, Ludwig-Hardman, Thornam & Dunlap, 2004).

Of late, there has been growing interest in a networked or viral model of learning, referring to learning which takes place through

personal, social and/or professional connections between teachers, learners, communities and resources, often (though not always) facilitated by ICTs (e.g., Goodyear, Jones, Asensio, Hodgson & Steeples, 2005). While there have been some attempts to combine the concepts of communities and networks (e.g., Earl & Katz, 2007; Katz, Earl & Ben Jaafar, 2009), these are generally treated as separate lenses, each of which can highlight particular aspects of professional learning. The notion of networked learning is linked to the wider development of network theory in the sciences and social sciences (Barabási, 2003; Buchanan, 2002; Watts, 2003), and to the increasing emphasis on personal learning networks (PLNs) in education (Ferriter, Ramsden & Sheninger, 2011; McElvaney & Berge, 2009; Richardson & Mancabelli, 2011). Referring to the related idea of viral learning, Cluett, Skene and Pegrum (2011) comment on the spread of ideas among professional university staff in terms of 'viral leadership', which entails:

> the promotion of ideas, knowledge and skills on an ad hoc basis via informal personal connections based on mutual interest and enthusiasm …. Unlike the kind of leadership associated with more formal training and a cascade model of knowledge and skills dissemination [i.e., a top-down training model], it can be seen that the viral model builds on the interconnected links between participants, with ideas, knowledge and skills spreading 'like a virus' through the network. (p. 3; italics in original)

Such a model allows staff who are not in official leadership positions to 'lead change in ways that are not predetermined or even entirely predictable' (p. 1). This echoes the widely stated observation in the ICT literature that it is important to have staff leaders – though not necessarily with official leadership positions – who can 'infect' other staff members with enthusiasm for using new technologies as they share their inspirations, ideas and successful innovations (Pegrum, 2014). It should be noted that there is no commonly accepted distinction between networked and viral learning. Both can involve ideas spreading rapidly and widely. However, it might be argued that networked learning

shades into viral learning when ideas are disseminated not only quickly and broadly but often in multiple directions at once; these ideas may also take on mutated or changed forms as they are adopted, adapted and repurposed to suit different areas, needs and interests.

The professional development of lecturers in the current project was originally organised in a traditional top-down training manner combined with optional coaching/mentoring (Kennedy, 2014), and without any specific focus on developing a community of practice or learning, or a learning network. A key insight of this study was that, in an appropriately innovative environment where teachers share a wish to transform their practices, and have some agency in determining how to do so, a bottom-up learning process can spontaneously emerge among staff members. It can complement, extend, and continue beyond the end of more formal learning periods. To the extent that learning flows through a variety of personal connections, whether face-to-face or technologically mediated or both, and to the extent that it flows in multiple directions through a network which is effectively unbounded, it can be helpfully viewed through the lens of a networked or viral learning model.

Methodology

This research used a case study methodology to examine changes in teaching practices among staff. Case studies allow researchers to examine a phenomenon 'in its natural setting, recognising its complexity and its context' (Punch, 2009, p. 119). As Gay, Mills and Airasian (2009, p. 427) point out, case studies are appropriate when researchers aim to study processes, such as change processes. This case study set out to investigate the question: *How do teacher educators change their pedagogical practices as a result of formal and informal professional learning about using digital technologies to enhance and transform their teaching?*

Conducted over four years, this study helps fulfil the pressing need for more longitudinal research into the use of new technologies in education (Pegrum, 2014).

The study was launched in tandem with a formal PD programme to upskill Faculty of Education staff in the pedagogically effective integration of new technologies into their classes, informed and partially funded by the Australian TTF initiative. The PD programme, in which most lecturers in the Faculty participated, is described in more detail below. All participating lecturers involved in teaching core units of the Early Childhood and Primary Master of Teaching programme in the Faculty were invited to take part in the current study.

As seen in Figure 3, the first phase of data collection took place in late 2012, i.e., the year following the Faculty's formal PD programme and the year when the TTF project ended. Data collection began with a questionnaire that was administered anonymously online to all PD participants, including the authors, with the purpose of obtaining an overview of staff learning and practices; it included Likert scale questions as well as open-ended questions. The results of this questionnaire are not presented in the current article, which focuses instead on case studies derived from the subsequent focus group and interviews. The focus group involved four lecturers who, in the course of their discussion, collaboratively developed key themes associated with the whole group's learning over the period of 2011-2012. This was followed by semi-structured interviews, to provide insights into individual staff members' learning trajectories over this same period. Two staff members who were identified as having changed their practices significantly, as detailed in the 'Most Significant Change' stories (Dart & Davies, 2003) created as part of the TTF project (Heck & Sweeney, 2013), were interviewed again in late 2014 to develop a longitudinal understanding of their professional learning journeys and their changing teaching practices involving ICTs. Inductive data analysis was used (Miles, Huberman & Saldana, 2014); this involves detailed readings and evaluation of

raw data by researchers 'to derive concepts, themes or a model' (Thomas, 2006, p. 238).

