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Deep Learning: Enriching Teacher Training through Mobile Technology and International Collaboration

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ABSTRACT

This article presents results from an international collaboration between college students and pre-service teachers in Norway and the UK. This research is part of a large, international project exploring and developing the interrelationship between mobile technology and teachers' perceptions of teaching and learning. Data was collected for this study through an on-line survey of 37 pre-service teachers followed by six semi-structured, in-depth interviews. The data analysis revealed the themes of collaboration, authenticity and professional learning through the use of mobile technology in the data. The collaboration enabled the use of the affordances of mobile technology to enhance the pre-service teachers' professional learning and the data suggested that this enhanced their emergent conceptions of teaching and learning.

KEYWORDS

Authenticity, Collaboration, eBooks, Education, iPads, Mobile Technology, Pedagogy, Pre-Service Teachers, Professional Learning, Teacher Training

INTRODUCTION

This paper is based on collaborative work using mobile learning between pre-service teachers in two different subject areas, English and science, working with Norwegian college students, who studied both subjects. This research was nested within a larger international project, *Mobilising and Transforming Teacher Education Pedagogies* (MTTEP). This three year (2014-2017) Erasmus+funded project focused on exploring and developing teacher education pedagogy through the use of mobile technology. A pilot for this study was undertaken with the same cohort of English and science pre-service teachers (Naylor & Gibbs, 2015), exploring the possibilities of collaboration using mobile technology between different subject areas within the field of pre-service teacher education. For the study that is the focus of this article, the collaboration was taken further by adding Norwegian college students to the mix, to enable the pre-service teachers to take their ideas from the pilot and develop them with these students. The focus of this specific research project is the use of iPads in particular, as all the pre-service teachers in this cohort were given iPads by the university to use throughout their training year (see Burden & Hopkins (2016) in the special issue of this journal devoted to Mobile Learning in Teacher Education). Specifically, the App *Book Creator* was chosen as the medium for this work. Using *Book Creator* enabled the pre-service teachers and the college students to produce eBooks as a focus for their work and as an output for them to work on collaboratively. This paper explores two questions: the first being about how the process of constructing eBooks using iPads

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impacted on the pre-service students' perceptions of teaching and learning and the second, exploring what relevant skills and competencies the pre-service teachers perceived they gained from constructing eBooks using the iPads.

LITERATURE REVIEW

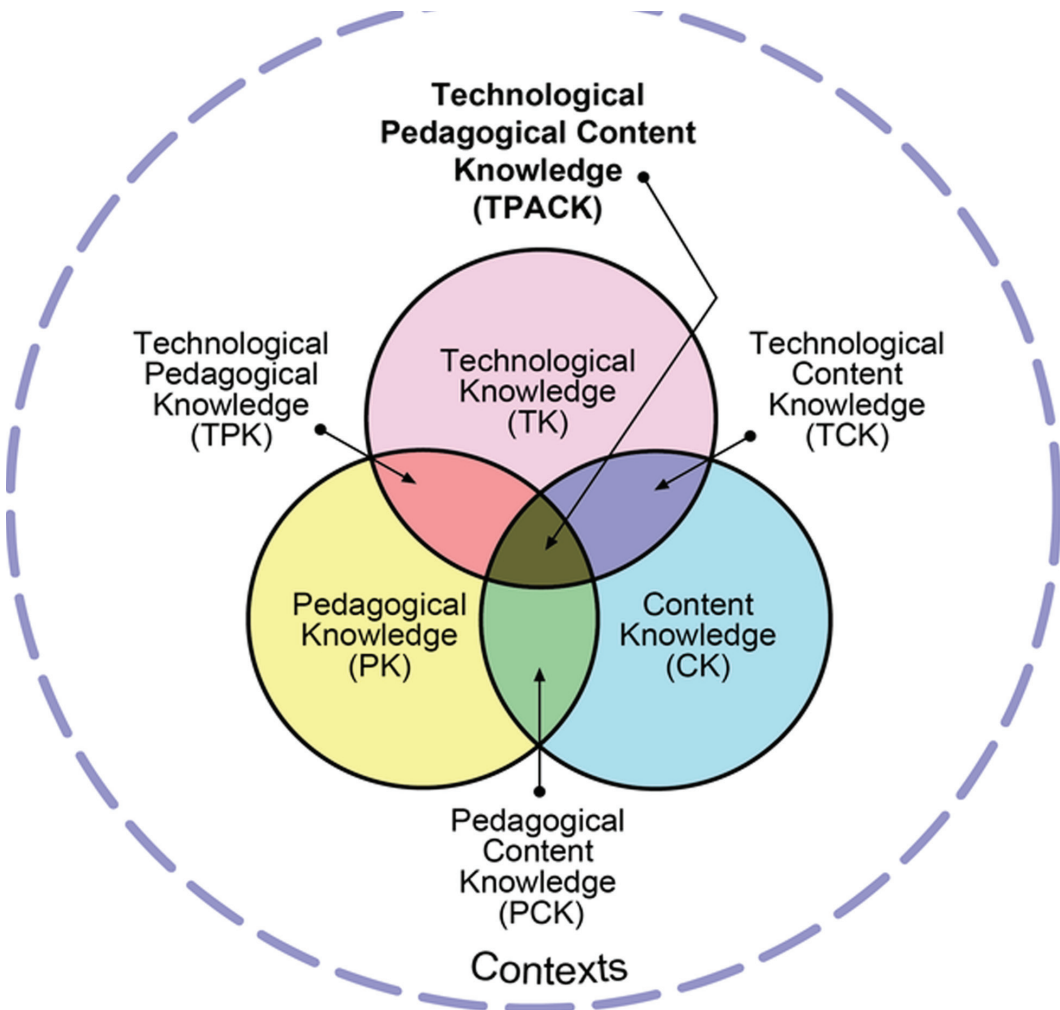
As digital technology advances, it follows that teachers and pre-service teachers need to understand the ways that their students consume and produce knowledge, which is increasingly via mobile technology (Burden & Hopkins, 2016). Mobile technology is defined as portable, handheld devices and mobile or m-learning is the process of learning mediated by a mobile device (Kearney et al., 2012). Baran (2014) in her review of research into mobile learning in teacher education, analysed various definitions of mobile learning and distilled the various qualities that different authors have attributed to mobile learning; mobility (Sharples et al., 2009), access (Parsons & Ryu, 2006), immediacy (Kynäslahti, 2003), situativity (Cheon, Lee, Crooks, & Song, 2012), ubiquity (Kukulska-Hulme et al., 2009), convenience (Kynäslahti, 2003), and contextuality (Kearney, Schuck, Burden, & Aubusson, 2012). According to Sharples et al., (2009), mobile learning includes the characteristics of mobility in physical, conceptual, and social spaces. Baran (2014

