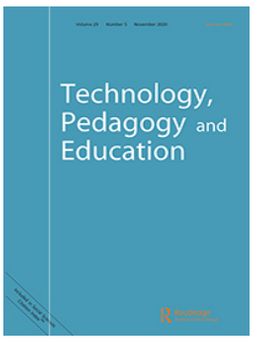

Technology, Pedagogy and Education

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rtpe20

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To cite this article: Gerald J. Galway, Beth Maddigan & Mary Stordy (2020) Teacher educator experiences of iPad integration in pre-service teacher education: successes and challenges, Technology, Pedagogy and Education, 29:5, 557-575, DOI: 10.1080/1475939X.2020.1819397

To link to this article: https://doi.org/10.1080/1475939X.2020.1819397

TECHNOLOGY, PEDAGOGY AND EDUCATION
2020, VOL. 29, NO. 5, 557–575
https://doi.org/10.1080/1475939X.2020.1819397

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Teacher educator experiences of iPad integration in pre-service teacher education: successes and challenges

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ABSTRACT

In this yearlong qualitative study, situated within cognitive and social constructivist theory, the authors investigate the adoption of tablets (iPads) by a group of nine teacher educators for use in pre-service teacher instruction. Using data gathered from focus groups following each of three teaching terms, the authors examined how teacher educators represent their experiences in using tablet technology and the ways they integrate tablets into their teaching and mentoring practices. Participants were generally positive in their appraisal of tablets, citing promising applications for inquiry-based and collaborative learning, reflective teaching, exploratory pedagogy and authentic student assessment, among others. Several challenges to tablet use were identified, including technical infrastructure issues, a requirement for instructor support, concerns about equity in student access, cross-platform compatibility and the general pedagogical shift to iPads as a teaching platform. Recommendations and implications for practice are discussed.

ARTICLE HISTORY
Received 4 July 2018
Accepted 6 March 2020

KEYWORDS
Tablet technology; iPad; teacher education; teacher educator; technology integration

Introduction

The explosion of mobile technology in education has opened up new channels for teaching and learning, offering educators new models and fresh approaches for organising the delivery of instruction, most of which are still evolving. This shift is also being propelled by an influx of teachers with new skill sets that enable them to exploit these technologies to rearrange and enhance the curriculum and to deliver technology-mediated instruction (Mcvicker, 2017). Research on mobile technology has documented a significant rise in mobile device use in schools; and with this, new ways for teachers and students to use smartphones and tablets to create, exchange and share information (Baran, 2014). Positive outcomes for students in K–12 (kindergarten to Year 12) settings have been reported in numerous studies, but the level of innovation is considered low to moderate (Burden et al., 2019). Changing expectations of contemporary students has been cited as a primary driver of mobile technology growth in schools and universities (Gupta & Koo, 2010; Kinash et al., 2012). Beauchamp et al. (2015) suggested that mobile technologies are now considered to be a serious alternative to desktop and portable laptop computers. As the technology culture accelerates forward, redefining the way we live and learn, considerable pressure rests with educational institutions to innovate in order to remain current and relevant.

Educational authorities have tried to keep pace by investing in tablets for educational use, even as research evidence on the effectiveness of tablet technology is still being accumulated (Mourlam & Montgomery, 2015). Schools began to acquire iPads for use in classrooms as early as 2010, and by 2016 Apple had sold about 350 million units to educational institutions worldwide,

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while in the same year there were some 170,000 education-related applications (apps) available for download from the App Store (Swartz, 2016). As less expensive Google and Microsoft tablet options have become available there have been some changes in acquisition patterns; for example, globally in 2017 the Chrome operating system powered about a third of mobile devices shipped to K–12 schools (Richter, 2018). However, recent data show that interest in iPads is rebounding, with quarterly sales in 2019 up by more than 20% over 2018 (Murphy, 2019).

Given their widespread adoption across the K–12 education sector, research on the integration of tablets in teacher education programmes is somewhat limited. Although there is a shortage of studies on teacher perceptions of educational technology generally, there is far less research on tablet integration in higher education, and specifically, teacher education. The vast majority of research on mobile device use in education is situated in a K–12 context, with most studies centring on classroom teaching and learning (e.g. Burden et al., 2019; Chou & Block, 2019; Haßler et al., 2015; Khalid & Guttesen, 2016; Tamim et al., 2015). Baran (2014) observed that teacher support and teacher training have been the least explored topics in mobile learning research. Many of the extant studies on tablet usage in teacher education are situated in professional development or in-service contexts rather than in pre-service teacher education (e.g. Mourlam & Montgomery, 2015; Shen, 2016; Vu, 2015). For example, of the 37 articles examined in Baran's (2014) review of research on all forms of mobile learning in teacher education, only 26 were situated in initial teacher education contexts, and in the vast majority of these articles, the research participants were pre-service (student) teachers. Only a handful of the reported research examined tablet usage by teacher educators and only one of these studies (Herro et al., 2013) examined tablet integration for instructional purposes. More recently, however, additional research has emerged specifically focusing on use of mobile learning in teacher education (e.g. Bai, 2019; Burden & Kearney, 2017; Vasinda et al., 2017). As we begin to gain a more fulsome understanding of mobile learning, additional research is needed that examines tablet integration within the specific context of teacher education.

In this article we contribute to this literature base by giving voice to the experiences of teacher educators who have used tablet technology in their teacher education practice. The purpose of this research was to study how teacher educators use tablets for instructional purposes and to examine what they perceive as the benefits and challenges of the technology. We begin the article by describing the theoretical framework within which we approach this work. This is followed by a brief literature review on the educational applications of tablet technology in higher education, and more specifically, teacher education. We then outline the research methodology and present findings from the study based on teacher educator representations of their experiences using tablets in their instructional practice. In the final section of the article we discuss the findings and address implications for policy and practice.