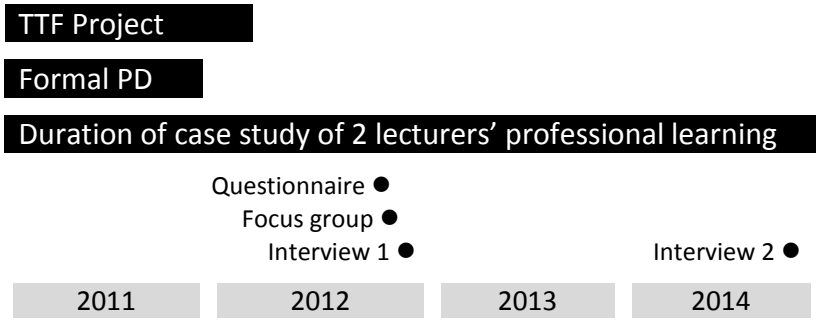

Figure 3. Timeline of case study of lecturers' professional learning.

The research complied fully with institutional ethics requirements, and permission to undertake it was granted by the university's Human Research Ethics Committee. Participants were aware that they could withdraw from the research, and confidentiality was assured. Pseudonyms are used in this paper to protect participants' anonymity, and some details about their teaching areas and other identifying factors have been omitted for this reason. As briefly indicated above, the authors, who worked on the TTF project and helped oversee PD in the Faculty, were necessarily participant researchers, which gave them additional insights into the ongoing change processes. However, they did not participate in the focus group, nor were they involved in conducting the focus group or interviews.

Lecturers' professional learning and innovations

Formal professional learning

All lecturers in the Faculty were expected to attend some of the formal PD sessions on the use of ICTs in education, which were organised and delivered in part by the authors of this paper. Most of these sessions made some reference to TPACK and SAMR, with the first two listed below having a strong focus on these frameworks. SAMR found particular resonance among lecturers as a way of conceptualising the pedagogical effectiveness of their current and planned uses of ICTs. The full PD programme, delivered in 2011, consisted of:

- Delivery of a presentation by one of the authors of this paper to introduce staff to TPACK, SAMR, and a range of web 2.0 and social media tools and techniques – for example, blogs, wikis, folksonomies, podcasting, vodcasting, and digital storytelling platforms – and showcase examples of their use in schools and universities;
- Delivery of a presentation and workshop by both authors of this paper on how ICTs might be built into programme units, with staff bringing their unit outlines for a discussion with colleagues about how they could push their use of new technologies towards the higher SAMR levels;
- Delivery of two workshops on using wikis, and specifically the Wikispaces platform, to enable staff to assist pre-service teachers in building wiki-based e-portfolios;
- Delivery of two workshops on using IWBs, specifically Smartboards, given that these had recently been installed in the main teaching rooms;

- Delivery of two workshops on using iPads for teaching and learning, given that all first-year students on the Master of Teaching programme had been loaned iPads for the duration of their first year of study, following the loaning of these devices to staff;
- One-on-one mentoring by the ICTPO, available on request over 12 months;
- Development of a repository of tools, ideas and instructions, built and made available to staff through the university's learning management system (LMS), Moodle.

Informal professional learning

It was found that lecturers engaged in a variety of informal learning activities which were not planned or predicted. This often took place through staff experimenting or 'playing' with the technologies, frequently in pairs or small groups. The process involved investigating how different hardware and/or software could be used to teach particular content areas or support particular teaching strategies, and then passing on emerging insights to others. One lecturer put it this way:

> I just wanted to find out what people were doing and [see] what they were doing. We talked about this great app – I would like to see it. It is not formal sharing, it is more an informal sharing. (Focus Group)

As staff enthusiasm for and engagement with digital technologies increased over time, some chose to attend PD sessions outside the university and then spread key ideas to their colleagues in the Faculty. For example, one lecturer said:

> How did I find Book Creator? I think I was at an Early Childhood Conference and someone mentioned it … I would not have found it by myself. (Bronwyn, Interview 2)

Sometimes new ideas were shared in a face-to-face manner with colleagues, and at other times in the form of digital links to websites or apps. Thus, learning occurred through blended networks consisting of both non-digital and digital connections. Staff also found themselves learning from and with the pre-service teachers who were their students:

> We saw [the pre-service teachers] doing things we never expected .... We learned from them, showing us apps and things. (Bronwyn, Interview 1)

