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Factors influencing digital technology use in early childhood education

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ABSTRACT

The current study uses path modeling to investigate the relationship between extrinsic and intrinsic factors that influence early childhood educators' digital technology use. Survey data from 1234 early childhood educators indicate that attitudes toward the value of technology to aid children's learning have the strongest effect on technology use, followed by confidence and support in using technology. Additionally, student SES has the strongest effect on attitudes, while support and technology policy influence teacher confidence, which in turn influences attitudes. In contrast, more experienced teachers have more negative attitudes. Overall, the study provides the first path model investigating early childhood educators' technology use and provides practical considerations to aid teachers' use of technology in the classroom.

1. Introduction

Historically, many educators and policymakers alike have valued the potential of digital technology to revolutionize the education system. From the introduction of educational television to the large-scale federal E-Rate program subsidizing Internet connectivity to the current investment in iPads from school districts around the nation, each new technology is introduced with the potential to benefit children's learning (Wartella & Robb, 2007). Indeed, in 2010, the U.S. Department of Education released the National Education Technology Plan to promote student-centered learning with technology as a way to improve student achievement (U.S. Department of Education, 2010), and most recently the Federal Communications Commission announced a $3 billion investment along with additional investments by private technology companies to "close the technology gaps in our schools" (qtd. in Bidwell, 2014). Further, school districts are spending millions of dollars on newer devices, including LA county, the second largest school district in the country, which spent $30 million on iPads for every k-12 classroom (Svensson, 2013).

Despite the excitement around technology, some school leaders and policymakers may fail to recognize that technology in and of itself may not have the inherent power to change teaching and learning practices. Teachers are a powerful mediator of technology's impact on student learning (Neiderhauser & Stoddart, 2001), but there is a lack of evidence that teachers are effectively integrating technology into their classrooms (Keengwe, Onchwari, & Wachira, 2008). Even with increased access to technology, the National Education Association and American Federation of Teachers (2008) asserted, "we have few assurances that [educators] are able to use technology for teaching and learning" (pg. 1), suggesting barriers exist above and beyond access that prevent teachers from successfully integrating technology into their classroom. Indeed, intrinsic barriers, such as preexisting teaching beliefs, attitudes toward the educational value of technology, and comfort with technology have been shown to influence the ways in which teachers use technology in the classroom (Ertmer, 1999; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012; Ottenbreit-Leftwich, Glazewski, Newby, & Ertmer, 2010).

In light of this research and the federal and local initiatives to promote technology use in the classroom, the current study investigates both the factors that influence teacher use of technology as well as the relationship between these factors. Given the importance that early childhood education has on children's future academic success and life trajectory (e.g., Chetty et al., 2011; Isaacs, 2008), this study focuses

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specifically on early childhood teachers' attitudes toward technology for student learning for children birth through age 4. While we do not seek to make claims that more technology use equates to higher student achievement, we believe the focus on and investment in technology by the federal government and schools across the country warrants a closer look at what influences teachers' use of technology, given that technology must be used in the first place if it is to have any effect on student learning. Therefore, using survey data from 1234 educators, we explored various factors, both environmental and personal, that influence teachers' use of technology.

1.1. Technology integration

Despite increased access to computers and newer mobile devices, the actual use of technology in the classroom remains infrequent (Gray, Thomas, & Lewis, 2010), especially in early childhood education (Vockley & Lang, 2011; Wartella, Blackwell, Lauricella, & Robb, 2013). Further, when technology is used, it is often not used in meaningful, student-centered ways but is integrated in more traditional, didactic practices (Cuban, 2001; Ertmer & Ottenbreit-Leftwich, 2013). A survey of 35,525 K-12 teachers by Project Tomorrow (2011) showed that the most frequent use of technology is for homework and practice (58%), while Eteokleous (2008) described teachers' rare use of technology as "fancy chalkboards," suggesting technology is integrated in more didactic ways and as a substitute for more traditional tools, instead of as an extension of the curriculum. Others note that teachers primarily use technology for communicating with parents or preparing class materials instead of using it for student learning (Russell, Bebell, O'Dwyer, & O'Connor, 2003; Zhao, Pugh, Sheldon, & Byer, 2002).

