

Preparing Literacy Teachers for Integrating Technology

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Abstract

A survey of 199 literacy professors explored the supports and barriers related to three outcomes (1) types of technologies they prepared teachers to integrate, (2) methods they used to prepare teachers to integrate technology, and (3) digital literacy strategies they prepared teachers to use, using a mixed response model. Time, access to equipment and professional development, and literacy professors' interest and knowledge about integrating technology supported the types of technologies they taught and methods they used to prepare teachers. Time, access to technical support, and literacy professors' interest in integrating technology supported the digital literacy strategies they prepared teachers to use. Time was a barrier to both the methods that literacy professors used and digital literacy strategies they prepared teachers to use. Our findings underscore the importance of providing time for literacy professors to plan and practice technology integration to improve their teacher preparation practices.

Keywords: technology integration, literacy professors, survey, supports, barriers

Preparing Literacy Teachers for Integrating Technology

Recent international learning standards underscore the importance of technology integration in literacy instruction (International Literacy Association, 2019; International Society for Technology in Education, 2019). However, despite teachers across the globe (e.g., Indonesia, Iran, Japan, Jordan, and the U.S.) having technology skills, they often are unable to effectively integrate technology in their primary and secondary school instruction. These gaps are due to insufficient teacher preparation (Alelaimat, et al., 2020; Curcic, et al., 2015; Martin, 2018; Prasoj, et al., 2018; Taghizadeh & Yourdshahi, 2020; Voogt & McKenney, 2017). For example, Taghizadeh and Yourdshahi's (2020) study in Iran found that "most teachers did not have sufficient pedagogical and technological knowledge to use technology to teach the English language to young learners" (p.1). In particular, teachers' preparation in Botswana, Jordan, the Netherlands, and Turkey lack opportunities to *actually integrate technology in their lessons* (Alelaimat, et al., 2020; Batane & Ngwako, 2017; Dinçer, 2018; Farjon et al., 2019). For example, Dinçer (2018) found that teachers in Turkey "had not received any education about the use of technology *for teaching activities*" during their university coursework (p. 2710; our emphasis). Therefore, we need to understand why teachers are not getting this preparation. In particular, we need to know what supports or hinders professors' preparation of teachers to integrate technology in their literacy lessons.

However, while many studies focus on supports and barriers to professors' use of technology in higher education classes, across Estonia, Korea, Malaysia, and the U.S. (e.g., Arya et al., 2016; Cheok et al., 2016; Lee & Son, 2018; Luongo, 2018; Taimalu & Luik, 2019), few focus on supports and barriers related to professors' *preparation of teachers* to integrate technology in instruction (Adnan & Tondeur, 2018; Foulger et al., 2015; Voogt & McKenney,

2017). These few studies broadly explore the supports and barriers to professors' preparation of teachers to integrate technology in their classrooms, but do not connect specific supports or barriers (e.g., time, knowledge) to specific professors' practices (e.g., modeling, teaching digital writing, etc.). Further, Adnan and Tondeur's (2018) study of professors in Turkey argues that research still needs to examine the "strategies used by TTIs [teacher training institutes] in efforts to prepare future teachers to teach with technology" (p.9).

Our research addresses these gaps by investigating more fine-grained relations amongst supports, barriers, and professor practices. Specifically, we examine the supports and barriers that are related to literacy professors' (1) technologies that they prepare teachers to use, (2) methods that they use to prepare teachers, and (3) digital literacy strategies that they prepare teachers to teach K-12 children. These findings inform how to better support literacy professors to prepare K-12 teachers to integrate technology in their instruction.

Literature Review

Only a handful of studies explore how supports and barriers are related to professors' preparation of teachers to integrate technology in K-12 classrooms (Adnan & Tondeur, 2018; Foulger et al., 2015; Voogt & McKenney, 2017). Therefore, we review the broader body of research on the supports and barriers related to education professors and professors from other disciplines use of technology in their courses to inform our study.

Support for Professors' Integration of Technology in their Courses and Related Outcomes

Institutional support, access to technology, experience using technologies, and perceptions of the usefulness of technologies are important factors that support professors' use of technology in their courses. When institutions support technology integration in courses, technology use increases or improves (Nelson et al., 2019). For example, a survey of professors

across various content areas shows that when they receive support to integrate specific technologies (e.g., videos) their use of those technologies increases by 67% (Arya et al., 2016). Similarly, in other studies, when professors receive professional development on how to infuse technology effectively, educators improve their technology integration and also shift to using more effective methods for preparing preservice teachers to integrate technology in their K-12 instruction (Foulger et al., 2015). Further, professors report that when institutions create policies that include incentives (e.g., sustained financial support for integrating technology), they are more likely to integrate technology (Lee & Son, 2018). In addition to institutional support, colleagues and technical staff are the next most frequent sources of support for technology integration in courses (Chittur, 2018; Christ et al., 2017; Harbin, 2019; Lee & Son, 2018).

Additionally, availability of and access to technology resources is critical for educators' integration of technology in their teaching. More technology is used in courses when professors have greater access to equipment (Arya et al., 2016; Lee & Son, 2018).