Theoretical framework and research questions

This qualitative research study is situated within the constructivist theoretical literature, specifically within cognitive and social constructivism. Cognitive constructivist theory is centred on providing learning contexts and platforms that enable learners to generate experience-based knowledge, individually or through interaction with others (Dennen & Hao, 2014). Social constructivism draws on the work of Vygotsky (1962, 1978, 1981), Wertsch (1985), Wenger (1988) and others who conceptualise learning as a co-constructed product of social interaction through collaborative problem solving, peer engagement and mentorship. Both forms of constructivism are oriented around the belief that effective learning is highly contextualised within authentic (or models of authentic) settings that involve realistic approaches to problem solving. Within this theoretical framework the research questions for the study are:

- How do teacher educators represent their experiences in using mobile tablet technology as a tool for pre-service teacher education?
- In what ways do pre-service teacher educators integrate mobile tablet technology into their instructional practice?

Literature review

We examined research studies and other sources of information from traditional scholarly sources (online searchable databases and scholarly books), other online sources, government and industry reports, trade journals and news websites, and other sources. An initial search was conducted to identify themes and to guide the development of focus group questions. This broad review included all aspects of mobile learning in the discipline of education. Upon completion of the study we conducted a further review of the literature focused specifically on the integration of tablets by instructors in preservice teacher education. The focused search yielded more than 300 items that were analysed and pared down based on relevance to the current study. The results of the review are organised into two categories: tablet usage in pre-service education and challenges to the use of tablet technology.

Tablet usage in pre-service teacher education

Baran (2014) identified pedagogical advantages in a range of teacher education contexts, although studies of pre-service teacher candidates were by far the most common. These include: enhanced connectivity and collaboration within class activities; the ability to use alternative learning approaches such as blended learning and flipped classrooms; mobility within and outside of traditional classroom spaces; enabling peer-to-peer communications, social media sharing/exchange and participation in professional learning communities; the ability to create and access digital content; connecting pre-service teachers with mentors; supervising and assessing field experiences; and peer evaluation. Consistent with Baran (2014), our review of the literature indicates that tablet devices are generally thought to be beneficial both for personal convenience and productivity, and as a tool to support and enhance curriculum/programme delivery.

Three aspects of teacher education where tablets show considerable potential relate to collaborative learning, authentic learning and personalising learning (e.g. Ally et al., 2014; Alrasheedi & Capretz, 2015; Chou & Block, 2019; Cochrane, 2014; Kearney et al., 2015; Naylor & Gibbs, 2015; Vaughan et al., 2015). Kearney et al. (2012) combined these three constructs (personalisation, authenticity and collaboration) into a mobile pedagogical framework for mobile learning (m-learning). Burden and Kearney (2017) later applied the mobile pedagogical framework to their survey of teacher educators and found high self-ratings of authenticity (opportunities for in-situ and participatory learning) and positive perceptions of collaborative sharing in the application of the pedagogical features of mobile technologies. Although the personalisation construct was less evident in this research, other studies in higher education contexts highlight the benefits of personalisation of the mobile tablet platform both in terms of individual needs and programme/course delivery (e.g. Fisher et al., 2013; Handy & Suter, 2011; Hedberg, 2014; Kearney & Maher, 2013). The ability to personalise tablet use through the selection of desired applications to accommodate students' individual programme needs and interests was identified as a key feature of the hardware (Hahn & Bussell, 2012). In the Burden and Kearney (2017) study, personalisation of mobile technologies was suggested as an area where more professional development is needed.

Naylor and Gibbs (2015) asked pre-service teachers to integrate mobile technology skills into their learning experiences and found benefits in enhancing peer mentoring and collaboration. Results from a follow-up questionnaire suggested the devices were also beneficial in terms of fostering interpersonal and social skills, confidence and self-esteem. Bai (2019) studied education graduate students enrolled in an online course on integrating technology into elementary classrooms, with

respect to their perceptions of mobile learning and mobile technology use. She found instructional benefits in terms of their value for promoting individualised learning, active and inquiry-based learning, access to information, motivation to learn, ease of use and versatility.

Kalonde and Mousa (2016) used a mixed-methods approach to study the major factors that drive teacher educators' decisions relating to use of technology for pre-service methods courses. Data from participants in two US universities (90 surveys and 10 interviews) show that choice of technology was strongly influenced by the nature of the content to be delivered and ease of technology use. This was followed, in order of magnitude, by a technology's availability and accessibility, teacher educator familiarity with a particular form of technology and cost issues. The study also highlighted the importance of effective modelling of technology integration to the professional practice of teacher graduates.

Shen (2016) surveyed pre-service teachers and teacher educators after three yearlong cycles of iPad use in an instructional milieu. Teacher candidates reported overall positive experiences including improvements and increased confidence in multimedia use, while instructors saw benefits in modelling technology use and reflective practice. A significant disadvantage, however, was lthat students had limited access to the devices: they were only available to students through sign-out (and for a limited period), were already loaded with pre-selected apps and could not be personalised. In a related study Vasinda et al. (2017) used data from collaborative autoethnographic research to explore teacher educators' integration of iPad technology into pre-service methods courses. Their findings, framed using Hughes et al.'s (2006) Replacement, Amplification and Transformation framework, suggest that teacher educators need more than access to iPad technology; for effective integration to take place, time must be allocated for professional learning, experimentation, exploration and practice, and provision must be made for professional support.

In one recent study of iPad integration among pre-service nurse educators, Stec et al. (2020) analysed focus group data to categorise individual influencing factors into student attributes, faculty attributes and device capabilities. Student attributes thought to influence iPad integration were student learning preferences; training level; device preference; screen size; and the availability of tablet-compatible content. Faculty attributes were somewhat conflated with device capabilities but included the ability to roam free; to engage students in active learning; to engage in collaborative learning (through Airplay); and to work with instructional designers in creating content. Device capabilities included their capacity for direct content delivery and access to outside resources, including various apps.

Johnson et al. (2016) examined tablet usage in a pre-service practicum context and found the devices effective in improving communication and streamlining the observation and feedback process, simplifying scheduling and record keeping and increasing professional collaboration. The mobility feature of tablets was judged to be superior to other computers in terms of the capacity to facilitate near-immediate reflection on classroom practice, post-teaching interviews and reflective journal writing. Its value in providing ready access to recorded data immediately following a lesson has been noted elsewhere as a means to more authentic post-instruction reflection and self-evaluation (Allen et al., 2016). Similar observations have been made in the context of nursing education (Brown & McCrorie, 2015; Tidwell et al., 2016).