Ertmer (1999) proposed one plausible explanation for this lack and ineffective use of technology, describing two types of barriers to technology integration. First-order extrinsic barriers prevent teachers from using technology due to a lack of access to technology, time to learn and use technology, training and support, and professional development. Second-order intrinsic barriers, on the other hand, limit teachers' use of technology due to teaching beliefs, comfort with technology, and perceived values of technology for student learning. Others have supported this distinction, showing that teachers feel both limited by the structural elements of their environment as well as their personal beliefs (Mueller, Wood, Willoughby, Ross, & Specht, 2008; Parette, Quesenberry, & Blum, 2010; Wachira & Keengwe, 2010).

Some have argued that second-order intrinsic barriers are actually more important to teachers' acceptance and use of technology than first-order barriers (Ertmer et al., 2012; Zhao et al., 2002). In recent years, access to technology as well as training and professional development opportunities have increased (Gray et al., 2010), but research continually shows teachers fail to integrate technology in their classrooms (e.g., Ertmer, Addison, Lane, Ross, & Woods, 1999; Ertmer et al., 2012; Zhao et al., 2002). Indeed, individual attitudes and confidence or anxiety about using technology are correlated with actual use, such that those more in favor of technology are more likely to adopt technology in their classroom (e.g., van Braak, Tondeur, & Valcke, 2004; Ertmer et al., 2012; Karaca, Can, & Yildirim, 2013; Lindahl & Folkesson, 2012). Additionally, teachers' pedagogical beliefs influence use, such that those with more student-centered beliefs are more likely to use technology in innovative and effective ways, compared to teachers with more traditional beliefs (Ertmer & Ottenbreit-Leftwich, 2013; Tondeur, Hermans, van Braak, & Valke, 2008).

1.2. Technology in early childhood education

Much of the research on teacher barriers has been conducted in K-12 learning environments, but the influence of personal beliefs on technology use may be even more pertinent for early childhood educators due to the debate over the place of technology in young children's lives. Research has shown that quality educational media can enhance young children's learning (e.g., Fisch & Truglio, 2001; Jennings, Hooker, & Linebarger, 2009). In their seminal study on *Sesame Street*, Anderson, Huston, Schmitt, Linebarger, and Wright (2001) demonstrated how watching quality educational television in the preschool years can lead to long-term academic and social benefits. Similarly, Penuel et al's (2012) randomized-controlled trial tested the effects of a media-rich literacy supplement that used television clips from popular PBS shows in preschool classrooms, and results showed children who received the media supplement made greater gains on letter recognition, phonics, and print and story concepts. Moreover, the National Association for the Education of Young Children (NAEYC, 2012) supports the developmentally appropriate and intentional use of technology in early childhood education.

In contrast, others have noted the potential negative impact of technology. Violent television and videogames, in particular, have been associated with aggressive and anti-social behavior (Anderson & Bushman, 2001; Anderson et al., 2003; Christakis & Zimmerman, 2007), while heavy television viewing has been associated with less time reading, decreased verbal literacy and theory of mind skills, and later attention problems (Christakis, Zimmerman, DiGiuseppe, & McCarty, 2004; Nathanson, Sharp, M., Aladé, Rasmussen, & Christy, 2013; Vandewater et al., 2005). In light of this, the American Academy of Pediatrics (2013) recommends no screen time for children under 2 and limited screen time for older children. Provided the differing views of the benefits and detriments of technology for young children, this environment likely influences early childhood educators' personal attitudes toward using technology for student learning in different ways than teachers of older children.

1.3. Technology integration model

Various models have been suggested to help explain the relationship between first- and second-order barriers with teachers' technology use (van Braak et al., 2004; Inan & Lowther, 2010b; Pynoo et al., 2013; Robinson, 2003). Most recently, Karaca et al. (2013) proposed a technology use model for Turkish elementary school teachers, and found that colleague support and technology competencies have significant positive associations while teaching experience has a significant negative association, and teaching attitudes/beliefs have a significant positive association on use. As one of the few studies to look at teachers of younger children, Karaca et al.' (2013) model provides a foundation to investigate use of technology in early childhood education. However, several modifications are necessary given the current study's focus on U.S. teachers of very young children.