Further, professors' experience using technology supports technology integration in their teaching. Studies show that professors and professors who have more experience using technology—i.e., experience integrating technology (Foulger et al., 2015), teaching online (Khin, 2021) using computers (Karsh, 2018), using Blackboard (Woods 2004), or using Web applications (Alsadoon, 2018)—are more likely to use technology in their courses than professors with less experience. Thus, “teachers’ knowledge affects their decision about whether they use technology at all, and if they do then how they use technology to promote learning” (Taimalu & Luik, 2019, p. 108). Also, over time, educators move from viewing “technology integration as an isolated set of skill[s] revolving around technology, to technology integration as

an integral part of teaching content and pedagogical knowledge to [teacher] candidates” (Foulger et al., 2015, p.144).

Finally, when professors perceive that technology is useful (e.g., Web applications) they integrate it more frequently (Alsadoon, 2018). Likewise, professors are more likely to integrate technology when they think that this will yield to good teaching and improved learning outcomes (Cheok et al., 2016; Chittur, 2018, Taimalu & Luik, 2019).

Barriers for Professors’ Integration of Technology in their Courses and Related Outcome

The main barriers to professors’ use of technology in their teaching are poor university policies, lack of technology resources, lack of professors’ technical skills and unavailability of technical support, lack of professor interest, and time constraints. One barrier is unclear university policies or models regarding technology integration in the classroom (Mercader, 2019; Tshabalala et al., 2014) that makes technology integration sporadic and inconsistent. Sometimes professors also feel that they do not have their administration’s support to integrate certain technologies (Alfalah, 2018; Luongo, 2018). Related to this, professors sometimes do not feel that integrating technology adds value toward achieving tenure and promotion (Luongo, 2018).

Another barrier to professors’ technology integration is a lack of technology resources at the university level (Cheok et al., 2016; Luongo, 2018; Marzilli et al., 2014). Specifically, not having enough computers and tablets on campus, or having outdated platforms and software, or not being able to use software due to security issues, or limited access to Internet all contribute to professors not employing technology in their courses (Cheok et al., 2016; Khin, 2021; Marzilli et al., 2014). In a survey of professors, only 35% report that their students have access to needed technology resources (Arya et al., 2016). Another survey conducted with business professors reports that not having enough computers is a “moderate” barrier to integrating technology

(Karsh, 2018, p. 11). Additionally, lack of high-quality technology-based instructional materials, such as video case studies, further acts as a barrier to technology integration (Arya et al., 2016). Many of these realities have to do with costs of technology being a barrier (Alfalah, 2018).

Further, even when some institutions have the resources, sometimes professors do not have the technical skills to integrate certain technologies (Alfalah, 2018; Cuhadar, 2018; Khin, 2021; Tondeur et al., 2019). This lack of technological competency is compounded by a lack of technical support by the university, which is also a barrier to professors' integration of technology in their courses (Cheok et al., 2016; Khin, 2021; Luongo, 2018; Karsh, 2018). In one study, over half of professors (52%) report that their university does not provide technical support, which makes it harder for them to use technology with their students (Arya et al., 2016). In another study, professors talk about the lack of communication and collaboration with technology experts as a barrier to their use of technology (Voogt & McKenney, 2017). A third study shows that professors want training and professional development to support their uses of technologies in their teaching (Luongo, 2018).

Another factor that acts as a barrier is professors' lack of interest or knowledge about integrating technology in their teaching (Alfalah, 2018; Adnan & Tondeur, 2018; Cheok, et al., 2016; Mercader, 2019; Mercader & Gairín, 2020). In a study of 527 university professors, 65% report that they had never received training about digital technologies and only 11% report having the highest level of digital skills (Mercader & Gairín, 2020). Likewise, professors report not knowing how to integrate specific technologies such as virtual reality into their discipline areas (Alfalah, 2018). Further, professors' concerns about their students' abilities to use technologies effectively also deters their use of technologies in their courses (Khin, 2021; Marzilli et al., 2014).