Vaughan et al. (2015) explored the effectiveness of tablets in a teacher educator professional learning initiative. The study examined the use of the iPads specifically with respect to their impact on innovation among a group of nine teacher educators who committed to learning about using them for teaching, research and service. Results indicated an appreciation for the value of tablets in collaborative professional development and engagement, instructional organisation and the provision of student feedback. Similarly, Beauchamp et al. (2015) examined data from two national studies of iPad use in Scotland and Wales and found that teachers learn to use and integrate tablet technology in a 'highly experiential and playful fashion' (p. 173), which they argued has broad implications for initial teacher education. They theorised that teachers co-construct their understandings of technologies alongside their students in a manner that is 'far more symmetrical' than

traditional notions of teacher professional development, suggesting a need for alternative, non-hierarchical models of professional learning.

Challenges to the instructional use of tablets

A majority of the studies we reviewed situate mobile tablets as valuable education productivity tools, highlighting among other attributes their flexibility and portability. However, challenges to the instructional use of tablets were also identified. These include security and technical issues; administrative challenges; knowledge, training and professional development issues; shifting the dominant instructional paradigm; cost issues, off-task use of tablets; and financial risks.

Under the general rubric of security, several researchers point to privacy and ethical issues, including the safeguarding of information and the potential for inappropriate mobile device use, including cyberbullying, intentional misuse (including misuse of cameras) and online disinhibition (Ally et al., 2014; Bai, 2019; Baran, 2014; Burke, 2013; Chou & Block, 2019; Gentile, 2012). For example, Bai (2019) referenced pre-service teacher concerns with data security, student anxiety, cyberbullying and cheating related to the use of mobile technology. Striking an appropriate balance in the design of mobile device policies is a significant administrative issue since such policies bear heavily on the issue of digital security. Overly liberal policies may inadvertently create the conditions for inappropriate use, while prohibitive policies (of the institution or the instructor), including no devices in class, or restricting access to social media networks, run the risk of obstructing their effective instructional use (Ally et al., 2014; Baran, 2014; Hogue, 2013; Nguyen et al., 2015; Oliver & Townsend, 2013). Technical issues were highlighted in several studies (e.g. Bai, 2019; Chou & Block, 2019; Vasinda et al., 2017) and generally tend to focus on malfunctioning apps, tablet failure due to misuse, inconsistency in updating units and failure to recharge units while in classroom use.

Administering the adoption and use of mobile technology in an institutional environment is seen as a second challenge. Several studies (e.g. Mitchell, 2014; Oliver & Townsend, 2013; Pegrum et al., 2013; Psiropoulos et al., 2016; Vasinda et al., 2017) highlight the need for sufficient time for educators to investigate and explore mobile technology. For example, Psiropoulos et al. (2016) stressed the importance of administrators allowing instructors the latitude to 'play' with the devices and apply their skills in navigating the learning process. This is especially pertinent given the difficult task of curating the considerable and growing number of apps now on the market intended for educational use (Baab & Bansavich, 2015; Baran, 2014; Pegrum et al., 2013). Stec et al. (2020) made the point that with any emerging technology, there is a distinct learning curve requiring a period of adaptation and support. The fact that most new teachers are digital natives, and many teacher educators are accustomed to frequent technology change in education, does not negate the need for professional learning on how to effectively integrate tablet technology into classroom practice. In their study, Chou and Block (2019) described widespread frustration among teachers with regard to inadequate information technology (IT) support and ineffective training of IT personnel. Other problems included small screen size (especially with iPad minis), lack of keyboard attachments and authority to download apps.

Tablets and other mobile devices also bring with them basic shifts in instructional practices and paradigms. Biddix et al. (2015) suggested higher education pedagogy is poised for a hybrid shift that will fundamentally restructure traditional face-to-face classes. However, as Alrasheedi and Capretz (2015) observed, greater collaboration and mobility may challenge the norms of the traditional university lecture class and, while such norms are shifting, many professors are not entirely ready to embrace the change. Nguyen et al. (2015) reported that academics are sceptical of the value of tablets, noting that there has not been enough well-demonstrated evidence that they definitively help improve learning. On this point, there have been calls for leadership and vision among education decision makers to account for this shift in their planning and policy making (Hogue, 2013; Oliver & Townsend, 2013). Fisher et al. (2013) observed that mobile platforms such as tablets

will require educational planners to consider the connection between the primary technology used and the physical design and deployment of classroom space for teaching and learning.

A related leadership challenge is managing the pace and scope of paradigm change, for example, the predicted migration from print to digital content, the potential of tablets for storage and retrieval of course materials, and the associated training challenges. Other challenges discussed in the work we reviewed include concerns around technical limitations including structural constraints that may exist within a university such as institutional firewalls, compatibility with learning management systems and other infrastructure restrictions (Baab & Bansavich, 2015; Baran, 2014; Buchanan et al., 2013; Nguyen et al., 2015; Oliver & Townsend, 2013; Stec et al., 2020).

Finally, there are student-level challenges identified in the extant literature including the cost of tablet devices (Stec et al., 2020) and their potential as a distraction to learning through off-task use (Bai, 2019; Chou & Block, 2019; Stec et al., 2020; Vasinda et al., 2017), cheating and signing in to personal Apple accounts (Chou & Block, 2019), but these studies are generally situated in the K–12 context.

Method and data sources

In August 2013, 13 instructors from a faculty of education in a Canadian university responded to a recruitment email to participate in a yearlong study to examine the use of iPads in their instructional practice. Nine participants who met the following criteria (six females and three males) were selected:

- their teaching assignment included undergraduate pre-service teachers in a classroom (versus online) environment at some time during the 2013–14 academic year; and
- they were willing to become familiar with and use the iPad as a teaching device.

Participants represented a wide variety of subject area specialties and included instructors in both primary/elementary and intermediate/secondary pre-service programmes. Most identified themselves as new iPad users. Participants were provided with iPads and adapters to enable the projection of iPad content in the classroom. They also received a 50.00 USD iTunes card for app purchases, and several participants requested and received additional iTunes gift cards.