p.3) identifies a definition that she pinpoints as defining what is unique to mobile learning, which is that the “relationship between the context of learning and context of being” is very specific to mobile learning, as learning may occur in independent, formal, or socialized contexts (Frohberg et al., 2009, p.313). The research for this particular study focused on pre-service teacher training and the use of mobile devices, specifically iPads, so three themes in the literature will now be examined which are of particular relevance to this paper; the types of knowledge needed by pre-service teachers, the use of iPads as a tool for learning and models of mobile learning.

DOMAINS OF KNOWLEDGE FOR PRE-SERVICE TEACHERS

As developing professionals, pre-service teachers need to understand their subject matter in a profound and flexible manner. In the 1980s Shulman suggested three categories of content knowledge that teachers need to master to be successful in order to communicate with their students and support them with their learning. Koehler et al., (2013) have developed and extended Shulman's framework by adding technology to the domains of the knowledge that teachers, and pre-service teachers, need to possess in order to successfully develop their students' understanding. They argue that new digital technologies are 'protean, unstable and opaque' (2013, p. 14). Unlike older technologies such as pencils and microscopes, which are unlikely to change very quickly, digital technology changes very quickly, is 'protean', as well as being difficult to understand in terms of its mechanics, 'opaque', so consequently these technologies are more challenging to integrate into teachers' instruction. The blending of content knowledge and pedagogy (PCK) provides an understanding of how particular aspects of 'subject matter are organized, adapted and represented for instruction' (Mishra & Koehler, 2006, p. 1021). It follows that if pre-service teachers are to become successful at their profession they must develop in equal measure all three aspects of Shulman's domains of knowledge. Further, they argue that there is a multiplicity of different affordances available via different digital technologies, so that understanding how these are applied in an educational environment is 'not straightforward' (2013, p. 14). Given the complexity of this situation Koehler et al., identify a new domain of knowledge to be added to Shulman's original conception and have added Technological Content Knowledge (TCK) to the original conception (see Figure 1). Technological content knowledge (TCK) is knowledge about how the manner of technology and content are related. So, teachers need to know how the subject matter can be changed by the application of technology (Mishra & Koehler, 2006). Technological pedagogical knowledge (TPK) is the knowledge of the capabilities of digital technology in teaching and learning settings, which includes the ability to select a tool that is fit for purpose. Technological

Figure 1. The seven components of TPACK (<http://tpack.org/>)



pedagogical content knowledge (TPACK) goes beyond technology, pedagogy and content and is the basis of good teaching with technology.

Using mobile devices in the classroom or in the field enables immediate access to knowledge, thus providing the learner with individual support tailored to their needs (Kukulska-Hulme & Traxler, 2005). According to Kukulska-Hulme & Traxler, teachers' and teacher educators' 'perceptions about the capacity of mobile technologies to support different conceptions of teaching' determine whether or not mobile technologies are embraced in the classroom. It was this that the study set out to explore.