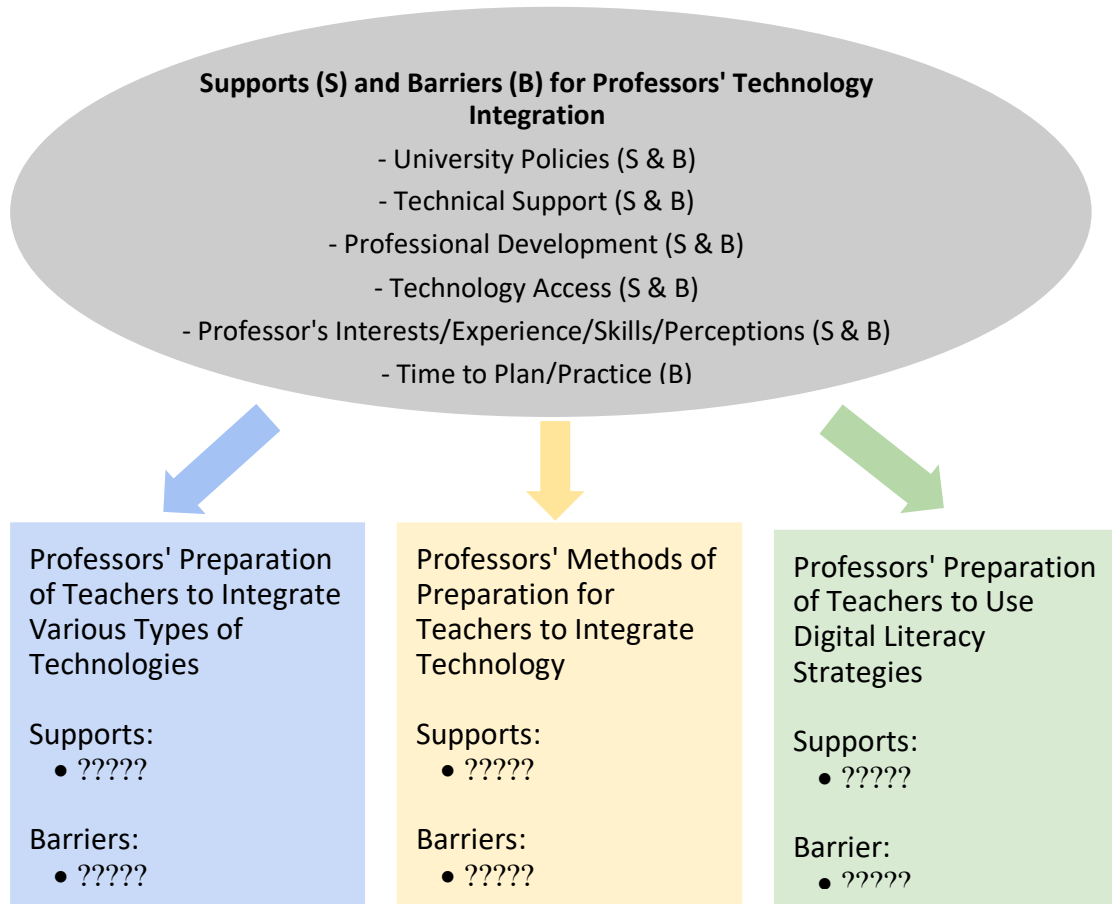
Finally, time constraints significantly impede professors' technology use in teaching (Alfalah, 2018; Cheok et al., 2016; Luongo, 2018; Mercader & Gairín, 2020; Karsh, 2018; Voogt & McKenney, 2017). Professors feel that they “don't have time to experiment with it [technology]”, which is needed to incorporate technology in courses (Voogt & McKenney, 2017, p.77). Furthermore, professors believe that it is more time consuming and stressful to teach in an online environment because there is pressure to work more frequently, such as being available to respond to student queries immediately, which acts a barrier to their technology integration (Marzilli et al., 2014). These added responsibilities and lack of compensation or incentives pose additional barriers to professors' teaching online or integrating technology in their classrooms (Luongo, 2018; Mercader & Gairín, 2020).

Conceptual Framework and Research Questions

Our conceptual framework shows how the broader research on supports and barriers for professors' technology integration inform our investigation of the specific support and barriers for literacy professors' (a) preparation of teachers to integrate various types of technologies, (b) methods used to prepare teachers to integrate technology, and (c) preparation of teachers to use digital literacies strategies in literacy instruction (see Figure 1).

The following research question guides our study: *What supports and barriers do literacy professors report related to how they prepare preservice teachers to integrate technologies in their K-12 literacy instruction?*

Figure 1. Conceptual Framework



Methods

Participants

Our study included 199 literacy professors who were between 24-74 years old (mean = 47). They had taught between 1-45 years, ten years on average. Demographic information about participants is provided in Table 1.

Data Source

We used the Technology Integration in Literacy Instruction Survey. Its online survey format allowed us to (a) circumvent social desirability bias issues associated with phone interviews, (b) avoid the high costs of mail surveys, and (c) allow for branching/skip question patterns that increase the appropriateness of questions that each participant was asked (Fowler, 2014).

The design of our survey questions was guided by previous research and questions from other related surveys (Arya et al., 2016; Adnan & Tondeur, 2018; Boche & Shoffner, 2017; Cheok et al., 2017; Foulger et al., 2013; Han et al., 2013; Husbye & Elsener, 2013; John, 2015; Marzilli et al., 2014; Mouza et al., 2014; Ottenbreit-Leftwich et al., 2015; Setiawan et al., 2018; Smith & Greene, 2013; Voogt & McKenney, 2017; Wetzel et al., 2014). In this paper, we focused on the survey questions about professors reported supports and barriers that served as predictor variables. Participants' responses to survey questions about (a) technologies that literacy professors prepare teachers to use, (b) teaching methods that literacy professors use to prepare teachers, and (c) digital literacy strategies that literacy professors prepare teachers to use in K-12 were used as outcome variables. Finally, participants' responses to survey questions about professor characteristics and institution characteristics were included in the analysis because we found these variables were significant predictors of outcomes in our previous

research (Christ et al., 2021). However, these variables were not a focus in this study. They were included to avoid omitted variable bias. See online Table A1 for sample survey questions (<https://bit.ly/2V0BNA8>)

Our design of the survey addressed several common survey errors (Fowler, 2014). (1) Participants were screened to ascertain their suitability to participate in the survey (i.e., being literacy professors). (2) To reduce the time needed to complete the survey, we attended to logical question flow and contingency by using skip logic. (3) To reduce answering errors, we used questions that (a) were closed, (b) were objective, (c) lacked *do not know* as an option, and (d) had ordinal responses that followed a clear continuum of options. The survey was piloted with a small group of professors, none of whom were part of the dataset. This helped to identify poorly worded questions and construct validity issues. Questions were revised based on the feedback, thereby improving the survey's reliability and validity (Fowler, 2014).