This study was conducted in a bring-your-own device (BYOD) environment. The classrooms and spaces in which the research was enacted were generally well equipped with high-speed Internet, computers, digital audio-video capabilities, interactive whiteboards and projection equipment, but class sets of iPads were not available. We conducted a pre-study meeting and an initial focus group session (September 2013), during which participants were briefed on the study and given basic instruction on using the devices and finding and downloading education apps using an iTunes account. Open-ended questions were used to elicit participant representations of their knowledge and perceptions of the pedagogical use of tablet technologies, the specific use of mobile technology in their professional practice and ideas for the potential of the technology for instruction in the participant's focus area.

The focus group protocol and analysis of the focus group data followed the general procedures described by Meijer et al. (2002), Merriam (2009), Miles and Huberman (1994), Krueger (1998), and Krueger and Casey (2009). Each session was recorded and transcribed. Transcriptions were thematically coded by indexing the text and establishing categories based on the discussions. The analysis was conducted with refinements specific to eliminating bias within a group discussion environment as outlined by Krueger and Casey (2009). Data were reduced to categorised segments, which were combined to create themes. Unanticipated patterns also emerged, and these data segments were analysed for meaning and included as cohesive topics or discarded as unrelated content. At the analysis stage, after the initial identification of themes based on researcher analysis of the transcripts, the data were reviewed against current literature in the field.

Limitations

The work is primarily dependent on naturalistic and interpretive methodologies that acknowledge the personal involvement of the researchers in representing the perceptions of participants. Data from focus groups are actively constituted by the interaction of the researcher with research participants. The inherent limitation of this type of methodology is that the results cannot be broadened to represent larger populations. However, it can reasonably be assumed that the findings would have relevance in similar contexts at other Canadian universities.

Research findings

At the end of the study seven of the nine participants reported that they had either used the iPad within the context of classroom teaching or had explored its potential. In several cases participants reported that they were primarily Windows users and had little or no exposure to the iOS computing environment. One participant from the original nine indicated a degree of personal adoption but indicated s/he did not perceive enough benefit for the pre-service teachers taking his/her courses. Another reported s/he did not use the device for either personal or classroom purposes, citing a need for additional training.

We separated the findings into two general categories, *Tablet Usage and Adoption* and *Challenges to Tablet Usage and Adoption*. The analysis presented here identifies three themes under the general category Tablet Usage and Adoption, namely (1) intentional and explorative instructional use, (2) collaborative learning, and (3) personal use. Under the category *Challenges to Tablet Usage and Adoption*, six themes emerged: (1) technical and network challenges, (2) training and support, (3) equity of access, (4) differentiating useful apps from 'noise', (5) navigating the shift from print to electronic text, and, (6) differentiating among digital devices. In the presentation of results, quotations were chosen to highlight and represent relevant group discussions; pseudonyms are used to protect the confidentiality of the participants in the study.

Tablet usage and adoption

Intentional and exploratory instructional use

The participants who adopted the iPads for instructional use reported using them in a wide variety of pedagogical contexts. These included creating inquiry-based activities or assignments by asking students to evaluate and compile information on software apps or asking students to create curriculum-based activities for use in the K–12 classroom. Other participants used the iPads to enhance standard evaluation practices, such as providing immediate audio and video feedback to students, or to introduce new instructional practices, for example, providing short video overviews of face-to-face classes in advance of a class, or lesson summaries following a class.

Inquiry-based, higher-level instruction. Some participants reported using the devices as a means to promote inquiry-based instruction through the appraisal of subject-specific or general teaching apps requiring higher level cognitive processes such as analysis and evaluation. Throughout the project instructors recounted instances where they provided opportunities for pre-service student teachers to evaluate apps, analyse their appropriateness and usefulness in relation to curriculum outcomes, and create shareable profiles that would be useful in their own teaching practices and those of their colleagues. The fact that the market is flooded with thousands of apps, many of which claim to be designed for educational purposes, was represented by participants as a challenge for all teachers, not just pre-service teachers. The instructors who used the iPads in this way talked about the importance of separating the so-called 'noise' from well-developed teaching and learning tools that intersect with established curriculum outcomes:

> Amy: The assignment was to find apps for Math that are good to use in the classroom – educational apps – and to review them according to the philosophy of Math, which is the front matter, the curriculum, [and] process standards.

> Alan: I did a lot of research in identifying apps based on reviews. So I just threw out this list, and [students] had to review three. One of the main things … they found was that some of the music apps that have the best reviews are the weakest apps in terms of classroom use.

In a similar case another participant reported that s/he gave students a choice to evaluate either a content-based app or a productivity app and to use the technology to create a multimedia representation to share what they had learned from the exercise.

Student and instructor evaluation. Several participants commented on the effectiveness of iPads as an evaluation tool, particularly as a means of providing timely formative evaluation, either through video or audio commentary. A majority of participants said they would continue to provide either video or audio feedback to their students in the future, as this method was considered more flexible and authentic than written feedback and could be easily created and communicated. In this example a participant used a specific audio app to distribute summative feedback and commentary at the end of a case study assignment.

> Glenda: I had a final case study in the course and I wanted to be able to give feedback on this and I wanted to look at the most efficacious way to do this. I recorded the grade and then I incorporated my audio feedback for everything. So after I post the grades, then I will send each person the link to their audio feedback.

Participants also saw the potential of iPad technology for recording student presentations and practice teaching sessions, both for self-assessment and as a means to enable instructor and student to review and deconstruct lessons to identify areas of strength and to target areas where improvements could be made. The ease with which tablets can be used for this purpose – without the administrative burden of setting up cameras and later organising and managing the video files – and the fact that the resultant videos are stored on a personal, but shareable, platform, was seen to be an important application for pre-service teacher education. One participant referenced the potential application of iPads to record teacher observation sessions during internships:

> Patti: The idea was to have [their teaching] videotaped so the students could reflect on their own teaching. […] There's so many possibilities [with] things like *iMovies* and so forth that students can use to show learning in different ways so assessment can be done in very different ways as opposed to [the] traditional paper and pen thing.