USE OF THE IPAD AS A TOOL FOR LEARNING

The iPad has been increasingly used and researched over the last few years in educational contexts. Murray & Olcese (2011) investigated whether the iPad allowed users to do things in educational settings that they could not otherwise do. They found that while the iPad was 'pushing the edge

of both hardware and software innovations' that these 'advances are underused in ... teaching and learning' (2011, p. 48). They reviewed a large number of applications and found that the 'bulk of applications written to run on iOS devices are woefully out of sync with modern theories of learning and skills students will need' (2011, p. 48). They could not find a single one that stepped up to modern understandings of how people learn, but relied upon behavioural models of teaching.

Beauchamp, Burden, & Abbinett, (2015) investigated iPad use in the primary classroom across eleven schools in Scotland and Wales. The study used mixed methods that included conducting an on-line exit survey of parents and pupils, lesson observations, interviews with teachers and pupils and focus group semi-structured interviews with senior managers. This particular paper concentrated upon reporting the findings from the qualitative interviews from 184 pupils and 34 teachers. They found that students' early use of the iPad showed it was fun to use, partly due to the multimedia capabilities of the iPad, which helped their learning, and it also fostered collaboration. The teachers were also willing to listen to the student voice, which empowered students, leading to both synergistic and dialogic interactions. Pedagogic development arose from such interactions, so that the teachers also learned at the same time as the students. The pupils were 'co-constructors of knowledge with their teachers' (Beauchamp et al., 2015, p. 173). As Murray and Olcese (2011, p. 43) state, 'technologies prosper when they extend what users are able to do in productive ways.'

In researching the use of the iPad with pre-service teachers, Pegrum et al., (2013) identified four common themes relating to its use as a learning tool. Two of these were to develop an understanding of content and pedagogy, specifically relating to student engagement, group work and selection of applications, but encouraging reflection on learning did not figure so prominently. They argue that the tutors have 'to be convinced of the value of the devices and to have a solid grasp of their pedagogical possibilities' (2013, p. 245) in order to use them effectively in the classroom, something recently noted by Burden and Hopkins (2016). This point is explored by Haydn (2014) working with newly qualified teachers (NQTs), subject mentors in school and university tutors, all of whom have a stake in producing the next generation of teachers. Haydn's (2014, p. 463) work demonstrated quite clearly that for NQTs to feel confident and well prepared in using ICT in the classroom they depended upon the expertise of their university tutor. Therefore, the university tutors in this study considered modelling the use of m-learning as something very important that the pre-service teachers might want to utilize, so it was a significant use of 'precious face-to-face time' at the university.

Mang and Wardley (2012), similarly to Haydn (2014), found that in working with pre-service teachers and iPads, the university tutor needs to provide structured tasks which enable the student to engage with the technology and that the students themselves need to see a reason to use the technology. This logically leads to the question that if those individuals who train teachers are not themselves embracing this technology, why should the pre-service and NQTs do so? Mang and Wardley (2012) also found that some schools and colleges were not themselves successful in integrating the technology into their classes. As well as having strong management, the students must see a need to use the technology. This comes through the educator/lecturer providing structured tasks that enable the student to engage with the technology. Without this, the iPad becomes a meaningless accessory that would not be used. In this project, in modelling the creation of an eBook, the teacher educators were taking on board Pegrum et al's (2013) and Haydn's (2014) conclusions about the importance of showing pre-service teachers how to use mobile technology in an authentic way, with meaningful tasks relevant to learning. The task of making an eBook was designed to enable the pre-service teachers to co-construct knowledge, in collaboration with their peers, some of whom may have had more expertise in the subject and could support those less experienced with their learning.

MODELS OF MOBILE LEARNING

The study that is the subject of this paper was nested within a larger, international research project aimed at exploring and developing practice in teacher education pedagogy through the use of mobile

technology. The significant quality of this project was that it was clearly focused on pedagogy rather than technology, so that the research project explored ways in which teacher education can support pre-service teachers to use mobile technology to create meaningful and significant learning experiences for their students (www.mobilelearningtoolkit.com). Central to this project was the utilisation and development of the iPAC framework (see Figure 2) around which to construct and evaluate meaningful mobile learning pedagogies.