Data Collection

Qualtrics (<http://www.qualtrics.com>) was used to collect data via an online survey. Across five months, two methods were used to recruit respondents. We posted the survey link and invitation via (1) professional organization Facebook pages (American Educational Research Association Division K, International Literacy Association, and National Council of Teachers of English), and (2) the Literacy Research Association listserv. We reposted the survey information four times to increase the number of respondents (Fowler, 2014). The survey took about 10-15 minutes to complete. Data did not include any respondent identifiers.

Analysis

We modeled the outcomes with a *mixed response analysis* (Goldstein, 2011).

$$\mathbf{Outcomes}_{yi} = \beta_y + \beta_{yv}\mathbf{Institution}_{yi} + \beta_{yw}\mathbf{Barriers}_{yi} + \beta_{yx}\mathbf{Supports}_{yi} + \beta_{yz}\mathbf{Professor}_{yi} + e_{yi} \quad (1)$$

$$P(\mathbf{Outcomes}_{yi}) = F(\beta_y + \beta_{yv}\mathbf{Institution}_{yi} + \beta_{yw}\mathbf{Barriers}_{yi} + \beta_{yx}\mathbf{Supports}_i + \beta_{yz}\mathbf{Professor}_{yi}) + e_{yi} \quad (2)$$

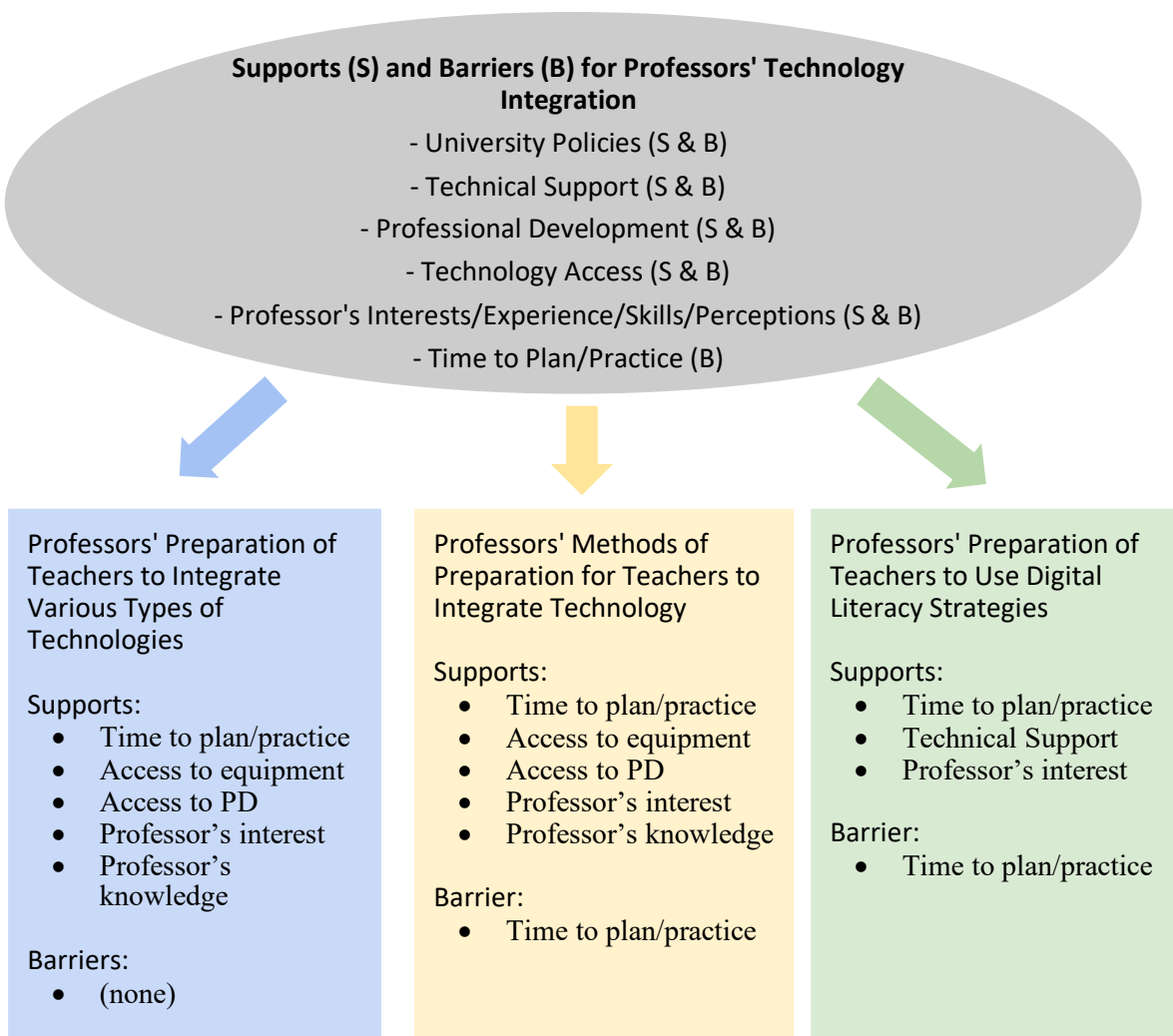
In the vector of **Outcomes**_{yi}, a continuous outcome *y* by professor *i* has a grand mean intercept β_{y0} , with *residual* e_{yi} . For discrete outcomes, the probability $P(\mathbf{Outcomes}_{yi})$ that the outcome *y* by professor *i* occurs is the expected value of **Outcomes**_{yi} via the Logit or Probit link function (F) of the overall mean β_y . First, we entered **Institution** attributes (urban, suburban [vs. rural]; public, private [vs. both]; undergraduate only ... doctoral granting). Then, we entered **Barriers** to preparing teachers to use technology in K-12 settings (*lack of*: time, access to equipment, access to programs or apps, knowledge about technology integration, professional development, technical support, incentives for using technology, interest in integrating technology, and reliable internet connectivity). Next, we enter **Support** factors that professors reported helped them improve their technology use and preparation of teachers to use technology in K-12 settings (time to plan or practice integration, access to equipment, knowledge about technology integration, interest in integrating technology; availability of professional development, technical support, incentives for using technology). Then, we entered **Professor** characteristics (gender: female, male [vs. no response]; age; education level: doctorate vs. master's; years of teaching; academic rank: part time adjunct ... distinguished professor; knowledge level about digital literacies: slightly knowledgeable ... extremely knowledgeable; and comfort level using technology: somewhat uncomfortable ... extremely comfortable).