First, research on teachers of older children suggests that a strong school technology vision can have positive associations with teacher attitudes toward and use of technology (Fullan, 2007; Lui, 2012; Somekh, 2008), a fact that may be heightened in early childhood education given the continued debate over the appropriateness of young children using technology. While Karaca et al. (2013) suggest using principal

support as a proxy for this, we use a direct measure of whether or not the school has a technology policy, as this specifically speaks to the school's technology culture, in addition to perceived school support.

Second, while not specific to early childhood education in particular, student socioeconomic status may influence teacher attitudes toward technology, a factor that is missing from prior work and perhaps of particular interest in a U.S. sample of teachers. As students from lower SES are expected to have less access to technology outside of the classroom compared to their higher SES peers (Blackwell, 2013; Purcell, Heaps, Buchanan, & Friedrich, 2013), teachers are more favorable about using technology with these students to help close the digital divide.

2. Current study

The current study draws on survey data from 1234 U.S. early childhood educators working with children 0–4 years of age collected from a larger online survey of 1457 early childhood educators serving children ages 0-8 conducted in the fall of 2012. We extend previous research investigating factors that influence teacher use of specific technologies using the same dataset (Blackwell, Lauricella, Wartella, Robb, & Schomburg, 2013) to take a more global view of technology use to explore the relationship between first- and second-order barriers in explaining technology use in the early childhood classroom. Given research that suggests teacher attitudes may play a more important role in teachers' adoption and use of technology, and given research that suggests more extrinsic factors, such as support and school culture, may influence these attitudes, the current study uses path analysis and is the first study to our knowledge to explore this relationship with teachers of very young children. Our main research question is: What factors contribute to early childhood educators' technology use in the classroom? We hypothesized the following relationships, which are presented graphically in Fig. 1.

2.1. First-order barrier hypotheses

H1. Teachers with higher perceived support from their schools have higher levels of confidence, more positive attitudes, and higher technology use compared to teachers with lower perceived support.

H2. Having a school technology policy positively influences teacher attitudes, confidence, and technology use.

H3. Teachers whose students are from lower socioeconomic backgrounds have more positive attitudes toward using technology in the classroom and use technology more frequently compared to teachers whose students are from higher socioeconomic backgrounds.

H4. Teachers with more teaching experience have less favorable attitudes toward technology and use technology less often than teachers with less experience.

2.2. Second-order barrier hypotheses

H1. Teacher confidence using technology in developmentally appropriate ways has a positive influence on technology use and mediates the relationship between support and technology policy on technology use.

H2. Teacher attitudes toward the value of technology for children's learning have a positive influence on technology use and mediate the relationship between support, technology policy, student SES, and teaching experience on technology use.