One lecturer spoke of how she learnt about technology from pre-service teachers, while simultaneously helping to deepen their and her own TPACK through critical analysis of digital resources and their pedagogical applications. Thus, there was a fertile reciprocal sharing, with the lecturer's knowledge about pedagogy and content, and the pre-service teachers' knowledge about technology, being drawn together in an almost symbiotic way:

We did the apps. I don't know very much. But I had the students share and I learned so much more. They know these apps and the video YouTube things as well. But they are not critical and some of those [video clips] are totally against what we have been learning about the ways students' concepts develop. We actually did a critique of guys in a video clip, it was a YouTube [clip] rapping maths. They all thought it was wonderful but in the end they all realised that it was just bells and whistles. (Focus Group)

In this way, learning transcended the staff-student divide, with ideas being passed back and forth within and between the two groups. Moreover, learning transcended the boundaries of the Faculty and university, especially once digital tools were employed. Given that ideas were spread in multiple directions to multiple people, and took on varying forms suited to different areas and outcomes, it is apparent that networked, or even viral, learning played a role here.

Changing practices and innovations

Staff reported that they had changed their teaching in a variety of ways but, as seen above, this was not always as a result of planned professional learning. We turn now to our two case stories, based in part on our institution's 'Most Significant Change' stories, which were submitted to the TTF project for analysis. These draw on the focus group but mainly on the individual semi-structured Interviews 1 and 2. Ursula and Bronwyn were selected for inclusion in the TTF Most Significant Change stories, and hence the case stories in this paper, because of the transformations they demonstrated in their teaching practices over the TTF project period. The second set of interviews, conducted two years after the initial interviews, and therefore well after the end of the TTF project, allowed us to investigate how those transformations had or had not continued in the period following the Faculty's push to encourage staff to incorporate ICTs in their teaching.

Case Story 1: Ursula

Ursula (all names are pseudonyms) had many years of experience as a primary school teacher, and had subsequently worked in teacher education for more than a decade. She specialised mainly in teaching English and Humanities units in the Master of Teaching programme. She had considerable CK and PK in the units she taught and had built up a certain amount of TK before the TTF project commenced. For example, in 2010, she required her pre-service teachers to create a 'multimedia showcase' of their school-based teaching as an assessment item for a Science and Humanities unit. In the first iteration of this innovation, many of the pre-service teachers used the recommended PowerPoint software to produce technically rather unsophisticated showcases. Yet when viewing assignments by those pre-service teachers who took the opportunity to demonstrate innovative classroom uses of digital technologies, Ursula herself was exposed to new ideas and possibilities for using ICTs. She came to the conclusion that the

pedagogical applications of ICTs were considerably more extensive than she had originally thought:

> I probably started out thinking that there would be a limit to what I could do with the technologies; I was even against iPhones in classrooms because of a limited awareness of their application beyond a phone, so in that respect I have shifted my thinking considerably. Considering my awareness of what works with kids in classrooms, I have had my eyes opened wider; that is, I have seen a number of sensible applications that could be applied in a classroom. (Interview 1)

The multimedia showcases were, for Ursula, an exciting influence on, and a complement to, her own TPACK. In 2011-2012, in light of her developing understanding and in the context of the TTF project and the PD which was available, Ursula began to build increasingly sophisticated technological requirements into the assessment. By the end of 2012, she had tasked her pre-service teachers with using a range of web 2.0 tools – some of which she had seen past pre-service teachers use, and some of which she had encountered in the PD presentations and workshops – to create their multimedia showcases. The deliberate integration of additional multimodal and collaborative elements anchored in web 2.0 helped push this task towards the higher, transformational levels of the SAMR model.

Despite the fact that Ursula had started to innovate with ICTs before the TTF project, she still considered her TK to be in need of development. In addition to attending PD sessions, she found it advantageous to draw regularly on the coaching of the ICTPO, Jamie, as well as the support of technologically experienced colleagues. For instance, in implementing wikis, she came to rely heavily on Jamie's personalised support. She pointed out: 'Having Jamie at the [Faculty] meant that you actually did seek help and engage with the ideas' (Interview 1). Although recognising that she was in many respects a co-learner with her students, Ursula also needed to be able to assess their learning about the use of ICTs for teaching children. Thus, while building her TK in

interaction with Jamie, colleagues and her students, she was able to draw on her own developing TPACK in the pedagogical design of a wiki-based assignment for the pre-service teachers. This task required them to appropriately embed the use of a wiki into a sequence of lessons, which they then implemented in schools. Given the capabilities of wikis to support multimodality, collaboration, and co-construction of knowledge, they were an ideal tool to facilitate tasks at the modification and redefinition levels of SAMR – both for the students taught by the pre-service teachers, and the pre-service teachers themselves.