The iPAC model was first proposed by Kearney et al., (2012). Foregrounded in this model is a socio-cultural perspective of learning (Kearney et al., 2012). The authors identify that they have, in particular, extended Koole's (2009) FRAME model of mobile learning, as her model also foregrounds the socio-cultural elements of learning, in that she pays particular attention to the enhanced collaboration and contextual aspects of mobile learning. The authors state that their iPAC model extends Koole's model to create one in which 'discussion of pedagogy... is central and explicit' (Kearney et al., 2012, p. 2). In advancing the basis for the iPAC model, the authors review a variety of m-learning theories (see for example Traxler, 2009 or Vavoula & Sharples, 2009) and identify the common themes of 'portability of m-learning devices and mobility of learners; interactivity; control and communication' (Kearney et al., 2012, p. 3). The authors argue that what unites these other m-learning theories is that they 'typically tend to merge affordances of mobile devices or characteristics of applications with features of the learners' experience' (Kearney et al., 2012 p. 3). The authors want to move away from merging the learner's experiences with the technological tool and want to 'propose a succinct framework highlighting a unique combination of distinctive characteristics of current mobile pedagogy to bring socio-cultural insights to the literature on m-learning' (Kearney et al., 2012, p. 3). The iPAC model was developed and extensively tested through a range of activities in two m-learning projects located in teacher education communities.

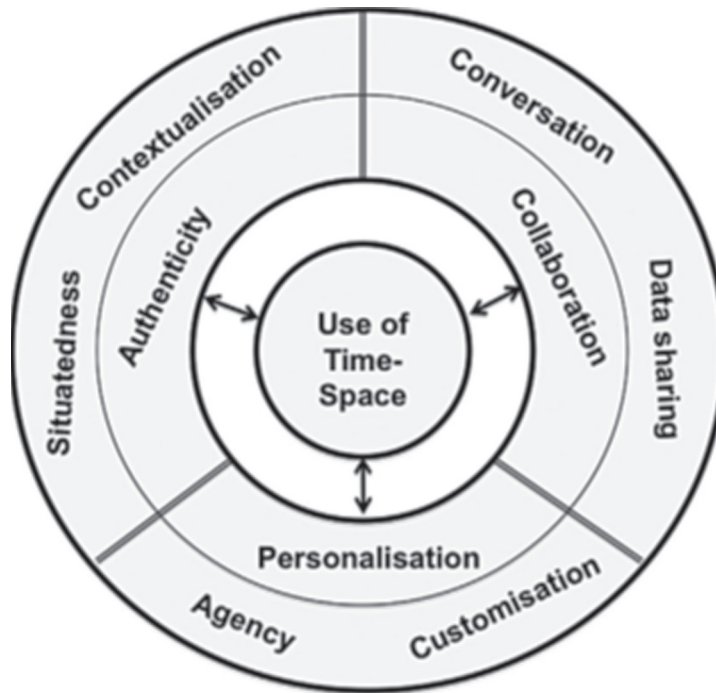
The iPAC Model: Personalisation, Authenticity and Collaboration

The iPAC model has three distinctive features of m-learning; Personalisation, Authenticity and Collaboration, each of which each have two sub-scales. Personalisation has the sub-scales of Agency and Customisation. Agency includes the qualities that a well-planned mobile learning activity exhibits; that learners have control over the pace and time of their work, that they have greater control over the place of their learning, either physical or virtual, and have more autonomy and control over the content of their work (Kearney, Schuck, Burden, & Aubusson, 2012). The second sub-scale of Personalisation is Customisation, either of tool or activity. The significance of Customisation in mobile learning is that learners can utilise their personal devices, so encouraging a quality of convenience and intimacy, and that often individually tailored activities enable learners to enjoy a sense of ownership of their own learning (Traxler, 2009).

Kearney et al., provide a definition of Authenticity as 'tasks that provide real world relevance and personal meaning to the learner' (2012, p. 9). This feature in the iPAC model is sub-divided into Situatedness, which relates to real life practices and problems encountered in the real world, and Contextualisation, such that well designed mobile learning activities support authentic learning through rich, contextual tasks, that may include settings (physical or virtual), characters and tools (e.g. Apps) involving 'real -life' (Kearney et al., 2012, p. 10) practices.

The model proposed by Kearney et al. (2012) foregrounds the socio-cultural perspective in the use of mobile technologies, which is why Collaboration features as the third aspect of the iPAC model. The authors highlight the relationship to the ideas of Vygotsky (1992) in that social interaction, dialogue and conversation are fundamental to learning from a socio-cultural perspective. Vygotsky argued that the use of language to communicate develops new ways of thinking: what we learn from our inter-mental (collaborative) experience shapes our intra-mental (individual) thinking (Vygotsky, 1992). By collaborating together, learners engage in negotiating meaning and extending their own thinking and 'the skills of *constructing* and exploring knowledge, *conversing* and collaborating with peers, and the ability to control one's own learning are fundamental requirements of effective

Figure 2. The iPAC model (Kearney, Schuck, Burden, & Aubusson, 2012)



learning' (Sharples, 2009, p.7). The sub-scales are presented in the model as Conversation, around and during the learning process, and data sharing, which extends collaboration into the virtual space:

The networking capability of mobile devices creates shared, socially interactive environments allowing students to easily communicate multi-modally with peers, teachers and other experts, and to exchange information. Learners consume, produce and exchange an array of "content", sharing information and artefacts across time and place. (mobilelearningtoolkit.com)

The work of the international (MTTEP) research project, within which this study was undertaken, used Kearney et al.'s (2012) iPAC model as the basis to plan and evaluate their work in the area of m-learning pedagogy and practice. The socio-cultural perspective was crucial and pedagogical design fundamental to the research undertaken. The technology utilized was under investigation only for what may have been distinctive about the learning afforded by it, with the teacher educators.