Results

The main focus of this paper is on supports and barriers, so we only focus on presenting results for these variables (which are labeled in Tables 2-4; Figure 2) and any mediation effects from professor and institution characteristic variables. Statistically significant results related to professor and institution characteristics that do not mediate supports/barriers are discussed

elsewhere (Christ et al., 2021). To aid understanding of these results, we report the *odds ratio* of the regression coefficient, namely the percentage increase or decrease in the likelihood of the outcome (Kennedy, 2008).

Figure 2. Visual Overview of the Findings



Types of Technologies Literacy Professors Prepare Teachers to Integrate

Supports

Five supports enhanced the types of technologies that literacy professors prepared teachers to integrate in K-12 classrooms. First, time to plan or practice integration was linked to literacy professors being significantly more likely to instruct K-12 teachers to integrate the following technologies: basic software (21% more likely), app games (21%), website games (19%), websites with hyperlinks (20%), and apps that support reader processing or reader responses (32%). Second, literacy professors who had access to equipment were more likely to prepare teachers to use basic software (33%), websites without hyperlinks (24%), videos for children (27%), and interactive whiteboard (13%). Third, access to professional development made it 12% more likely that literacy professors taught teachers to integrate basic software in their K-12 instruction. Fourth, literacy professors who were interested in integrating technology were 27% and 16% more likely to prepare teachers to integrate interactive web-based books and interactive app books, respectively. Fifth, literacy professors who reported being knowledgeable about technology were 17% more likely to prepare teachers to use the internet with hyperlinks.

Mediation Effects

Literacy professors who reported having both time to plan or practice integration and were provided professional development to improve their technology use were 2% more likely to prepare teachers to use basic software in K-12 classrooms. Literacy professors at public institutions who had access to equipment were 17% more likely to prepare teachers to use websites with hyperlinks in their K-12 instruction.

Methods to Prepare Teachers to Integrate Technology

Supports

Five supports were related to the methods that literacy professors used to prepare teachers to integrate technology in K-12 classrooms. First, having time to plan or practice integration was related to literacy professors being 23%, 32%, and 19% more likely to model how to use devices, model technology use within a lesson to meet an objective, and provide feedback on teachers' literacy lesson plans or integration, respectively. Second, literacy professors' access to equipment was related to them being 18% more likely to have their teachers read about technology or its integration, 11% more likely that they model how to use devices, 30% more likely to guide teachers as they practice using a device, and 22% more likely to guide teachers as they practice integrating the technology in a lesson. Third, literacy professors' access to professional development was related to them being 19% more likely to model technology use within a lesson to meet an objective, and 11% more likely to provide feedback on teachers' lesson plans or integration. Fourth, literacy professors' knowledge about technology integration was related to them being 27% more likely to have their teachers read about technology or integration, and 55% more likely to tell teachers about it. Fifth, literacy professors who were interested in integrating technology were 16%, 20%, 39%, 37%, 32%, and 39% more likely to have teachers read about technology or integration, model how to use devices, model technology use within a lesson, guide teachers as they practice using a device, guide teachers as they practice integrating the technology in a lesson to meet an objective, and provide feedback on teachers' lesson plans or integration, respectively.