Others spoke about the potential of using tablet technology to assess the effectiveness of their own instructional practice by creating ways for students to provide immediate feedback, not only on lesson content, but also on her/his approach to a particular topic or how a lecture or a particular instructional method was working.

Exploratory use. Participants shared their strategies for incorporating iPad technology at the instructional planning level. In the following excerpt one participant was reflecting on how K–12 teachers had begun to use the 'flipped classroom' as an instructional model and how to experiment with the iPad as a tool for using the approach in her own classes:

> Glenda: [Teachers] want to use the flipped classroom as a model. It's very popular; it has a lot of appeal. So I'm thinking maybe I might toy around with that, which would mean using iPad tools or web tools as well.

As the study proceeded, participants shared examples of how they or their students explored different approaches to integrating the technology with the course subject matter. In this excerpt, Patti is talking about her interning students who were teaching a class in a Grade 3 classroom:

> Patti: [O]ne group did a great lesson plan on compasses and actually they started off by reading a story about explorers travelling through the Northern Passage and the students got talking about how did they find their

> way? … So they actually used their iPad as the compass app and they had magnets and allowed the students to explore … how the magnets caused the compass to move and they got to talk about Magnetic North and how compasses work and so forth. So it was a really great hands-on activity for the students to really see a compass in action and see the impact magnets had on a compass.

In another case a participant reported she was using the iPad to conduct fieldwork involving document retrieval and interviews.

Instructional productivity. Participants also used the devices as a means of improving instructional productivity. The ability to easily capture audio and video files and distribute these to students using the iPad was seen as one of the most effective uses for the tablets. One person described the benefits of using tools such as news aggregator apps to gather the most current articles on a topic and distribute them to the students using social media. Another participant talked about the use of the iPad as a means of easily handling and transporting working files, such as lesson plans, student work or other documents between workspaces:

> Mark: When I work on my iPad I just turn Airdrop on and I'll send everything onto my desktop automatically … and I edit on my desktop and push it back to my laptop at the end of the day and I work [on] it at home.

Another benefit is the ability to easily use material generated using iPads to augment conventional web-based instructional tools such as course websites. In the following excerpt, Mark explains how he was able to provide short overviews of his classes, clarify assignments or create impromptu video segments and instantly post these as learning objects with other course materials:

> Mark: I get my Montreal Canadians mug and … I'll do a quick little two-minute exercise like a review of the lesson to make sure [the students] get the main points and I'll post it on the website. So they go and review my stuff or I can give an assignment using this. Anywhere where I am if I think of something I can post a little video two minutes long, put it up on the [learning management system] website and they have them.

Collaborative learning

In all focus group sessions there was a robust discussion on the application of iPad technology for collaboration in educational contexts. This was expressed in myriad ways, from connecting classes of students with authors, artists, scientists and decision makers, to connecting individual learners to specific resource persons or mentors. Several participants also focused on the ways in which tablets could serve as a mechanism for connecting learners in formal communities of practice or professional learning communities:

> Alan: [W]ith the Choral Methods class, I've tried to really focus on a personal learning network and building on what Jane had done with her Math blogs. We've done that so there is a class blog and a student blog and we've used … ChoralNet which is the backbone of all things choral worldwide, to stimulate discussion topics that they will have to respond to on their blog. So we're building this kind of community. And there's been some success with people outside the class getting involved, which has been kind of exciting for [students].

Others commented that students are part of other collaborative social networks that have the potential to enable collaborative learning in the classroom to continue beyond the confines of the school day, although questions were raised about boundaries and the need to exercise professional judgement in this area. In one of the sessions there was a discussion about personal identity and belongingness in the virtual world. There was a sense that some aspects of community have shifted to virtual spaces and seem to occur only through personal and group interchange as mediated through social media and other electronic communications. Some instructors wondered how individual engagement in online spaces through tablets might be connected to one's identity and attachment to a community:

> Velma: I've had to look very carefully at what draws me to that and I think about that in terms of the ideas of belonging: Do we belong? How do we know that we belong and what is it about texting and emailing that draws us that fully? Because it's our connection to this social dynamic that says we belong, or we're marginalized.

Other participants represented participation in social networks as a means of accessing a virtual marketplace of ideas – spaces where we can learn how people think about and exchange those ideas, some of which are contested. Some participants conceptualised tablet devices as the entry point to this flow of information and ideas.

Personal use

All active participants used iPad applications for a variety of purposes they categorised as personal activities such as email and social media, entertainment and reading. While all members of the group owned or used desktop and/or laptop computers, they liked the convenience and size of the iPad for some of the functions they would normally have performed using a regular computer:

> Haley: It's convenient to be able to sit in a comfortable armchair and look up information ... I enjoyed reading this [book] on the iPad. I also like reading articles on the iPad – much more pleasant and comfortable than reading them on a laptop or desktop computer.

There was general agreement that the iPad was a more flexible substitute for desktops/laptops for several, but not for all applications. Portability and flexibility in file/learning object creation, management and sharing were consistently mentioned as key productivity features for teacher educators. Other features such as the camera and audio recording capabilities were also considered to be benefits, but the iPads were not deemed suitable for larger writing projects or other work requiring the opening of multiple applications or software programmes.

Challenges to iPad usage and adoption

Under the category Challenges to iPad Usage and Adoption, a number of technical obstacles and implementation challenges were identified and are captured under the six aforementioned themes.

Technical and network challenges

The findings suggest a number of limitations in linking the iPads to the university's communications infrastructure. Almost all those who tried to use the iPad in various instructional spaces ran into connectivity problems at one time or another, causing problems with reliability. Participants reported difficulties establishing connectivity between the iPad and classroom projection systems as they prohibited wireless projection from mobile devices. In several instances, instructors came to class prepared to work with their iPad but had to revert to their laptop or the computer equipment that was installed in the classroom. These problems effectively negated one of the anticipated benefits of iPad technology – the ability of instructors to effectively use the tablets while moving around instructional spaces. As one participant commented, there was no solution to the problem other than to use adaptors and hard connections between the iPad and the 'smart' classroom's projection system:

> Mark: I was forced to simply connect as I would with the laptop. This did not make the iPad advantageous over the laptop. I looked like a NASA space technician before class hooking up all the wires and connectors to operate my laptop, desktop, iPad and phone. My clickers also required an adaptor. I carried more gear than a TV repairman. [. . .] I'll just use my laptop or a data stick I plug in and go from there. Otherwise I'd use this more, because I'd love to be able to walk around the classroom using my notes and then throwing images up and videos up, but I can't.