THE STUDY

This study presents an international project featuring English and science pre-service teachers from a UK University, working alongside, and in partnership with, students from a college in Norway. The grouping of science with English pre-service teachers was a result of their tutors' wish to explore how iPads could be used to enhance the pedagogy associated with these particular subjects. The university tutors hoped that both groups of pre-service teachers would be taken out of their comfort zone by working in the field and undertaking activities new to them. By sharing this experience with Norwegian college students, the pre-service teachers were developing their own pedagogy and engaging in complex collaborative tasks.

A pilot study had previously been undertaken for cross subject collaboration (Naylor and Gibbs, 2015), in which science and English pre-service teachers had worked together on a field trip to the sea shore, using iPads to create Key Stage Three Science resources, and poetry for young readers inspired by the trip to the seaside. Following the success of this pilot study, it was agreed to extend the collaboration to include the Norwegian students and teachers. Together, the teachers and university tutors agreed a common focus for the collaborative project that centred on science and maritime topics common to both the English 'A' level and the Norwegian science curriculum. The outcome for the pre-service teachers and college students was to produce an interactive learning resource for students preparing for university in the form of an eBook. The Norwegian students visited the university in the UK for two days to work with science and English pre-service teachers in developing a selection of eBooks on this topic.

A venue in the UK was used to provide a theme for the research and a stimulus for the students' thinking about the curriculum. The venue chosen was a large submarium in the North of the UK and the topics selected linked to aspects of the biology, physics and chemistry curriculum for college students. The first morning of the collaboration involved the groups introducing themselves, getting to know one another and beginning to consider suitable maritime related topics for their eBooks. The students and pre-service teachers then visited the submarium in the afternoon, using their iPads to collect any data relevant to their selected topic that they found through collaboratively exploring the content and information available at the submarium.

The second day of the project consisted of making and sharing the eBooks. Each group of students had the App *Book Creator* already downloaded for them to work with on their iPads. Having collected their data, the groups had to select the genre and the style of writing that they wished to use, depending on the role that they wished their eBook to fulfil, linking directly with the English national curriculum. For example, the final format for the eBook could be an interactive classroom resource, a newspaper article, a scientific report or a teaching resource depending on the choices of the groups. As far as possible, the Norwegian students led the work, as the pre-service teachers' role was to facilitate their learning, in preparation for their own roles as teachers in the future. In practice, this led to a lot of negotiation around selecting and editing material, depending of the focus of the eBook. The iPads were also used in this session to facilitate language translation issues, translating various terms and phrases that were needed to express scientific and technical terms, or expressing points with the appropriate level of formality or informality. The finished eBooks were loaded into a collective folder so that they could be displayed and shared throughout the group.

RESEARCH METHODS

The participants consisted of 24 science and 13 English pre-service teachers, working with 16 Norwegian college students. Data was collected through an on-line survey of all the participants and semi-structured interviews with six pre-service teachers. The pre-service teachers had undertaken a pilot study at an early stage in their postgraduate course, where they had worked collaboratively across subjects on a field trip, in order to explore the potential of this cross subject collaboration (Naylor & Gibbs, 2015). To explore the pre-service teachers' perceptions of this second collaborative, international project, later in their course, the trainee teachers were asked to complete a questionnaire immediately after it had taken place. The questions asked about their perceptions of using mobile technology before and after the fieldwork. Questions were also asked about how the pre-service teachers felt about the collaboration, what they had learnt from the experience and whether this would have any impact on their future teaching. The survey results provided the researchers with data that was used to create and design further questions which would be used in the semi-structured interviews to elicit more in-depth understanding about the experience and it is this data that will be discussed in this paper. The Norwegian college students were also surveyed for their responses, but that data is outside the scope of this article. Six semi-structured interviewed were undertaken, three with science

pre-service teachers and three with English pre-service teachers, further exploring their perceptions of the project. The questions explored how they felt about the international, collaborative element of the project. The questions also sought to examine the impact that working with mobile technology in the field had on the pre-service teachers' conceptions of teaching and to explore their trainees' perceptions of the impact this project might potentially have on their future practice as teachers.