Barrier

There was one barrier to literacy professors' use of methods to prepare teachers to integrate technology in their K-12 instruction. Literacy professors without time to plan or practice integration were 34% more likely to tell teachers about available technology or

integration ideas (rather than using more effective methods, such as modeling, guiding, or providing feedback).

Mediation Effects

Literacy professors who were one-year older and had knowledge about technology integration were 52% more likely to tell teachers about available technology or integration. Literacy professors who had both (a) time to plan or practice integration and (b) an interest in technology integration were 8% more likely to model how to use devices, 35% more likely to model technology use within a lesson, and 27% provide feedback on teachers' lesson plans or integration.

Digital Literacy Strategies that Literacy Professors Prepare Teachers to Use

Supports

There were three supports for the digital literacy strategies that literacy professors used to prepare teachers. First, when literacy professors had time to plan and practice integration, this made it 20% more likely that they prepared teachers to teach children to search and evaluate online information. Likewise, having enough time also made it 16% more likely that literacy professors prepared teachers to teach children to use both of the following digital literacy strategies: multimodal composing and hypertext to navigate meaning-making. Second, when literacy professors had access to technical support, they were 11% more likely to prepare teachers to teach children to search and evaluate online information. Similarly, such access made literacy professors 21% more likely to prepare teachers to teach children to use hotspots to strategically support meaning-making. Third, when literacy professors had an interest in integrating technology, they were 30% and 22% more likely to prepare teachers to teach children to use multi-modal composing and hypertext to navigate meaning-making, respectively.

Barrier

One barrier was related to the digital literacy strategies that literacy professors prepared teachers to use in their instruction with K-12 children. When literacy professors lacked time, they were 30% less likely to instruct teachers to teach children to use online search and evaluation strategies.

Discussion

In this section, we discuss our findings in the context of existing research. First, we discuss the factors that made the greatest impact on literacy professors' preparation of teachers to integrate technology: time to plan and practice technology integration, literacy professors' interest in integrating technology, literacy professors' knowledge about technology integration, access to professional development, access to equipment, and access to technical support. Second, we discuss other factors that were not significant in our study, but had been found to be significant in previous research.

Time to Plan and Practice Technology Integration

Our findings extend previous research by showing that literacy professors' time to plan and practice technology integration is a support, and its absence is a barrier. Previous research across Malaysia, the Middle East, Palestine, and U.S., only presents time as a barrier to technology integration, not as a support (Alfalah, 2018; Cheok et al., 2016; Luongo, 2018; Karsh, 2018; Voogt & McKenney, 2017). Our research findings provide a more nuanced understanding about how time affects three aspects of literacy professors' practices related to preparing teachers to integrate technologies in their instruction. For example, time is a support for literacy professors' preparation of teachers to use specific types of technologies (e.g., app games, internet with hyperlinks, etc.) in their K-12 instruction. However, time is both a support

and a barrier to literacy professors' types of methods that they used to prepare teachers for technology integration. Time supports literacy professors' modeling how to use devices and technology in a lesson, and providing feedback on lesson plans or actual integration—all potentially effective methods. However, lack of time results in professors merely telling teachers about available technology or integration ideas. This is a generally less effective method than modeling or feedback (Moore & Bell, 2019). Likewise, for strategies, time is both a support (search and evaluate information online, multimodal composing, using hypertext to navigate meaning making) and a barrier (with less time, literacy professors are less likely to teach strategies to search and evaluate information online). This underscores the importance of providing literacy professors' time to prepare for technology integration to ensure use of high-quality teaching methods.

Literacy Professors' Interest in Integrating Technology

Our findings show that U.S. literacy professors' interest in integrating technology serves as a support for the types of technologies that they prepare teachers to use, the methods that they use to prepare them, and the strategies that they teach teachers. This slightly differs from previous research across Spain, the Middle East, Malaysia, and Turkey, which focused on professors' lack of interest as a barrier to their integrating technology in their instruction (Adnan & Tondeur, 2018; Alfalah, 2018; Cheok, et al., 2016; Mercader & Gairín, 2020). This difference in focus may be because some researchers explicitly asked participants about barriers, but not supports (Alfalah, 2018). Other researchers used interview questions and then identified themes using emergent coding and constant comparative analysis, which did not yield patterns related to professors' interest as a support, but only as a barrier (Adnan & Tondeur, 2018). Based on our results, finding ways to increase literacy professors' interest in technology is warranted. Future

research might explore opportunities such as learning communities, workshops, or informal conversations to discuss technology (e.g., coffee talks or brown bag lunch meetings) as ways to address this.

Literacy Professors' Knowledge about Technology Integration

Literacy professors' knowledge about technology integration supports their preparation of teachers to use one type of technology (internet with hyperlinks) and two methods to prepare teachers to integrate technology (having teachers read about or telling teachers about technology or integration). Our findings extend previous research across Myanmar, Palestine, and the U.S., which focused on professors' *experience* with technology (e.g., Foulger et al., 2015; Khin, 2021; Karsh, 2018), by identifying professor *knowledge* about technology as another kind of support. While professors' experience and knowledge might often grow along a shared trajectory, this might not always be the case. For example, some professors with little university teaching experience may be deeply knowledgeable about technology, while others with lots of university teaching experience may not be very knowledgeable about technology. An implication would be to provide ongoing professional development for professors to support their development of knowledge about technology across time, as they also increase their university teaching experience.