Thus, she was intrinsically curious and interested in trying out new technologies, and was enthused by the ideas spread through the PD sessions and the innovative, co-operative environment which emerged in the Faculty. Supported by Jamie in translating this enthusiasm into action, she was stimulated to try more ICT-based strategies as a result of informal conversations with colleagues as well as, crucially, interactions with pre-service teachers. Once the ICTPO was no longer available in the second year, she continued to network to improve her TPACK.

At the end of 2012, when asked to reflect on successes and challenges, Ursula felt that she had experienced only limited success in developing and applying her TPACK, although she had succeeded in designing some learning tasks for the pre-service teachers which could be seen as transformational according to the SAMR model. She cited a lack of time and appropriate technological resources as having impeded her development. She also indicated that she had not integrated e-portfolios into her units as fully as she would have liked because of her uncertainty about how best to link them to unit outcomes; nor had she fully utilised the affordances of the iPads as m-learning devices, since she had not encouraged pre-service teachers to use them to communicate with each other in real time, or to facilitate learning in non-traditional spaces outside the classroom.

Interviewed again at the end of 2014, Ursula indicated that she had continued to learn about and experiment with ICTs in her

teaching. In her multimedia showcase assessment task she openly encouraged pre-service teachers to use a wide range of self-selected digital tools. Many of them took the opportunity to experiment with cutting-edge tools they were introduced to in another unit, run by one of the authors. In this way Ursula learned about a variety of tools such as website platforms like Weebly, blogging platforms like Tumblr, and aggregator platforms like Symbaloo; in this case, technological ideas were effectively spreading from one staff member to another though the intermediate agency of students. iPads also became more central to her classes and were used in a greater variety of ways, including in supporting students to turn their everyday environments into learning contexts through multimedia recordings:

> We use [the iPad] all the time. We might use it to access information, we might use it to record something … I encourage students to download [apps] if they are not costly. (Interview 2)

Because she was working across two campuses several hundred kilometres apart, Ursula found it convenient to learn how to use screencasts, podcasts and web conferencing tools such as Google Hangouts, Adobe Connect and GoToMeeting. Given that Jamie was no longer available, she accessed central university ICT support services to help her do this but also needed to ask another Faculty staff member to help, because she felt that the central services did not fully cater to her specific needs.

In terms of TPACK, Ursula suggested that her technological pedagogical knowledge (TPK) in particular had improved over the preceding four-year period. She was less sure how to gauge her learning in terms of the SAMR model: 'I would like to suggest I'm in the transformative area but I really don't know … but I do engage with technology in a far greater way than I ever did previously' (Interview 2). Ursula did not consider that her practices and innovations had particularly impacted on other lecturers' learning, even though her discussions of how to approach technological tools with more expert colleagues (in the TK domain) might well have helped disseminate her own

pedagogical ideas (in the PK and TPK domains). She was however confident that she had influenced pre-service teachers' learning about the use of ICTs in the classroom, as had been her priority.

Over the four years, Ursula had gradually built up the confidence to try a range of innovations that she deemed relevant to her own teaching context, modelling this approach for the pre-service teachers, whom she expected to investigate and try out technologies for themselves; she did not attempt to be the expert in everything. She viewed her increasing embedding of ICTs in her classes as essentially self-directed, but facilitated by a network of people she could turn to for information and assistance:

> I suppose the change that has taken place is that my confidence has built and I'm more willing to make sure things are embedded in what I expect students to do. If I can't do these things myself, I don't hesitate to find someone who can. (Interview 2)

She noted that she was 'always watching' (Interview 2) other lecturers in the Faculty, as well as students, to learn about new tools. She attended no formal professional learning during 2012-2014, but relied a lot on informal modes: 'If I need help, I track the [right] person down and they sit down and help me, teach me' (ibid.). She also engaged in 'ongoing professional discussion' (ibid.) but this took place face-to-face rather than digitally. Thus, starting from a position where she absorbed ideas from PD sessions as well as using the ICTPO extensively as a source of inspiration and support – essentially receiving new information in 'push' mode – she progressed to a point where she began to 'pull' ideas and support from a network of connections as needed, as well as increasingly pushing out her own ideas, if not so much to colleagues, then certainly to her pre-service teachers.

Case Story 2: Bronwyn

Bronwyn possessed a sophisticated level of CK and PK, developed over several years of practice, personal reflection, and

involvement in teacher education, primarily in the areas of Science and Mathematics. At the beginning of the TTF programme, she felt she had relatively limited TK and was somewhat sceptical about its value. Unlike Ursula, she had not yet found time or inspiration to develop her TK further. She used only a limited number of ICTs in her teaching, generally on the lower SAMR levels; for instance, showing YouTube videos to illustrate concepts and provide a context for discussion, which might be seen as substitution or, at best, an augmentation of content transmission.