The researchers analysed and coded the qualitative data, following Richards' (2005) three stages of analysis. Individually, the researchers produced first level 'descriptive' (Richards, 2005, p.87) codes, classifying and recording the data. The researchers then came together and worked collaboratively to review their 'descriptive' codes, producing joint 'topic' codes, labelling the data. At this point, the researchers discussed the patterns developing in the data and clarified their shared interpretations of the data. The third stage of Richards' (2005) levels is analytic coding, which is essentially the same as Miles and Huberman's (1994) definition of pattern codes, the purpose of which is to interpret and conceptualise data. In order to synthesise and theorise the data from the pre-service teachers, the coding was refined further and theorised between the researchers, to produce three broad analytical codes or themes. These overarching codes were classified as Collaboration, Authenticity and Professional Learning

The quantitative data was analysed numerically, the response rate being $N = 34$ for the pre-service teachers and $N=43$ for the pre-service teachers together with the Norwegian college students. Although the quantitative results are not the focus of this article, in broad terms the pre-service teachers were positive about using the technology and about the educational value of using mobile technology. Both sets of participants, pre-service teachers and Norwegian students, found that the work challenged their thinking. However, the focus of this report is on the qualitative responses given in the semi-structured interviews with the pre-service teachers, and the ways in which the work impacted on their conceptions of knowledge and their roles as developing teachers.

RESULTS AND ANALYSIS

This study set out to answer two research questions:

- *How might the process of constructing eBooks using iPads impact on the pre-service teachers' perceptions of teaching and learning?*
- *What relevant skills and competencies do pre-service teachers perceive they gain from constructing eBooks using iPads?*

The study did not set out to validate the iPAC model, but the data analysis revealed that two of the three themes of the iPAC model did feature predominantly in the participants' responses; collaboration and authenticity. However, in this specific data set, professional learning was the third, most prominent, theme.

Collaboration

The task that the participants worked on was quite open ended and the pre-service teachers and Norwegian students had to collaborate to select their project to investigate. The open-ended tasks assumed a constructivist model of learning, where the pre-service teachers and students built a representation of their understanding of the problem to be investigated (McFarlane, 2015). The use of group work added a social dimension and the cross-curricular and international nature of the collaboration added a cultural dimension. The theme of collaboration recurred in the interviews substantively and was perceived as being fundamental to the experience of the project by the participants. Niemi and Multisilta (2016, p.2) consider that collaboration is a 'twenty first century skill' whereby students become 'engaged in learning and motivated to learn more'. The theme of

collaboration as it manifested in the data can be sub-divided into the ways that the pre-service teachers characterized working in the various groups during the project, the ways that the groups interacted with and around the iPads, and the social construction of knowledge as they worked through the project, including the use of dialogue, the motivating factors of working in groups and the influences this had on their conceptions of learning and teaching.

All the participants commented on the collaborative interaction between different sub-sets of the participants; the cross-curricular work between science and English subject areas; the work between pre-service teachers and college students and the international context between the UK and Norway. On the role that the iPad project played in focusing the various groups to work together, one English pre-service teacher characterized the project through active verbs, that the device had made the participants 'bring that technology into a collaborative process', 'pull all our thoughts together' and 'join up your ideas through the iPad....and the eBooks' while another characterized the process of working together on the eBooks through the metaphor of putting 'everyone's strengths into one basket.'

On the collaboration between science and English subject areas, interestingly the participants set up a dichotomy between science and English pre-service teachers, such that the scientists were characterized as 'knowledgeable' by the English pre-service teachers, and the English pre-service teachers perceived their contribution to be creativity, so that working on the eBook was 'a break from the science, a nice creative response.' One science pre-service teacher observed the impact of the iPads in supporting the scientific literacy of the second language, Norwegian students, during the process of the work, such that the iPad enabled instant translation of 'science words' and that this immediate facility could 'bring the boundary down'. On working in an international context, one English pre-service teacher observed that 'with the Norwegians it was nice to bring in sort of like different cultures'

The theme of collaboration over using the iPads for the project featured significantly. Comments were made on the collaborative aspects of the whole process of the project. The use of the iPad as an introductory element to getting the groups to know each other and to facilitate research was commented on by two of the pre-service teachers. At different points, all of the pre-service teachers noted the role the iPad played in the work collecting data in the field, at the submarium; filming, audio recording, taking photos, using Apps on site and interviewing staff at the venue. What was particularly significant was the way that the mobility of the devices supported interactivity:

We walked round the Deep, we could video fish, and different things and interview each other and it was a really good way to, like, make sure we collaborated as a group rather than separating off, by using just one iPad and having to share the resource.

Both the scientists and the English pre-service teachers commented on the importance of the data on the iPad to support the group reflecting on what they had learnt once they had returned to the university to make the eBooks, calling the iPad a 'data bank'. The use of the iPad as a collaborative focus was also highlighted in the writing of the eBook together, in groups, and then as a source of display and discussion.

One of the science pre-service teachers responded to the question regarding what he would take away from this project in this way:

I think the main thing I can take away from that, is the sort of benefits of working collaboratively and being able to bounce ideas off one another and how sort of, your finished product, in this case the eBook, is a lot richer because you have been able to share ideas and sort of bring everything together...working with the Norwegians of course it's interesting getting a completely different point of view on things. So it sort of challenges your own way of thinking in a way that someone else comes along and tells you how they see things. And then you have to kind of evaluate that and think, well where does that leave what I think?