Access to Professional Development

According to our findings, when literacy professors have access to professional development related to technology integration, this serves as a support for the types of technologies that they prepare teachers to use and the methods that they use to prepare them. This finding aligns with previous research in the U.S., which also found that professors who received professional development improved their technology integration and used more

effective methods to prepare preservice teachers for technology integration in K-12 instruction (Foulger et al., 2015). Based on these findings, professional development should be offered to literacy professors to support the types of technologies that they prepare teachers to use and the methods that they use to prepare teachers. This implication aligns with other previous research in the U.S. that showed that professors sought professional development to improve their technology use in their teaching (Luongo, 2018).

Interestingly, however, literacy professors did not report that professional development supported their teaching of strategies (e.g., navigating hyperlinks, multimodal composing, etc.) for teachers' use in K-12 instruction. It may be that professional development is not being provided that is specific to digital literacy strategies. Future research could explore whether this is the case, and whether professional development focused on digital literacy strategies supports literacy professors' instruction of these to teachers.

Access to Equipment

When literacy professors had access to technology equipment, this supported their preparation of teachers to use specific types of technologies (basic software, internet without hyperlinks, videos for kids, and interactive whiteboards). It also supported their use of specific methods to prepare teachers (reading about technology, modeling how to use devices, guide teachers as they practice using a device, and guide teachers as they practice integrating technology in a lesson). This extends previous research in Korea and the U.S. that more broadly found that when professors have access to technology equipment, they use more technology in their courses (Arya et al., 2016; Lee & Son, 2018).

However, unlike previous research in Malaysia and the U.S. (Cheok et al., 2016; Marzilli et al., 2014), we did not find that lack of access to equipment was a barrier to literacy professors'

preparation of teachers to integrate technology. This may be because technology equipment is more readily accessible now and therefore no longer poses a significant barrier.

In sum, it seems that literacy professors will still integrate technology without access to equipment, but lack of access will limit their scope of integration. That is, they will be less likely to model and guide teachers to use a variety of technologies. An implication is that institutions should provide literacy professors access to equipment to broaden their scope of integration.

Access to Technical Support

Our findings extend previous research by identifying that access to technical support is related to literacy professors' preparation of teachers to use two strategies: (1) search/evaluate information online, and (2) use hotspots to support meaning-making in app books. Past research in Korea and the U.S. more broadly underscores the importance of technical support for professors' integration of technologies in their courses (Arya et al., 2016, Christ et al., 2017; Chittur, 2018; Harbin, 2019; Lee & Son, 2018). Given that previous studies in the U.S. show that there is a lack of technical support available to literacy professors (Arya et al., 2016; Voogt & McKenney, 2017), an implication of our finding is that institutions should provide better access to technical support if they want teachers to be better prepared to teach 21st century literacy strategies.

Other Factors

It is important to note that some other factors that significantly supported or hindered professors in previous studies across Korea, Malaysia, and the U.S. were not found to be significant in our study, such as access to programs or apps (Cheok et al., 2016; Marzilli et al., 2014), incentives for using technology (Lee & Son, 2018), or poor internet connectivity (Cheok et al., 2016; Marzilli et al., 2014). It may be that the impact of these has lessened over time,

given that these previous studies were conducted three to eleven years ago. Another possibility is that these factors are subsumed under other attributes in the current study. For example, literacy professors with more knowledge about technology integration might have greater access to programs, require fewer incentives to use technology, and have sufficient skills to overcome poor internet connectivity by using other resources (e.g., text messages). Further, differences in results might be related to technology advancements since those previous studies.

Implications

Universities who want to promote high quality teacher preparation for technology integration should focus on a 5-pronged approach. First, universities need to ensure that professors have access to a broad range of technology equipment so they can model a breadth of ways to integrate technology in K-12 settings, and allow teachers to practice these ways. Second, universities should find ways to increase professors' interest in technology integration. For example, methods such as tech talks, video-based models, and peer sharing of technology tools and their integration could be explored. Third, universities should offer professional development for professors to support their learning about technology tools and integration methods for K-12 instruction. This might include methods such as professional learning communities, workshops in which tools and integration are modeled and faculty's use of these is guided, Collaborative Peer Video Analysis, and use of rubrics to evaluate tool selection and integration methods. Fourth, universities should provide adequate time for professors to prepare for teaching teachers how to integrate technology in their courses. This could be in the form of course releases, reduced service load, paid summer planning workshops (in lieu of summer teaching), etc. Fifth, universities should provide access to high quality technical assistance, so

that as professors are integrating technology, they have in-the-moment support that allows them to overcome challenges to their integration.

