MOBILE LEARNING IN MATHS TEACHER EDUCATION: DRIVING PRE-SERVICE TEACHERS’ PROFESSIONAL DEVELOPMENT

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Abstract

An emerging body of literature explores mobile learning in teacher education contexts. A common theme is the facilitation of collaborative, authentic professional learning experiences, often leveraged by the immediate and spontaneous nature of learning in informal settings. This paper takes a snapshot of current developments with mobile learning in teacher education. It draws on preliminary analysis of data from a study investigating mobile learning approaches in this context, with a particular focus on pre-service Maths teachers’ professional development. The study was developed as part of our institution’s activities in the national Teaching Teachers for the Future (TTF) project.

Introduction

Like other recent technological developments, there is considerable interest in exploiting the huge appeal and availability of mobile devices for their pedagogical uses. Consequently, various educational applications of mobile technologies (‘mobile learning’, or ‘m-learning’) are being examined. However, mobile learning in the context of higher education is relatively new and under-theorised both in initial teacher education and more generally in university teaching. In this paper we introduce a work-in-progress study in which we are seeking to gain an understanding of ways mobile learning technologies might mediate pre-service Maths teachers’ professional learning. The paper outlines contemporary uses of mobile learning technologies in teacher education and outlines our study in the context of a national Australian project—The Teaching Teachers for the Future (TTF) project—aiming to develop pre-service teachers’ Information and Communication Technology in Education (ICTE) proficiencies.

Background

There is a burgeoning interest in mobile learning approaches in Teacher Education and consequently academics are involved in sharing and exchanging information on research and potential uses of mobile technologies through communities of practice, working groups and professional learning communities (e.g. Schuck, Aubusson, Kearney & Burden, 2012). For example, Broda, Schmidt and Wereley (2011) explore meaningful strategies for using iPads both in pre-service teacher education and within K-12 contexts. They emphasise the need for educators to adopt a “progressive ethic for teaching and learning, supporting efforts to think differently and use the technology tools to explore and embody the fluid nature of learning and teaching” (p. 3150). More recently, Hodges et al., (2012) explored possibilities for pre-service teachers to develop their technological, pedagogical and content knowledge (or TPACK – see Mishra & Koehler, 2006) through the use of iPads in teacher education, including the transfer of relevant skills and techniques to K-12 settings.

Similar interest in the use of handheld devices is evident in Maths Education contexts. Bannon, Martin and Nunes-Bufford (2012) found that both pre-service and in-service teachers saw value in integrating iPads into Maths education as a tool to promote student learning. For example, supporting learning through the use of specific Maths games ‘apps’ targeting specific concepts. The project noted the need for careful preparation in iPad implementation to initiate transformation in teacher education. Also, smart phones have been exploited to extend thinking and enhance problem-solving procedures (Tangney et al, 2010). Given the potential of these devices to support collaborative and contextualised learning, their use may address some of the concerns in Maths teaching such as didactic approaches.
and de-contextualised material removed from real-world settings. At the school level, Tangney et al explore innovative uses of smart phones among school students studying mathematical concepts such as trigonometry and fractions taking place ‘out of class’ but structured and mediated by the teacher. Informed by a social constructivist pedagogical approach to m-learning, the authors provide examples whereby the functions and capabilities of smart phone applications can be used as a basis for scaffolding learning scenarios occurring in real-life contexts, opening up student exploration of Maths concepts and developing higher order thinking skills.

Niess’s (2006) work has been significant in understanding the opportunities and challenges of integrating technology in Maths teacher education, particularly using the TPACK framework. She considers whether it is possible to “teach the important ideas embodied in the mathematical concepts in such a way that the technology places the concept in a form understood by the students” (p. 196). Sample technological tools considered are the calculator, spreadsheet, Geometer’s sketchpad and some applets. However, teacher educators need to be prepared to explore the learning possibilities of mobile devices in Maths education and “need to develop a professional attitude of evaluation and reflection about tools for teaching – a thoughtful visioning that investigates and considers the impact of the tools for teaching Maths” (p. 199).

A framework for interrogating mobile learning

Research studies have attempted to examine m-learning through identified theoretical perspectives and frameworks such as activity based approaches, authentic learning, action learning and experiential learning (Sharples, Taylor & Vavoula, 2007). More recently, Kearney, Schuck, Burden and Aubusson (2012) have put forward a pedagogical framework of mobile learning informed by a socio-cultural perspective, comprising three central features: personalisation, authenticity and collaboration. How learners ultimately experience these distinctive characteristics is strongly influenced by the organisation of spatial and temporal aspects of the m-learning environment, as depicted in Figure 1.