Bronwyn had never used a smartphone or tablet before receiving her Faculty-issued iPad. In fact, she noted: 'When I got the iPad I asked, "Where do you switch it on?" [My colleagues] laughed at me, and then I asked, "Where do I switch it off?" And they laughed again' (Interview 1). When, through TTF PD, she was challenged to think of ways of using iPads in her teaching, she was initially unsure that she would be able to integrate them effectively. As she and the pre-service teachers experimented with the iPads together, however, they found various ways of using them and connecting their growing TK with their CK and PK. Like Ursula, she soon found that she and her students were co-learners. Pre-service teachers would often find apps and show them to Bronwyn and, together, they would critique them and explore how to use them in pedagogically effective ways. Bronwyn felt it was essential that the use of ICTs had 'meaning', which depended on an appropriate convergence of technology, pedagogical strategy and content.

A highly significant learning event for Bronwyn came about as a result of a conversation with a colleague:

> Where I feel we really did use the iPad in a way that enhanced the students' learning was when we decided to incorporate mind maps. The minute it was suggested to me I think [my colleague] Maddie actually saw the lightbulb above my head go off .... I could see this was something that [the pre-service teachers] could actually learn about. They could use it themselves

> individually; they could then take it into a classroom situation if they chose to do so …. It had meaning to me and to them. (Interview 1)

This connection of TK and PK – effectively TPK – thus resulted not from formal PD (although that had helped frame Bronwyn's understanding of new technologies through TPACK and SAMR, as well as presenting some possibilities for iPad use), nor from 1:1 support from Jamie (although this was always available), but from informal networking with a colleague, which allowed her to seize on an idea she found especially relevant to her teaching context. She went on to identify, and teach her pre-service teachers how to use, a free mind-mapping app for Apple iOS called SimpleMind+.

Initially students were encouraged to 'just play' (Interview 1) with the app, and subsequently to exchange ideas about how to use it for teaching and learning, both with each other and with Bronwyn. What is more, as students started to work with the capabilities of mind-mapping software to support co-construction of understanding, which could be revisited and reworked over time both individually and as a group, Bronwyn found herself beginning to set collaborative mind-mapping tasks at the transformational levels of SAMR.

Bronwyn did benefit from 1:1 support in other aspects of technology use. In 2011 she began to work with blogs, although she had initially rejected the idea: 'When Jamie first mentioned the blog ... I just said, "No, I am not interested in the blog"' (Interview 1). However, some months later, Bronwyn found herself having to cancel a face-to-face class because of an unexpected disruption. As she contemplated alternative means of delivery, she reconsidered Jamie's earlier suggestion. After receiving assistance from Jamie in setting up a blog, she was surprised to find that most of the students had logged in before the live session was due to begin:

> So, half an hour before the session, students were already on there and we started a conversation – we started the blog then

> and there. So it ended up going for two and a half hours. I literally put an end to it because I was having problems with my computer. I was doing this from home. Otherwise I am sure it would still be going now ... (Interview 1)

Her approach was to cycle through a series of questions during the blogging session, giving students time to respond before suggesting any answers:

> I wanted to see what comments they could come up with and how they could support each other's learning, and they did …. They were incredibly supportive. They were really giving some bright ideas and they gave so much affirmation ... so I am just blown away by this and I let Jamie know how successful it was. I would love to do a similar thing in every unit – if someone could set up the blog. I still need the support in setting it up but I am so sold on using it. (Interview 1)

It is clear that, with appropriate 1:1 support, Bronwyn was able to combine her existing deep PK with her developing TK to create a task which fostered a constructivist online discussion among her students, through which they engaged in deeper reflection than a similar face-to-face discussion might have encouraged. On the SAMR model, this use of technology could be viewed as transformational.

When interviewed again at the end of 2014, Bronwyn made it clear that she had transformed her practice a great deal since her early days of not knowing how to turn on an iPad. After four years of professional development, most of which was informal networked learning, she was using a range of ICTs to support the flipped approach she had switched to in most of her classes. This involved PowerPoints and videos provided through Moodle, which in turn fed into student-led face-to-face classes, and supported students in utilising a range of learning spaces outside traditional classrooms.

Looking back on her journey, she said of her TPACK development: 'In 2012 I was very much a PCK person … now I

strongly believe I'm TPACK – I'm smack in the middle of the Venn diagram' (Interview 2). The SAMR model appealed to her as a practical way to gauge her progress:

> I certainly would have started at substitution – at the most basic level. When I was first given an iPad I was definitely at the bottom and not knowing what … I was supposed to do with it. I'm at modification now ... somewhere between modification and redefinition … because I'll think of my task first and then think 'well, what technology can I bring in?' (Interview 2)

Over the four years of the study, immersed in the same TTF-inspired professional learning culture as Ursula, Bronwyn had also gained confidence, consolidated her TPACK, and moved up the SAMR levels towards more instances of transformational pedagogies. As she put it: 'I'm a lot more open to ICTs – I'm not scared any more. I'm prepared to try new things and I'm not worried if they don't work'. She indicated that her professional development had continued after the conclusion of the formal PD programme. It was clear that she had become self-regulating in her learning and was able to 'pull in' information as needed:

> Things that have worked and worked the way I've wanted them to work – there's no reason to change them. Things that haven't worked as I planned … that's when I go in and look for something better.