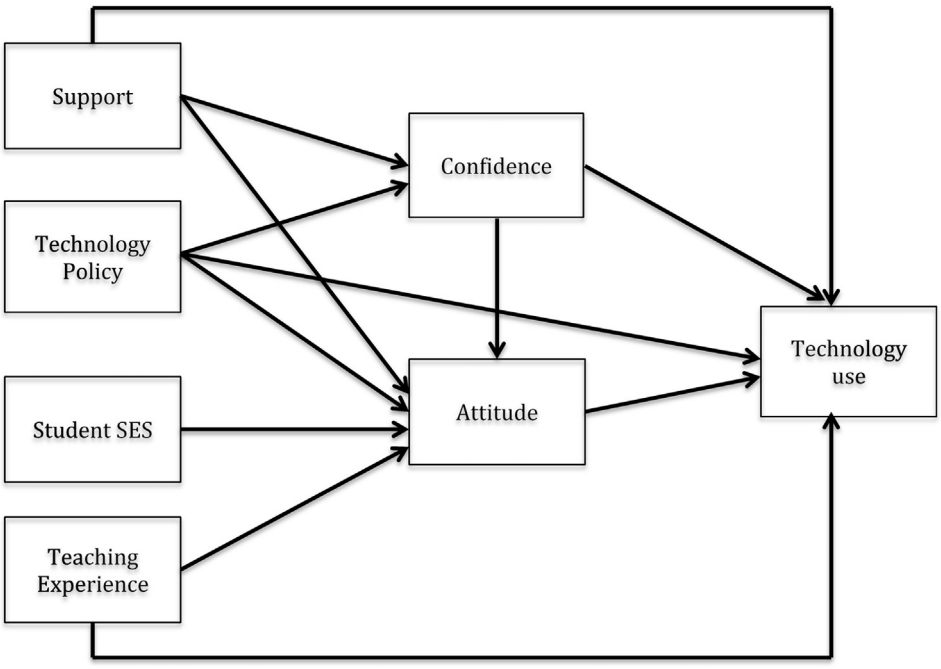

Fig. 1. Hypothesized path model.

3. Methods

3.1. Participants

All participants were associated with NAEYC and were recruited to participate by email through the NAEYC listserv. Participants in this study taught children 0–4 years old in three types of childcare settings: 52% worked in center-based care (i.e., for- or non-profit non-school based care, such as a YMCA, Montessori, or Bright Horizons), 36% in school-based care (public or private programs within K-12 school programs), and 11% in Head Start centers. The majority of participants were female (98%) and White (87%). The average age of participants was 48 years ($SD = 10.8$). The sample was national in scope, representing 48 states. Thirty-eight percent of teachers had a graduate degree, 53% had a 4-year college degree, and 9% had a high school degree or less. Teachers had been working in the classroom for an average of 20 years ($SD = 10$).

3.2. Procedure

Researchers developed an original 46-item survey instrument (http://goo.gl/Rxeky) that asked participants about their access to and use of multiple technologies, as well as their attitudes toward technology and their perceived level of support. Only surveys completed by early childhood educators working with children 0–4 years old located in Head Start, school-based, and center-based programs were used in these analyses, resulting in 1234 completed surveys.

3.3. Measures & coding

3.3.1. Technology use

We asked participants how often they used 12 technologies (TV/DVD, computer/laptop, Internet, digital camera, video game player, light table, SmartBoard, iPod/MP3 player, iPod Touch, Smartphone, E-Reader, and tablet computer) for instructional purposes in their classroom, defined as the teacher using technology with students to reinforce a curricular goal (e.g., using the Internet to view a YouTube video related to an in-class discussion, taking and sharing digital pictures, or using an iPad to access reading apps). Frequency of use was measured on a 7-point likert scale anchored by never and daily. We converted the scale to represent how many days a month teachers use each technology—never (0), less than once a month (0.5), once a month (1), 2-3 times a month (2.5), once a week (4), 3-4 times a week (14), and daily (30). If teachers did not have access to a certain technology, they were counted as missing for that specific technology. We then calculated the average technology use for each teacher by summing their overall technology use and dividing it by the number of different technologies to which they had access to obtain an average technology use measure. This variable was treated as a continuous variable given that the underlying concept of frequency of use was continuous and the original scale had 7 points, which research has shown valid for using this method (e.g., Johnson & Creech, 1983; Zumbo & Zimmerman, 1993). The overall average technology use for teachers with access to technology was 9.41 days per month; the overall average technology use for all teachers, regardless of whether they had access to a certain device, was 8.5 days per month (see Table 1 for averages across each technology).