Another participant remarked that the existing institutional capacity, while robust, was not keeping pace with advances in tablet technology; she also referenced similar difficulties in utilising other technology, such as Apple TV. These technical problems caused participants to abandon their attempts to integrate wireless applications of the iPads until solutions could be found to these compatibility issues.

Training and support

Some participants reported a significant learning curve associated with the systematic adoption of the iPad for classroom use and a need for support and training. Several of those involved in the study

recounted that they felt reasonably adept in the application of technology to their teaching practice, but the shift to mobile device technology represented a fundamental change to the way they normally work. Some members of the group admitted feeling overwhelmed, and we heard a number of calls for additional training and support. It became clear, early in the study, that one of the participants was struggling to become familiar with the iPad and didn't make very much progress in learning its basic functionality. As the study continued he effectively dropped out. An individual follow-up interview revealed that the participant felt he was not comfortable using the device in the classroom and required more training than could be provided under the provisions of the study's methodology.

Throughout the focus group sessions, there were many references to technical challenges and steep learning curves requiring technical training and sustained professional development, both for instructor and students:

> Mandy: There would have to be a considerable amount of professional development for teacher-candidate instructors. Because if the investment is going to be made, if the expectation is there, then how is it you do it … in music, in art, in special education? […] I've had lots of teaching from the tech folks over the years in various positions and it requires you come back, and for people like me, you have to keep coming back to it. It's not a one-off.

Equity of access

Student access to tablets was identified as a problem; fewer than half of the pre-service teachers in classes taught by the teacher educators in this study indicated that they had access to an iPad. This is generally consistent with the Canadian Radio-television and Telecommunications Commission's *2017 Communications Monitoring Report*, where 54% of respondents over the age of 18 in Canada own a tablet (Canadian Radio-television and Telecommunications Commission, 2017, p. 306). While many of the students were able to acquire the use of an iPad, a much higher proportion own and regularly use a smartphone, and they used these as a substitute for the iPad in some of the classroom activities. Some instructors expressed concerns about working in a classroom environment where not all students could fully participate. As one instructor observed, '[m]y big dilemma with involving students with the iPad in the classroom is around the equity issue, around access'.

Affordability was identified as an issue, especially in circumstances where students might be required to own an iPad as part of the required resources for their teacher education programme. Some participants felt that unless iPads were required as a mandatory tool, or signed out to students at the beginning of their programmes, there would be difficulties in integrating the devices into the curriculum in a systematic way:

> Velma: Do we want to see an iPad in every student's hands in the next two or three years? And then how does that disadvantage some of our students? What about the students who can't afford that?

As the study progressed, some instructors who used iPads in their classrooms found that the problem of access required that they modify their lesson plans in different ways, for example, adapting activities so that students with Windows-based laptops or smartphones could use compatible or similar web-based apps to achieve the same learning outcomes. Instructors modified assignments to accommodate different kinds of devices using different apps or web-based versions of the apps available from the App Store. Participants also encountered a few cases where students felt left out of some tablet-based instructional activities because they did not have access to a device, and the financial burden of acquiring one was too great. In such cases instructors changed some of the course objectives or scaled back on the use of tablet-based course work:

> Mark: I assumed this year that everybody had smart devices and I had a number of people approach me saying … 'I don't have … I can't connect here at campus because I can't afford it.' So I had to curb some of the things I was doing because of that.

Some participants struggled with the equity problem and felt that use of specific apps for instructional purposes would mean some students could be marginalised. There was discussion around the importance of choosing apps with cross-platform compatibility, as a means of attenuating equity of access concerns.

Differentiating useful apps from 'noise'

Several participants spoke about the difficulty in navigating through the sheer number of available apps in terms of their instructional value, relative cost and potential for classroom use. Several members of the group expressed that they felt responsible but poorly equipped to provide guidance to teacher candidates about the most valuable apps in their subject areas. One instructor talked about the cognitive load associated with keeping on top of what is available and differentiating useful apps from 'noise'. Almost all of those in the group recounted examples of apps that, based on the descriptions, appeared to be appropriate and useful, but were very poor in terms of functionality:

> Mark: [S]ome of them aren't vetted at all and I can't trust them. So I'm going through the process now with my class to talk about how to look at scientifically validated teaching approaches. [. . .] It takes a tremendous amount of work on our part and our students' part, to find apps that are appropriate, that are effective; that aren't just a gimmick.

There was also a prevailing sense that a large proportion of the available educational apps were flashy and games oriented but lacked any substantive educational value. Participants had difficulty finding educational apps intended for teachers; most were aimed at individual learners. Generally, participants felt that an important role for pre-service teacher educators was providing students with ways and means of evaluating apps on several criteria, rather than simply providing examples of a few apps that might be useful in their teaching practice.

Navigating the shift from print to electronic text

One of the interesting themes that emerged in discussing the transition to tablet technology relates to the difficulty in migrating from print to (mostly) electronic text. Some participants volunteered their perspective that, in their own scholarly activity, print rather than electronic text seemed to be more conducive to greater comprehension and deeper learning. In one case a group member reported that she was concerned that when using a tablet, she increased the pace with which she engaged with text.

> Amy: What I've found . . . is that it's made me, despite my best efforts, way more discursive. I'm not able to sit with a book for long periods of time anymore. And I'm not a Luddite; technology is part of life and always has been . . . . But I want to be able to sit and read a book. So I'm making an effort now not to be discursive so I'm actually trying to take control of it as opposed to being controlled by it.

Some group members expressed concern about how to navigate this change and how to protect and foster the kind of deep reflective learning traditionally mediated through print books. There were concerns that students were reading more on mobile devices, and that the absence of a physical text might encourage more superficial reading or skimming of text. It would therefore follow that greater instructional use of mobile devices could have some negative implications for learning:

> Velma: People don't read any more. They're skimming. And when [students] have so much to do, and I think program wise, too, they're so overloaded that they can't do anything but skim.