Conclusion

Our study extended existing research by focusing on three aspects of literacy professors' teacher preparation: (1) what technologies they prepare teachers to use, (2) what methods they use to prepare teachers, and (3) what digital literacy strategies they prepare teachers to teach K-12 children. This study provided more nuanced findings about supports and barriers as they related to the three aspects of literacy professors' teacher preparation. Supports that were significantly related to the types of technologies that literacy professors prepared teachers to integrate and methods they used to prepare teachers included the following: (a) time to plan or practice integration, (b) access to equipment, (c) access to professional development, (d) literacy professors' interest in integrating technology, (e) literacy professors' knowledge about technology. Further, digital literacy strategies that literacy professors prepared teachers to use in K-12 instruction were supported by time to plan or practice integration, access to technical support, and literacy professors' interest in integrating technology. Finally, time to plan or practice integration was a barrier to both the methods that literacy professors used to prepare teachers and digital literacy strategies they prepared teachers to use. Our findings underscore the importance of providing time for literacy professors to plan and practice technology integration to improve their teacher preparation practices. Since our study only focused on survey data, future research might extend this to include interviews with literacy professors about how these supports and barriers affect their teacher preparation. This would extend our understanding of these findings.

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Table 1. *Participant Demographic Information (N=199)*

Demographic Variables	Number of Participants	Mean
Rank - Distinguished professor	1	0.005
Rank - Full professor	27	0.136
Rank - Associate professor	40	0.201
Rank - Assistant professor	89	0.447
Rank - Full time lecturer/instructor	15	0.075
Rank - Part time adjunct/lecturer/instructor	27	0.136
Highest degree – Doctorate	177	0.889
Highest degree - Master's	22	0.111
Gender – Female	177	0.889
Gender – Male	19	0.095
Gender - Prefer not to respond	3	0.015
Location – USA	191	0.960
Location – Europe	1	0.005
Location – Canada	3	0.015
Location – Australia	1	0.005
Location - Middle East	1	0.005
Location – Caribbean	2	0.010

Time to plan/practice integration	-1.473 *			
* Professional development	(0.712)			
Public * Access to equipment (barrier)		1.590 *		
		(0.756)		
Years of teaching (professor characteristic)	0.034 *			
	(0.016)			
Associate professor (professor characteristic)	0.856 **			
	(0.308)			
Assistant professor (professor characteristic)		0.625 *	-0.809 *	
		(0.265)	(0.234)	
Interest in integrating Technology (support)			1.181 **	0.671 *
			(0.258)	(0.288)
Knowledge about technology integration (support)		0.958 *	0.670	
		(0.357)	(0.363)	
Extremely knowledgeable in digital literacies (professor characteristic)	0.776 *			
	(0.335)			
Very knowledgeable in digital literacies (professor characteristic)		1.229 *		
		(0.360)		

Table 3.

Summary of Final Mixed Responses Model of Methods Professors use to Prepare Teachers to Integrate Technology

Explanatory variable	Have teachers read about technology or its integration	Tell teachers about available technology or integration ideas	Model how to use devices	Model how to use technology within a lesson to meet an objective	Guide teachers as they practice using a device	Guide teachers as they practice integrating the technology in a lesson to meet an objective	Provide feedback on teachers' lesson plans or actual integration
Age (professor characteristic)		-0.029 (0.017)					
Lack of time (barrier)		-1.893* (0.791)					
Time to plan/practice integration (support)			1.915*** (0.489)	1.380** (0.454)			0.928* (0.394)
Access to equipment (support)	1.030** (0.361)		1.177* (0.495)		1.304*** (0.372)	0.918* (0.360)	
Professional development (support)				1.398** (0.431)			0.882* (0.351)
Knowledge about technology integration (support)	1.424*** (0.381)	2.761*** (0.406)					

Interest in integrating technology (support)	0.945 ** (0.352)		1.738 ** (0.506)	1.670 *** (0.457)	1.593 *** (0.349)	1.309 *** (0.341)	1.729 *** (0.408)
Knowledge about technology integration * Age		-0.085 * (0.033)					
Time to plan/practice integration * Interest in integrating technology			-2.690 ** (0.950)	-2.004 * (0.889)			-1.501 * (0.761)
Extremely knowledgeable in digital literacies (professor characteristic)				1.490 * (0.694)			
Explained variance	0.311	0.458	0.525	0.537	0.279	0.188	0.375

Note. Each regression model included a constant term.

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 4.

Summary of Final Mixed Responses Model Predicting Strategies that Professors Prepare Teachers to Use

Explanatory variable	Use strategies search/ evaluate info online	Use hot spots to support meaning- making	Multi-modal composing	Use hypertext to navigate meaning- making
Doctoral granting - low research (institution characteristic)	-0.625 *			
	(0.260)			
Lack of time (barrier)	-1.338 **			
	(0.514)			
Time to plan/practice integration (support)	0.921 **		1.154 **	0.673 *
	(0.299)		(0.345)	(0.304)
Technical support (support)	0.816 **	1.354 ***		
	(0.283)	(0.325)		
Full professor (professor characteristic)			1.252 *	
			(0.543)	
Assistant professor (professor characteristic)				-0.594 *
				(0.262)
Interest in integrating technology (support)			1.774 ***	0.905 **
			(0.354)	(0.306)
Extremely knowledgeable in		0.936 **		

digital literacies (professor characteristic)		(0.351)		
Explained variance	0.230	0.152	0.366	0.111

Note. Each regression model included a constant term.

* $p < .05$, ** $p < .01$, *** $p < .00$