Here the science pre-service teacher utilizes the active verb 'bounce' to characterize the interchange of ideas between members of the group in a similar fashion to the active verbs used by the English pre-service teacher of the project as pulling together, or joining up. Pre-service teacher S suggests that the finished product, the eBook, is 'richer', through having been a collaborative venture, and he finishes by stating the effect of the work on him, that he has had to look at the world through other eyes, and where does that leave his thinking?

In summary, the pre-service teachers and students used the collaboration to converse and have a dialogue about their chosen topic in a mutually supportive environment. The learning that took place was mediated through the use of the technology, and as a result of using the technology it was transformed in a way that would not have been possible if the technology were not present. The ability to reflect upon the learning and to modify the knowledge content was important in making the experience richer for the participants.

Authenticity

Baran's (2014) argument that the 'greatest added value of mobile learning vis-a-vis PC learning lies in the aspects that extend classroom interaction to other locations' (2014, p.18) was fundamental to the way in which this project aimed to extend the experiences of pre-service teachers. In working at the sub-marium, which had no access to Wi-Fi, the mobile devices were used solely to record images, video clips, sounds and to store data collected in the field. Whilst there is nothing new in this way of learning, the use of mobile technology allowed for the inclusion of visual and audio recordings, which provided a record of the event and could act as an aide memoire. Two students commented, "I haven't seen anything like this before," and "It was an absolutely brilliant resource to take with us... it is immediate evidence you can bring back and use." The fact that the activity did not take place in a classroom modelled how such fieldwork experiences can be authentic and situated in the real world. Mobile technology, used in this way, supported the complex nature of the task and allowed the data collected to be situated in one location. As one pre-service teacher commented, "...you don't have to worry about scrappy bits of paper getting wet or blowing away in the wind."

In terms of the learning, the groups worked together to revise, discuss, feedback and reflect on their product. One student commented, "It encouraged independence/confidence and I would definitely use it in my future practice." The product, the eBook, represented the worldview of the pre-service teachers and the students, in that the topics chosen and the material was their own, and as such it was authentic (McFarlane, 2015). Student comments included:

I found the project an 'eye opener' – the 'process of doing it' was more important than the outcome. I think the main impact for me is seeing how useful mobile technology can be.

In relating the qualitative data to the survey, as a result of this work, 23 of the 34 pre-service teachers questioned would consider using mobile technologies on a school trip and, for the same number, the activities had changed their perceptions about how mobile technology could be used, in a positive way. 28 of the 34 pre-service teachers considered that the use of mobile technologies provided learning strategies that they could use in their future teaching. As a result of this collaborative activity, the pre-service teacher's perceptions about using mobile technology outside of the classroom had changed in a positive way. As teacher educators, this is a positive outcome and one which shows that if the technology is used in an appropriate fashion, involving meaningful tasks, then pre-service teachers can see the value of working in this way.

Professional Learning

The theme of Professional Learning featured highly in the interviews of the pre-service teachers. This theme was comprised of a number of sub-strands; the development of the trainees' use of the iPad

in their respective subject areas; the trainees' conceptions of the role of technology in their teaching, and the impact of the project on the trainees' understanding of learning and teaching.

With regard to the use of the iPad in different subject areas, the trainees looked at the work from slightly different angles, as the project impacted on their conceptions of the subject. The scientists discussed the impact of the device inside and outside of the classroom. All three scientists interviewed observed the significance of using iPads in the field and on their understanding of the affordances of mobile devices and what they can offer out and about; the ability they had to record data without the need for paper, using Apps in the field, and researching prior to the trip. In discussing the use of the iPad in the classroom in science lessons, science pre-service teacher L in particular discussed the facility that the device could provide in enabling students to quickly research points and support their own learning on an individual basis. All three also noted the motivational aspects with regard to their own learning and those of the students; 'fascinating,' 'more fun,' 'the class lifts.'

The English pre-service teachers observed the interrelationship between the mobile device and the various modalities of English; reading, writing and speaking and listening. All three commented on the interaction between using a screen and using a pen and paper to write, in that all assessments in English are pen and paper based, and that there is a tension here between new, motivating technology and the assessment practices of the system of exams currently in place in the UK. They noted the facility of using the iPad to record data that could then be used to feed into writing when back in the classroom. Pre-service teacher H commented that, back in the classroom, using iPads for English work was 'way more accessible' than using paper based resources. She states:

*I have come across quite a few students who say they do not like to read and say they do not like to write but on an iPad **do** like to read and they **do** like to write. They do read websites and they do read the news and do text and email quite eloquently, but they see paper and pen as an alien thing for some reason.*

Pre-service teacher H noted that pen and paper were seen as 'alien' by the pupils, while they 'like' to read and write on the iPad, which is similar to the comment pre-service teacher M made when he said that "...it's like they can speak a language through technology." One English pre-service teacher discussed the use that he had made of the iPad in supporting students with a speaking and listening assessment:

I think...its more than a video camera because... it's easy to get a video camera and film somebody, with the iPad I can actually use it on Moviemaker or I used another app to do that, and then created this video, it was easy to show back what...the students were doing and then they could see and they were getting excited about it as well which was nice.