In terms of sourcing new tools and ideas, Bronwyn relied greatly on informal networks. For her – unlike some other colleagues, but like Ursula – this did not involve social media platforms but was essentially about face-to-face interaction:

> [I have had] no mentoring – apart from the ICTPO. All the learning I get is informal. There hasn't been any formal PD [in 2012-2014]. It's having discussions with colleagues, going to conferences, talking about teaching maths … it was going to an EC [Early Childhood] workshop at a school where I was introduced to MadPad HD – seeing teachers using it in their context.

However, unlike Ursula, Bronwyn had also begun to actively share her innovations with colleagues through formal as well as informal means. In respect of the flipped classroom approach, for example, she noted:

> [One of the authors] and I did a presentation on [the flipped approach] to the Faculty and we invited others to it [from across the university] – now other colleagues have done it. We produced a short video that's available university-wide.

Thus, Bronwyn was confident that she had been able to influence not only her pre-service teachers but also her colleagues, by pushing her own ideas out into the same networks from which she pulled much of her inspiration.

Discussion and Conclusion

This study aimed to find out how, over a four-year period that began with an intensive phase of TTF-supported formal PD in the form of presentations, along with mentoring and coaching, lecturers in a Faculty of Education changed their teaching practices to integrate new technologies into their pedagogy. In particular, it focused on how formal and informal professional learning combined to help them use digital tools and techniques to enhance and transform their teaching.

The participating teacher educators indicated that, as they learned more about ICTs through both formal and informal learning opportunities, they reflected deeply on their pedagogy, in some cases fundamentally rethinking their approaches to teaching. Although there were some initial difficulties in conceptualising how to integrate digital tools without detracting from the nature of their units, both Ursula and Bronwyn came to challenge their assumptions about 'what works' and to modify or even transform their teaching strategies. Four years on, Ursula now gives students free rein to explore web 2.0 tools in their multimedia showcases, while Bronwyn teaches many of her classes in a flipped mode. This development over time supports Puentedura's (2012)

estimate that it can take about three years for a full-time teacher to move from tasks that entail substitution to tasks that involve redefinition. Crucially, although supported by generic, formal PD, ICT use did not spread in a homogenised way; both Ursula and Bronwyn found themselves with the agency to adopt different sets of tools and adapt them in different ways to their individual contexts.

Formal PD was nonetheless important, especially in introducing lecturers to theoretical knowledge such as the TPACK and SAMR frameworks, demonstrating hardware and software, and providing ideas, notably about using web 2.0 in teaching. More broadly, it played a key role in drawing educators' attention to the benefits of transforming their teaching practices through the incorporation of ICTs, which was at the root of the TTF agenda. The 1:1 mentoring and coaching provided by the ICTPO was also important, especially when lecturers needed advice on how to match technologies with pedagogies, and to develop their TK so that it could truly complement their CK and PK. But in addition the lecturers drew on discussions and interactions with colleagues, so that enthusiasm for using new tools, and specific ideas on how to do so, spread in a networked, or viral, way from colleague to colleague – and did so fairly widely, as some colleagues introduced learning gained in external PD sessions or at conferences. At the same time, staff became co-learners with the pre-service teachers, allowing for a wider spread of enthusiasm and ideas as different uses of tools were explored and shared back and forth between lecturers and students, with ideas sometimes even spreading from lecturer to lecturer via the intermediary agency of students.

This study was limited in a number of ways. First, it was based on a small number of participants, although the in-depth focus group and individual interviews provided detailed data which allowed rich insights into the personal learning experiences reported in this article. Second, the focus of the current study was on lecturers whose practices showed transformation; future studies might focus

on those whose practices had changed to a lesser extent, and explore the reasons for this.

Had the formal ICT-related presentations and workshops alerted participants to the possibilities of learning through informal networking, they might have capitalised even more on these possibilities from an earlier point in time; and they might have employed a wider range of networking tactics, including making use of digital social networking platforms. Moreover, some obvious learning options did not surface at all in our data collection.

Like Peeraer and Van Petegem (2012), in their large-scale study of teacher educators' professional learning about ICTs, we heard no reports of lecturers inviting each other to observe and provide critical feedback on their ICT-enriched practices, although at the university in question it was an expectation that academic staff should engage in peer observation. Bell and Mladenovic (2008) have pointed out the benefits peer observation offers in assisting lecturers to learn from each other. This practice could also have been recommended during formal PD sessions as a way to help lecturers deepen their understandings about TPACK, SAMR and ICTs in education.