> Amy: They don't read either, Velma. I think that was my point, too. The idea of being able to sit with a book, it's an embodied experience. It has depth that I don't find that I have with [the iPad].

Differentiating among digital devices

Among the discussion points that emerged during the final focus group session was the question of return on investment, not only (and perhaps not primarily) the financial investment, but also the

investment of time and energy required for a generalised shift to iPads as a teaching and learning tool. Some participants talked about the professional development challenges of scaling up. A few comments were directed at the challenges of managing multiple platforms (a smartphone, a tablet, a laptop and, in some cases, a desktop computer) and whether tablets offer enough unique advantages over other mobile devices such as smartphones. Generally, however, participants acknowledged the value of the iPad as a convenient and multipurpose instructional tool, but some felt that it was not substantively different from other mobile device options. They were critical of the proprietary app environment on grounds that the model runs counter to the principles of equity and accessibility. As a general rule, participants favoured compatible platforms in a non-proprietary setting where the best apps could be accessed using multiple devices.

Discussion

Generally speaking, the participants who remained in the study were positive in their appraisal of the iPad, both as an instructional technology and as a personal productivity tool. Participants named accessibility, versatility, heightened collaboration and flexibility in their pedagogy as some of the main instructional advantages. Applications of the technology ranged from simple mobile document retrieval and intra-class communication to more complex instructional activities such as multimodal evaluation. These results are consistent with other research on the instructional use of tablets in higher education where findings show potential in fostering collaborative learning, simulating authentic learning experiences and personalisation (e.g. Alrasheedi & Capretz, 2015; Burden & Kearney, 2017; Cochrane, 2014; Kalonde & Mousa, 2016; Kearney et al., 2012). Other benefits included enhancing instructional productivity, for example, in the areas of student teaching and assessment.

Participants in this study cited numerous examples of how the functionality of the iPad (mobility, Internet access, video, audio and communications) and its applications could be used in different ways to co-construct learning in collaborative and community contexts, including group work, and connecting pre-service teachers to communities of practice or other collaborative educational networks. The devices were used to enable student and instructor to ask questions or engage in side conversations within and outside the classroom. The tablets were also found to be effective and convenient in advancing exploratory pedagogy such as shifting instructional practices and traditional classroom structures, for example, participants experimented with flipped classroom instruction and lesson previews using various communication channels. Similarly, the devices were useful in effecting inquiry-based pedagogy, such as the analysis, evaluation and categorisation of apps and the creation of tablet-based lessons and lesson repositories – activities that require higher level cognitive processes such as those described by Anderson et al. (2001) and others.

Naismith et al. (2004, p. 13) argued that mobile devices are very well placed to enhance situated learning, which 'requires knowledge to be presented in authentic contexts and learners to participate within a community of practice'. The application of iPads in creating or augmenting authentic learning experiences was amply demonstrated in this research, for example, video-recording student teaching sessions for later review and evaluating pre-service teacher competency in classroom placements. Although these are not novel teacher education practices, the ease with which professors were able to integrate tablets is innovative because the size of the units and the capacity for instantaneous video and audio capture and transfer improve the execution of these pedagogies and all but eliminate the administrative and technical burden of traditional methods.

The uniqueness of tablets as a teaching technology is in their mobility and functionality. Although laptops can be packed up and transported, tablets are far more agile; they are quick and light to move – well suited for active, constructivist pedagogy. Active learning requires appropriate learning environments that are aligned with constructivist teaching strategies. Grabinger and Dunlap (1995) described such environments as dynamic spaces for: collaborative and interdisciplinary learning; the integration of prior knowledge with newly learning; the construction of knowledgeable learning communities; and the creation of conditions where learners acquire a realistic and practical sense of

the subject matter under study. Consistent with Fisher et al.'s (2013) observations about their physical attributes, we posit that the design and functionality of tablets are appropriate for constructivist teaching approaches that rely on cooperation among learners and foster the co-construction of knowledge. The devices are designed to sit flat on a student's desk for others to see, can be easily passed off to others in a group learning context, are more mobile within and outside of learning spaces, and allow students to communicate easily with the professor and with one another. Laptop (and desktop) computers, by comparison, are less portable and oriented spatially towards a stronger sense of private space.

Many of the challenges identified in the study were training related or were technical and context specific, by which we mean the problems experienced with infrastructure and wireless interfacing between the iPad and existing classroom technology were not durable issues. Other studies (e.g. Bai, 2019; Chou & Block, 2019; Stec et al., 2020; Vasinda et al., 2017) have highlighted technical and maintenance challenges, especially in school settings where the devices are more prone to accidental or intentional misuse. Such problems are likely to be more pervasive and require a wider range of technical and policy interventions than the issues identified in this study. While the university's technology support group was unable to provide solutions to the technical problems experienced by participants at the time this research was conducted, it appears that these are under active investigation and are likely to be resolved in the not too distant future.

However, other challenges such as instructor support, equity, cross-platform compatibility and the general pedagogical shift to iPads as teaching platforms bear further examination and discussion. Similar to findings reported by Kalonde and Mousa (2016), where technology availability and acquisition cost were highlighted as limiting factors, participants in this research identified equity of access to tablets as a serious concern, particularly in situations where students were assigned classroom-based activities and assignments specifically requiring an iPad. Although we could find only one other study (Bai, 2019) specifically highlighting equity issues in the applications of tablets in teacher education, a recent report on technology usage in Ontario schools identified disparities in students' access to digital tools in schools with 33% of elementary and 66% of secondary schools encouraging students to bring their own device to school every day (People for Education, 2019). The findings from our research support the proposition that technology-based classroom pedagogy should be flexible enough to support compatibility across digital platforms, especially in BYOD environments. For example, smartphones are far more prevalent than tablets among pre-service teachers, and while they might not provide all of the same functionality or access to educational apps, they should be considered as possible alternative to tablets. As Stec et al. (2020, p.663) observed, '[a]pplications are becoming increasingly device agnostic', and we can expect this trend to continue. That said, given the widespread adoption of iPads and other tablets within K–12 schools, we believe pre-service teachers should be familiar with the instructional applications of tablet technology. In our local experience, we find that many schools, particularly elementary schools, maintain class sets of tablets and so should faculties of education and teacher colleges. Although borrowing a tablet for class use does not allow the device to be personalised for learning – one of the demonstrated benefits of the technology – it does enable student access, thereby at least partially addressing equity concerns and providing practical knowledge in using tablets and in managing class sets.