![Figure 1: From Kearney et al. (2012, p.8).](image)

The rationale behind these scales is provided through the use of sub-themes under each of the central features and which pinpoints the critical features of m-learning from a pedagogical perspective. Personalisation consists of the sub-themes of agency and customisation. High levels of personalisation would mean the learner is able to enjoy a “high degree of agency in appropriately designed m-learning experiences” (p. 9) together with the ability to customise and tailor both tools and activities leading to a strong sense of ownership. In the case of authenticity, the sub-themes of contextualisation and situatedness bring to bear the significance of rich, contextual tasks both in formal and informal settings.
that students participate in m-learning episodes. Thirdly, collaboration consists of conversation and data sharing sub-themes, as “people engage in negotiating meaning” in m-learning environments (mediated by a mobile device) often ‘making rich networking connections to other people and sharing information and resources across time and space’ (p. 10). The authors emphasise that the framework provides a useful lens to explore how technology in the form of mobile handheld devices works in a range of formal and informal learning settings. Hence, it was used in this study to analyse participants’ mobile learning scenarios in the context of their professional learning.

**Study design**

Participants were 16 fourth year Bachelor of Education (Primary) pre-service teachers completing a Maths Education subject and two staff members (experts in Maths Education) who taught in this subject. All participants were issued with an iPad purchased by the University for the duration of the semester (3 pre-service teachers and 1 staff member used their own device). The project focused on participants’ use of their iPads in two types of professional learning activities: generic activities (e.g. organisational, communicative, reflective); and Maths-specific activities (e.g. using discipline-specific apps and other tools). These activities took place on-campus, in school settings and more informal settings.

The aim of the research project was to gain an understanding of the way mobile learning approaches can enhance pre-service Maths teacher education, particularly in the development of pre-service teachers’ TPACK. The research question relevant to this paper is: *How do pre-service primary Maths teachers use handheld technologies to support their professional learning?* A qualitative methodology (Erickson, 1986) was used drawing on aspects of case study methods. Data were collected during semester one, 2012 using participant journals, pre-service teacher focus groups, staff interviews and artefact collection.

**Preliminary findings**

An analysis of preliminary data (the pre-service teachers’ journal entries and interviews with two staff members) reveals that pre-service teachers are exploring ICT-enabled opportunities to think about rich, everyday Maths contexts in their teaching. They are also exploiting organisational benefits of the iPad in their own professional learning, with a focus on productivity, record-keeping, reflective practices and peer conversations. These experiences are stimulating their thinking about mobile learning applications and pedagogies in K-6 Maths teaching contexts.

**Exploring Maths in the real-world**

A strong theme in the preliminary data is pre-service teachers’ use of the iPad to explore and become more aware of Maths in everyday environments and to initiate their thinking about real-life contexts for K-6 Maths learning experiences. Activities involved capturing and annotating images from rich, meaningful, user-generated contexts. These artefacts subsequently became the focus of university class-based discussions with peers and staff as a catalyst for their thinking about authentic, technology-mediated Maths Education. In this way, they were developing knowledge about their nuanced use of ICT in their Maths teaching (or ‘Maths TPACK’). Geometry and fractions were the Maths domains most often used in these scenarios.

Joanna was walking through the city and noticed geometrical shapes in the urban landscapes. She used her iPad to take a photo (Fig. 2) and later, on the train travelling home, she annotated it to highlight the shapes in the photo (Fig. 3). She later showed these photos and discussed relevant Maths concepts with her peers and lecturer in a small group conversation ‘around the iPad’ during a campus-based class.
Sally and Mary took a similar approach using images to introduce everyday contexts into Maths education. On a trip to an amusement park, Sally took photos of ‘angles’ she observed in various park scenes. She annotated some of the photos (e.g. see Fig. 4) but planned to use other photos (e.g. Fig. 5) for her K-6 students to annotate. Like Joanna, Mary took a photo of a building and highlighted the shapes. She also used her iPad to capture and annotate images depicting fractions in real-life scenarios to convey specific knowledge about manipulating fractions (see Figs. 6 and 7)

Figures 4 and 5: Angles at an amusement park (captured and annotated by Sally)
Mary used this immersion experience to think about her own Maths teaching incorporating real-world contexts in this kind of image-based exercise and how this type of task caters for a range of K-6 student abilities and interest levels:

*Use of an iPad for fractions could be great fun for kids. How many ways can they illustrate fractions using a photo app such as Skitch? I have photographed a couple of different fraction examples which could add to a gallery of work by students. This approach allows for differentiation in ability, in creativity, and in interests.* (Mary, journal)

In her interview, lecturer Isabelle expanded on the value of pre-service teachers noticing out-of-class Maths phenomena. She emphasised that many pre-service primary Maths teachers often don’t see Maths in their everyday environment and indeed, many are fearful of Maths. She believed this type of mobile learning exercise allowed pre-service teachers to generate artefacts depicting rich contexts, enhancing their recognition and observation skills and developing more positive attitudes towards Maths. The iPad allowed them to follow-up and discuss the Maths associated with these artefacts: “Seeing [the phenomena] was spectacular. Having the facility to do something about it was also important…. the experience probably broadened what they might do in the future [in their teaching]” (Isabelle, interview). Indeed, one of Joanna’s journal entries supported her lecturer’s views about the effect on students’ Maths lesson planning:

*The iPad has allowed me to find inspiration from my surroundings and to then immediately develop and create a lesson plan from it. I realise that I can draw inspiration for math lessons everywhere…it means that no matter where I am, if I think of a really good lesson, or I see something that could be used in class to assist with placing mathematical concepts in real life situations, I can photograph or type it up using this mobile device.* (Joanna, Journal)

Kim stressed the importance of in-class, teacher-mediated conversations to follow-up these types of m-learning activities in K-6 contexts. In an audio-based journal entry, she discussed her observations of the relatively unstructured nature of children’s ‘out-of-class’ problem-solving (she used a mobile game playing context for this discussion) before noting the importance of using class-based discussion to ‘bridge-the-gap’ between ‘out-of-class’ informal learning experiences and formal school-based learning.

**Productivity and capturing evidence of learning**

Pre-service teachers are using the iPad to enhance organisational aspects of their professional learning. They initially used productivity ‘apps’ in class, often in a ‘just in time’, spontaneous fashion to take
notes, access scholarly papers and resources from the Internet, and record and annotate media. They particularly appreciated file-sharing apps such as Evernote and Dropbox to synchronise their notes, images and other work with their own array of personal computer devices to enhance the organisation of their learning. Larry for example, was impressed by the convenience and access benefits: “My notes were automatically pushed to my iMac and iPhone. This meant that the notes that began in the classroom could be viewed and edited either on the bus while I was standing or at home in the office” (Larry, Journal).

Many pre-service teachers emphasised the ability of the mobile device to conveniently keep records of their own learning journey both on and off campus. Nancy mentioned: “Personally I think I am more motivated to keep records of what I do and my thoughts now that I have the iPad” (Nancy, Journal). Pre-service teachers took photos of university class-based activities to help them ‘follow up’ on concepts and also to share with friends who were absent from class. For example, in one (campus-based) Maths class where exemplary activities were modeled around the room, they took photos of selected workstations and materials. They later annotated these image-based records with their own written reactions and thoughts. Their lecturer, Isabelle, observed them annotating their images during class discussions, essentially using the images as reflective prompts to think further about their Maths teaching. These experiences prompted them to think about how children could collect evidence of their Maths learning, for example, through journal and portfolio assessment procedures. Sally’s initial comments were typical: “I’m thinking that iPads could be used to help teachers identify if individual students do in fact understand taught Maths concepts during the lesson” (Sally, journal). She later drew on her experiences in her university Maths classes to discuss the possibilities for K-6 e-portfolios:

Today I used my iPad to capture images of the learning experiences undertaken in our Maths workshop on fractions and decimals. This demonstrates the benefit for teachers in using the iPad to capture evidence of children’s understanding of Mathematical concepts through the taking of photos. Photos can be stored to create an electronic portfolio of children’s learning throughout the school year and can be used for assessment purposes. (Sally, journal)

Similarly, Nancy discussed journaling in K-6 in light of her own use of the iPad to journal: “That made me think about the convenience of iPads … If every child had an iPad, journals would be easier to keep, let alone the ease of monitoring student progress on the teacher's part” (Nancy, journal). Building on her in-class efforts capturing and annotating photos for her own records, Kim commented on the potential for enhancing children’s reflective processes—how they could also use a handheld device to “write something about their learning … take a record of their learning – what’s going on!” (Kim, journal).

‘Fit’ with established model of mobile learning

Pre-service Maths teachers’ iPad-mediated professional activities have been analysed using the six sub-scales from the Kearney et al (2012) framework to rate the critical features of these m-learning activities from a pre-service teacher learning perspective. When researchers’ ratings differed, differences were resolved through group consensus. From this analysis, we selected three samples (see Table 1) to show a range of typical contexts and an indication of the extent to which features of the mobile learning model were exploited (Table 2).

<table>
<thead>
<tr>
<th>Sample Scenario</th>
<th>Brief description</th>
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<tbody>
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<td>Sample 1</td>
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<td>Sample 3</td>
<td>Sample 4</td>
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Table 1. Brief description of 3 samples of m-learning scenarios in Maths Education
A. Use of iPad at the Art
Gallery by Beth.
This activity takes place in
an informal setting to a
relatively unfixed schedule
and pacing.