The facility with which this pre-service English teacher had been able to edit using an App and give speedy feedback to his students on their oral work led him on to explain how he could extend this capacity if not just him, but his individual students, had access to iPads.

In reflecting on the impact of this project on the trainees' own learning, all of the trainees observed that it had significantly impacted on their conceptions of the role of technology in their teaching and their perceptions of what can be done. Three stated that they had not thought of using technology at all in this way, 'I think before the iPads I wouldn't have thought of using it in school', 'the actual opportunity to try it out in the classroom... made me realize that... you could do this effectively', and an 'eye-opener.' All the trainees also discussed their previous apprehension about using iPads, especially outside the classroom, and appreciated having an introduction to their potential pedagogical use in a safe environment. As one put it, it was 'nice to start at the uni' and another noted, 'you don't have to overly panic about damaging the poor thing.'

The shift in the trainees' understanding of learning and teaching was another element of the theme of Professional Learning in the data. Two trainees vividly described the impact the project had on their conceptions of how pupils learn and the way this has been impacted by their work with mobile devices. Pre-service teacher L has described a very powerful transformation in her conception of what teaching is, from starting her work as a trainee seeing it as a transmission activity, to one where she conceptualises the students' constructing knowledge for themselves, with the teacher and the technology facilitating this process.

CONCLUSION

In setting out to answer the research questions through this study, the themes of collaboration and authenticity emerged as the key ways in which the process of constructing eBooks using iPads impacted on the pre-service teachers' perceptions of teaching and learning. The participants identified collaboration between pre-service teachers and college students as enabling the former to extend their practice and develop strategies for learning outside the classroom using mobile technology. Together, the pre-service teachers and the college students used the iPad as a focus for collaboration and a tool to use collaboratively, negotiating meaning, aligning with socio-cultural principles (Vygotsky, 1978). The pre-service teachers used their subject knowledge and pedagogical knowledge, together with the technology, to ensure that the college students were involved in engaging learning experiences. The collaboration enabled both pre-service teachers and college students to share knowledge and expertise and to learn together, facilitating 'rich connections...mediated by a mobile device (Kearney et al., p. 10), or as one of the pre-service science teachers put it, the work is 'a lot richer because you have been able to share ideas and sort of bring everything together.'

By moving the learning from the classroom to a totally different venue, the participants perceived that the tasks became more authentic and situated in the real world. The focus of the eBook, which in this case was determined by both the pre-service teachers and the college students, was set within a realistic context and required examination from multiple perspectives (Herrington et al., 2006). The mobile technology supported the complex nature of the task they were working on and enabled the construction and application of knowledge by converting this into the format of an eBook, which according to Fullan and Langworthy (2014, p. 22) allows for 'deep learning' to take place. The task was perceived by the pre-service teachers to enable them to see 'relations between the practices they are carrying out and the use and value of these practices' (Barab, Squire and Dueber, 2000, p. 38).

The third theme that was identified in the data from the study was Professional Learning, which contributes towards an answer to the second research question posed: What relevant skills and competencies do trainee teachers perceive they gain from constructing eBooks using iPads? Three sub themes that were coded and were relevant to answering this question were; the ways that the trainees developed their use of the iPad in their respective subject areas; the expansion of trainees' conceptions of the role of technology in their teaching, and the impact that the project had on the trainees' understanding of learning and teaching. All three scientists interviewed observed the significance of using iPads in the field and on their understanding of the affordances of mobile devices and what they can offer out and about. The English pre-service teachers observed the interrelationship between the mobile device and the various modalities of English; reading, writing and speaking and listening. The pre-service teachers identified that using iPads for English work was 'way more accessible' than using paper based resources and that prior to this project three of them stated that they had not thought of using technology at all in this way. These responses suggest that the technological pedagogical content knowledge of the pre-service teachers has improved, in line with Murray and Olcese's (2011) argument that "...technologies prosper when they extend what users are able to do in productive ways." (p. 43).

As teacher educators, we are preparing pre-service teachers for a future where mobile technology is likely to become increasingly used in schools as a pedagogical tool, and when they begin to work in

schools as newly qualified teachers they need to be ready to embrace this. So, we as teacher educators need to model the functionality of various applications that might be useful in the classroom and use them on a regular basis, so that pre-service teachers become confident using the technology and are aware of the potential benefits that mobile technology can add to learning in schools today. They have to be the ambassadors of mobile technology and break through barriers to develop learning in this way.

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