The capacity to deliver immediate technical and pedagogical support has been referenced in the recent literature as a critical success factor (Cochrane, 2014; Mitchell, 2014; Nguyen et al., 2015; Oliver & Townsend, 2013; Polly & Rock, 2016; Psiropoulos et al., 2016; Vasinda et al., 2017). Technical and firewall problems preventing wireless connections and the BYOD environment were all obstacles; however, the broader issue of re-orienting instructional practices was more of a challenge than anticipated. The problems of lack of familiarity and the transition to a digital platform were more significant that either the participants or researchers had anticipated; some participants described the shift as difficult and reported that they struggled with conceptualising how the devices could change their traditional approach to teaching. The digital classroom environment represents

a transformative change in pedagogy for teacher educators; the participants in our study didn't fully recognise the implications of this shift and neither did we as researchers.

Conclusions and implications for practice

There are instructional and administrative implications of this study for pre-service teacher education. Teacher educators in this study recognised many promising applications of tablet technology for instructional use in pre-service teacher education programmes including: enhancing collaborative learning; creating inquiry-based learning experiences that foster higher cognitive level thinking; enabling innovative and alternative instructional practices; augmenting lectures and classroom-based instruction with video and audio; improving instructional productivity and improving communication among learners and between learners and communities of practice. Participants also experienced challenges and obstacles to tablet integration including how to effectively address equity concerns and pedagogical support for digitally mediated teaching using tablets. In many ways, the migration to tablet technology represents a sea change in the ways we deliver pre-service teacher education, and navigating that shift – especially in circumstances where programme-wide integration of tablet technology is being considered – should be approached cautiously, and with thoughtful planning.

First, to the issue of professional learning: at the inception of the study several potential participants told us that they were accustomed to a different operating system and were not ready to change. Another said s/he did not perceive enough benefit to invest the necessary time into learning how to operate and integrate the technology into his/her pedagogy. Still another opted out before the study began, citing a need for additional training. Even those participants who embraced the opportunity to use the iPad in their teaching over the course of an academic year emphasised the need for more training and professional development. Educators have long complained that fundamental instructional changes and/or paradigm shifts in education are executed without due attention to sustained professional development. These findings lead us to conclude that the importance of technical training and professional learning (in respect of the pedagogy of tablet technology) and sufficient time to enable the shift to tablet integration cannot be underestimated. Faculties of education must create the financial, technical and human resource conditions necessary to enable tablet use in the classroom, which includes technical support for the instructor. This could involve increasing or redirecting organisational capacity to be able to lease/lend, track and update tablets and provide adequate training. We earlier referenced the broader challenge of re-orienting instructional practices. Teacher educators in our study struggled somewhat with engaging pre-service teachers in learning activities that truly exploit the unique opportunities that tablets present, rather than transposing the same old activities and assignments from a computer. For these reasons, we argue that any institution planning a system-wide shift to tablets as teaching and productivity tools must account for the fundamental need to establish initial and ongoing training for faculty and administrators. In addition to basic training on functionality, such training might include demonstrations of tablet-based constructivist pedagogy, intelligence on the most effective apps and information on how to differentiate useful apps from those with little or no instructional value. It is also evident from the findings that some teacher educators will need more organisational support and individualised learning opportunities before they will be in a position to effectively exploit the technology. Therefore, initial and ongoing training and support mechanisms must be designed to be robust and flexible enough to account for a range of training/learning needs.

Second, it is important to recall that teaching is an active process and pre-service teacher instruction requires that teacher educators be able to adopt and model advances in teaching practice. Wireless interfacing of tablets with existing 'smart' classroom infrastructure is essential if we are to model active pedagogical approaches in the classroom; there is little value in having such a nimble teaching tool as a tablet if it must be tethered to a workspace. Challenges to the intentional use of tablets, such as the ones experienced by the participants in this study, pose limitations to the ability of

teacher educators to model tablet integration in their teaching. Tablet usage in preservice teacher education has the potential to advance constructivist pedagogy in the K–12 classroom, but operational challenges must be overcome to fully realise these goals. For example, the use of institutional firewalls, while necessary for security reasons, limits the collaborative power of tablet devices. Future advances in the technology may eliminate this challenge; however, research on how to respect network security protocols while allowing for maximum connectivity is an area that needs further exploration.

Third, our findings have implications for programmes delivery and raise questions about equity issues in BYOD classroom environments, where not all learners have access to a tablet. Issues of equal access are not new to the literature as Bai (2019) and others have raised similar concerns. For a host of reasons, class sets of tablets are far more common in K–12 classrooms than in post-secondary institutions, where learning spaces may be dispersed across different buildings and where pre-service teachers would likely require access to such devices over an extended period. In post-secondary contexts where class sets of tablets are available, personalisation of the devices is still problematic. If teacher educators are to embrace the use of tablets in their teaching, we contend that all learners must have access to a device. In our experience, virtually all pre-service teachers own a smartphone and/or a laptop, but there are limitations such as compatibility problems with functions/apps as well as other inconsistencies across platforms. In addition, some of the very features that make tablets ideal for collaborative learning are absent or far less robust in smartphones and laptops. For these reasons, we suggest that faculties of education consider strategies for acquiring and distributing (lending or leasing) tablets to those pre-service teachers who do not otherwise have access.

The purpose of this research was to investigate the ways teacher educators use tablets for instructional purposes and to examine how they represent the benefits and challenges of the technology. The findings presented here, combined with research described in the literature review, underline our contention that there are significant opportunities for innovative and transformative pedagogy in teacher education through the effective use of tablet technology; however, there are also technical, operational and equity challenges that must be overcome.

Acknowledgments

The authors are grateful to Michaela Drover for research assistance.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This research was funded by a grant from Memorial University's Centre for Innovation in Teaching and Learning, Memorial University of Newfoundland.

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