During a recreational visit to the Art Gallery, Beth decided to explore
“how the iPad could be used to interact with the exhibition” for children
visiting on an excursion. Using her iPad, she downloaded and evaluated a
Maths Education resource. One of her ‘findings’ is described in her
journal: “Children may be able to view a painting such as Three Figures
Under A Tree to explore the concept of area. They could create a list of the
shapes they can see, then create a simplified drawing of this painting on
squared paper using only geometric forms and then calculate the area these
figures fill on the picture. Students can use the application Skitch to create
their drawings. The image can then be emailed to the teacher from the iPad
and a class art gallery can be developed.”

B. Geometry in the city
by Joanna. Takes place in
an informal setting to an
unfixed schedule and
pacing.

Joanna was walking through the city when she noticed geometrical shapes
in a few of the ‘city landscapes’ she was passing and decided to
photograph the scenes using her iPad. On the way home in the train, she
used an ‘app’ to trace and highlight the geometric shapes in the pictures
(see Figs. 2 and 3). She showed the images to colleagues and her lecturer
in her next Maths Education class and this stimulated a discussion about
the shapes and Maths teaching implications.

C. In-class use
(on campus) by Amanda.
Takes place in a university
Maths Ed. class. It was in
a structured setting within
a fixed schedule.

Amanda was in class, viewing a presentation from another pre-service
teacher on Maths apps. She was taking notes on her iPad and decided to
download and view relevant apps (during the presentation). Her journal
notes describe the spontaneous nature of this episode: “I slid my iPad
toward me and checked out the credibility of the apps, determined if it
might be a good app to use in my classroom, slid my iPad away and
resumed listening for any more useful information.”

Table 2. Ratings for 3 sample m-learning scenarios (described in Table 1)

<table>
<thead>
<tr>
<th>SCALE</th>
<th>Sub-scales</th>
<th>A Use of iPad at Gallery</th>
<th>B Geometry in the city</th>
<th>C In-class use</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERSONALISATION</td>
<td>Agency</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Customisation</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>AUTHENTICITY</td>
<td>Contextualisation</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Situatedness</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>COLLABORATION</td>
<td>Conversation</td>
<td>Low</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Data sharing</td>
<td>Low</td>
<td>Medium</td>
<td>Low</td>
</tr>
</tbody>
</table>

Pre-service teachers’ professional m-learning activities have generally rated highly in the scales of
personalised learning and authenticity. The analysis reveals that pre-service teachers are taking
advantage of the agency and customisation offered by the iPads in their own professional learning.
Activities have been characterised by autonomy in terms of choice of content, goals etc. (agency) and
typically involve student teachers customising their own experiences from both a tool and activity
level (‘just-enough, just-in-time, just for me’). Pre-service teachers have chosen a range of relevant (to
them) formal and informal contexts but not always participatory, in terms of being embedded in real, professional community practices (situatedness). There were surprisingly low ratings in the Collaboration scales. The pre-service teachers have so far mainly used the iPad to elicit small group, peer learning conversations at (rather than through) the computer (Crooks, 1999). There has been minimal use of larger scale ‘networked collaboration’ and data sharing of learner-generated content (e.g. through Web 2 facilities such as microblogging). Access to wireless facilities could be a hindering factor although participants new to using tablet computers initially felt more comfortable using their iPad to facilitate more familiar, small-scale face-to-face conversations. Again, it was not surprising to find an emphasis on fairly isolated ‘data acquisition’ activities (accessing apps, journal papers etc.) rather than sharing of learner-generated data (such as images and video assets) in these early stages, as participants become more familiar with the media recording and networking facilities. We will pursue this area in further depth in the next phase of the project.

Conclusions

Pre-service Maths teachers are using their iPads to mediate their own professional learning, exploiting features of personalisation and authenticity in both formal and informal settings. They are using their mobile devices to notice and capture ‘out-of-class’ Maths phenomena, following-up and discussing implications for their Maths teaching. They are using the technology to develop an enhanced awareness of Maths in everyday contexts, and using this knowledge to develop rich, contextualised ideas for ICT-mediated K-6 Maths tasks. In this way, they are developing their knowledge of using technology to support Maths teaching (or ‘Maths TPACK’). Other findings include the use of iPads to enhance the pre-service teachers’ productivity and ability to capture evidence of their professional learning. They value the visual and presentational role of the tool in facilitating peer learning conversations ‘around the iPad ‘campfire’ (Thornburg, 2004), although we expect to see richer, larger-scale networked collaboration as the project unfolds. The next phase will include investigating pre-service teachers’ professional use of the iPad during their school-based professional experience, including their selection and use of innovative K-6 Maths apps to support their teaching.

This paper provides an overview of contemporary developments with mobile learning in Maths teacher education and presents preliminary findings from a project exploring how mobile learning approaches can enhance pre-service Maths teachers’ professional learning. The national TTF project has given us impetus to explore m-learning tasks in Maths Education and a recently established framework has been used to examine features of mobile pedagogy associated with these activities.

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