As Peeraer and Van Petegem (2012) point out, 'it may be best to combine programmed professional development addressing TPCK of teacher educators with incentives for additional engagement with the topic', including prompting 'ICT enthusiasts to exchange with and encourage peers' (p. 1053). Above all, it may be worth highlighting to staff the value of adopting a broad palette of strategies, and stressing the value of combining formal and informal opportunities, including those that involve learning from and with students, to engage with new technologies and their accompanying pedagogical possibilities.

Acknowledgements

Some data from the Most Significant Stories produced under the auspices of the TTF project have been drawn on for this article. Thanks are due to Mr Adam Marchant for his input and support in the 2011 phase of the project.

References

ACARA [Australian Curriculum, Assessment and Reporting Authority]. (n.d.). *Information and Communication Technology (ICT) capability*. http://www.australiancurriculum.edu.au/GeneralCapabilities/Information-and-Communication-Technology-capability/Introduction/Introduction

AITSL [Australian Institute for Teaching and School Leadership]. (2012). *Australian Professional Standards for Teachers.* http://www.teacherstandards.aitsl.edu.au/

Barabási, A.-L. (2003). *Linked: How everything is connected to everything else and what it means for business, science, and everyday life.* New York: Plume.

Bell, A., & Mladenovic, R. (2008). The benefits of peer observation of teaching for tutor development. *Higher Education, 55*(6), 735-752.

Brinkerhoff, J. (2006). Effects of a long-duration, professional development academy on technology skills, computer self-efficacy, and technology integration beliefs and practices. *Journal of Research on Technology in Education, 39*(1), 22-43.

Buchanan, M. (2002). *Nexus: Small worlds and the groundbreaking science of networks.* New York: W. W. Norton.

Cluett, L., Skene, J., & Pegrum, M. (2011). Infecting professional staff with the emerging technology 'virus': How the leadership game has changed. CCA-EDUCAUSE Australasia Conference, Sydney, Australia, 3-6 April. http://www.uwa.edu.au/__data/assets/pdf_file/0003/19044

39/Infecting-professional-staff-with-the-emerging-technology-virus.pdf

Dart, J., & Davies, R. (2003). A dialogical, story-based evaluation tool: The most significant change technique. *American Journal of Evaluation, 24*(2), 137-155.

Dudeney, G., Hockly, N., & Pegrum, M. (2013). *Digital literacies.* Harlow, Essex: Pearson.

Earl, L., & Katz, S. (2007). Leadership in networked learning communities: Defining the terrain. *School Leadership & Management, 27*(3), 239-258.

Ellis, R. A., & Goodyear, P. (2010). *Students' experiences of e-learning in higher education: The ecology of sustainable innovation*. Abingdon, Oxon: Routledge.

Ferriter, W. M., Ramsden, J. T., & Sheninger, E. C. (2011). *Communicating and connecting with social media.* Bloomington, IN: Solution Tree Press/NAESP.

Garrison, D. R. (2011). *E-learning in the 21st century: A framework for research and practice* (2nd ed.) New York: Routledge.

Gay, L. R., Mills, G. E., & Airasian, P. W. (2009). *Educational research: Competencies for analysis and applications*. Upper Saddle River, NJ: Pearson.

Goodyear, P., Jones, C., Asensio, M., Hodgson, V., & Steeples, C. (2005). Networked learning in higher education: Students' expectations and experiences. *Higher Education, 50*(3), 473-508.

Guskey, T. R. (2002). Professional development and teacher change. *Teachers and Teaching: Theory and Practice, 8*(3), 381-391.

Haythornthwaite, C., & Andrews, R. (2011). *E-learning theory and practice*. London: Sage.

Heck, D., & Sweeney, T. A. (2013). Using most significant change stories to document the impact of the Teaching Teachers for the Future project: An Australian teacher education story. *Australian Educational Computing, 27*(3), 36-47.

Hill, J. R. (2012). Learning communities: Theoretical foundations for making connections. In D. Jonassen & S. Land (Eds.),

Theoretical foundations of learning environments (2nd ed., pp. 268-285). New York: Routledge.

Horton, W. (2012). *E-learning by design* (2nd ed.). San Francisco: Pfeiffer.

Katz, S., Earl, L. M., & Ben Jaafar, S. (2009). *Building and connecting learning communities: The power of networks for school improvement*. Thousand Oaks, CA: Corwin.

Kennedy, A. (2014). Models of continuing professional development: A framework for analysis. *Professional Development in Education, 40*(3), 336-351.

Laurillard, D. (2002). *Rethinking university teaching: A conversational framework for the effective use of learning technologies* (2nd ed.). London: Routledge Falmer.

Laurillard, D. (2006). E-learning in higher education. In P. Ashwin (Ed.), *Higher education: The development of learning and teaching* (pp. 71-84). Abingdon, Oxon: Routledge.

Lim, C. P., Chai, C. S., & Churchill, D. (2011). A framework for developing pre-service teachers' competencies in using technologies to enhance teaching and learning. *Educational Media International, 48*(2), 69-83.

Mason, R., & Rennie, F. (2006). *Elearning: The key concepts*. London: Routledge.

McCaffrey, M. (2011, February 8). Why mobile is a must. *THE Journal*. http://thejournal.com/articles/2011/02/08/why-mobile-is-a-must.aspx

McElvaney, J., & Berge, Z. (2009). Weaving a personal web: Using online technologies to create customized, connected, and dynamic learning environments. *Canadian Journal of Learning and Technology, 35*(2). http://www.cjlt.ca/index.php/cjlt/article/viewArticle/524/257

Miles, B., Huberman, A. M., & Saldana, J. (2014). *Qualitative data analysis: A methods sourcebook*. Thousand Oaks, CA: Sage Publications.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108*(6), 1017-1054.

Oakley, G., Pegrum, M., & Johnston, S. (2013). Introducing e-portfolios to pre-service teachers as tools for reflection and growth: Lessons learnt. *Asia-Pacific Journal of Teacher Education, 42*(1), 36-50.

Pachler, N., & Daly, C. (2011). *Key issues in e-learning: Research and practice*. London: Continuum.

Pachler, N., Preston, C., Cuthell, J., Allen, A., & Pinheiro-Torres, C. (2010). *ICT CPD landscape: Final report*. Coventry: Becta. https://www.academia.edu/2062079/ICT_CPD_Landscape_Final_Report

Peeraer, J., & Van Petegem, P. (2012). The limits of programmed professional development on integration of information and communication technology in education. *Australasian Journal of Educational Technology, 28*(6), 1039-1056.

Pegrum, M. (2014). *Mobile learning: Languages, literacies and cultures.* Basingstoke, Hampshire: Palgrave Macmillan.

Pegrum, M., Howitt, C., & Striepe, M. (2013). Learning to take the tablet: How pre-service teachers use iPads to facilitate their learning. *Australasian Journal of Educational Technology, 29*(4), 464-479.

Puentedura, R. R. (2011, December 8). A brief introduction to TPCK and SAMR. Freeport workshop slides. *Ruben R. Puentedura's weblog.* http://www.hippasus.com/rrpweblog/archives/2011/12/08/BriefIntroTPCKSAMR.pdf

Puentedura, R. R. (2012, September 14). *Building upon SAMR.* Presented at Presbyterian Ladies' College, Perth, Australia.

Punch, K. F. (2009). *Introduction to research methods in education*. London: Sage.

Richardson, W., & Mancabelli, R. (2011). *Personal learning networks: Using the power of connections to transform education.* Bloomington, IN: Solution Tree Press.

Romeo, G., Lloyd, M., & Downes, T. (2012). Teaching Teachers for the Future (TTF): Building the ICT in education capacity of the next generation of teachers in Australia.

Australasian Journal of Educational Technology, 28(6), 949-964.

Sharples, M., Taylor, J., & Vavoula, G. (2010). A theory of learning for the mobile age: Learning through conversation and exploration across contexts. In B. Bachmair (Ed.), *Medienbildung in neuen Kulturräumen: Die deutschsprachige und britische Diskussion* (pp. 87-99). Wiesbaden: VS Verlag für Sozialwissenschaften.

Steketee, C. (2005). Integrating ICT as an integral teaching and learning tool into pre-service teacher training courses. *Issues in Educational Research, 15*(1), 101-113. http://www.iier.org.au/iier15/steketee.html

Thomas, D. R. (2006). A general inductive approach for analyzing qualitative evaluation data. *American Journal of Evaluation, 27*, 237-246.

Ward, L., & Parr, J. M. (2010). Revisiting and reframing use: Implications for the integration of ICT. *Computers & Education, 54*(1), 113-122.

Watts, D. J. (2003). *Six degrees: The science of a connected age*. New York: W. W. Norton.

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. Cambridge: Cambridge University Press.

Wenger, E. (n.d.). Communities of practice: A brief introduction. *Wenger-Trayner*. http://wenger-trayner.com/wp-content/uploads/2012/01/06-Brief-introduction-to-communities-of-practice.pdf

Wilson, B. G., Ludwig-Hardman, S., Thornam, C. L., & Dunlap, J. C. (2004). Bounded community: Designing and facilitating learning communities in formal courses. *The International Review of Research in Open and Distance Learning, 5*(3), 1-22. http://www.irrodl.org/index.php/irrodl/article/view/204/820