3.3.2. First-order variables

3.3.2.1. Support. We used factor analysis with varimax rotation on a 12-item index with a 5-point likert scale, anchored by *strongly disagree* and *strongly agree*, reflecting teachers' perceived support toward technology integration. The original index resulted in only one dimension, but because the second eigenvalue was close to one (0.82), accounted for an additional 7%, and was theoretically meaningful, we conducted a second factor analysis with two fixed dimensions, which accounted for 72% of the variation. All items fell on their respective dimension with a factor loading of 0.6 or greater on one component and 0.4 or smaller on the other component (Cronbach's Alpha = 0.95). The first factor described support for *children's learning*, and five items loaded on this factor: "integrating technology into specific subject areas," "integrating technology in developmentally appropriate ways," "documentation of children's learning with technology," "children's individualized learning with technology," and "helping find and navigate available digital media resource and content." The second factor described basic *access and support*, and 7 items loaded on this factor: "providing adequate software," "providing adequate hardware," "technical support," "learning basic user skills," "financial support," "sufficient time to learn technology," and "using technology to communicate with parents and caregivers." Each individual participant had a weighted factor score for each factor, which was calculated by multiplying the raw score of each item by its factor loading score and then summing these weighted scores.

Table 1
Average use of technology integration in developmentally appropriate ways in number of days per month.

Technology	*N*	Average use (with access)	Average use (entire population)
Digital camera	1124	14.63	13.32
Videogame	241	12.79	2.5
Computer	1003	12.68	10.31
Tablet	340	11.13	3.07
iPod/MP3	259	10.92	2.29
Internet	928	8.97	6.74
Light table	567	8.7	3.45
iPod touch	176	8.09	1.15
Smartphone	336	7.44	2.03
E-Reader	169	4.02	0.55
TV/DVD	960	2.51	1.95
Smart board	248	1.2	0.24

*Note. "Average use (with access)" describes the average use of each technology only for participants who reported having access to the technology. "Average Use (Entire population)" describes the average use of each technology over the entire population, $N = 1234$.

3.3.2.2. Technology policy. Participants were asked to report whether or not their program had a technology policy, coded as 1 for having a technology policy and 0 for not having one.

3.3.2.3. Student SES. Teachers were asked to describe the socioeconomic status of their students from five choices: low-income, low-middle-income, middle-income, upper-middle-income, and upper-income, a scale used in prior work (McManis, Simon, & Nemeth, 2012). These five categories were recoded into three dummy variable categories: low-income (low- and low-middle-income), middle-income, and upper-income (upper-middle- and upper-income), and dummy variables were created for each category.

3.3.2.4. Teaching experience. Participants were asked to report the number of years they had been teaching. This variable was continuous and ranged from 0 years to 50 years, with an average of 20 years ($SD = 10$).

3.3.3. Second-order variables

3.3.3.1. Attitudes. We used factor analysis with varimax rotation on a 9-item index with a 5-point likert scale, anchored by *strongly disagree* and *strongly agree*, reflecting teacher attitudes toward the affordances of technology; this resulted in 2 factors with eigenvalues greater than 1 and accounted for 62% of the variation. All items fell on either dimension with a factor loading of 0.6 or greater on one component and 0.4 or smaller on the other component, with the exception of the statement, "Technology is useful for assisting children with disabilities," which did not load on either factor and was dropped from the subsequent analysis (Cronbach's alpha = 0.89). The first factor described teachers' attitudes toward *children's learning*, and five items loaded on this factor: "Technology can improve individualized learning," "Technology can help to develop children's critical thinking skills," "Technology can help to develop children's higher-order skills," "Technology can help to develop children's content knowledge," and "Technology is useful for social interactions among children." The second factor described *technology for administration* and 3 items loaded: "Technology can improve documentation of children's learning," "Technology can improve my ability to communicate with parents and other caregivers," and "Technology is useful for online Professional Development." Each participant had a weighted factor score for each factor, which was calculated by multiplying the raw score of each item by its factor loading score and then summing these weighted scores.

3.3.3.2. Technological confidence. Teachers were asked to rate how confident they felt integrating the 12 technologies from the *technology use* variable in developmentally appropriate ways in their classroom on a likert-scale, anchored by (1) *not at all confident* and (5) *very confident*. An average confidence variable was created for each participant by summing up the confidence value for each technology and dividing by the number of technologies to which they had access.

4. Results

The endogenous variables in the model (see Fig. 2) are confidence, attitudes, and technology use, and the exogenous variables are support, technology policy, student SES, and teaching experience. We used MPlus software to conduct a path analysis to test our model. In the hypothesized model, support and attitudes were latent variables with two factors each, but this did not result in a good model fit.

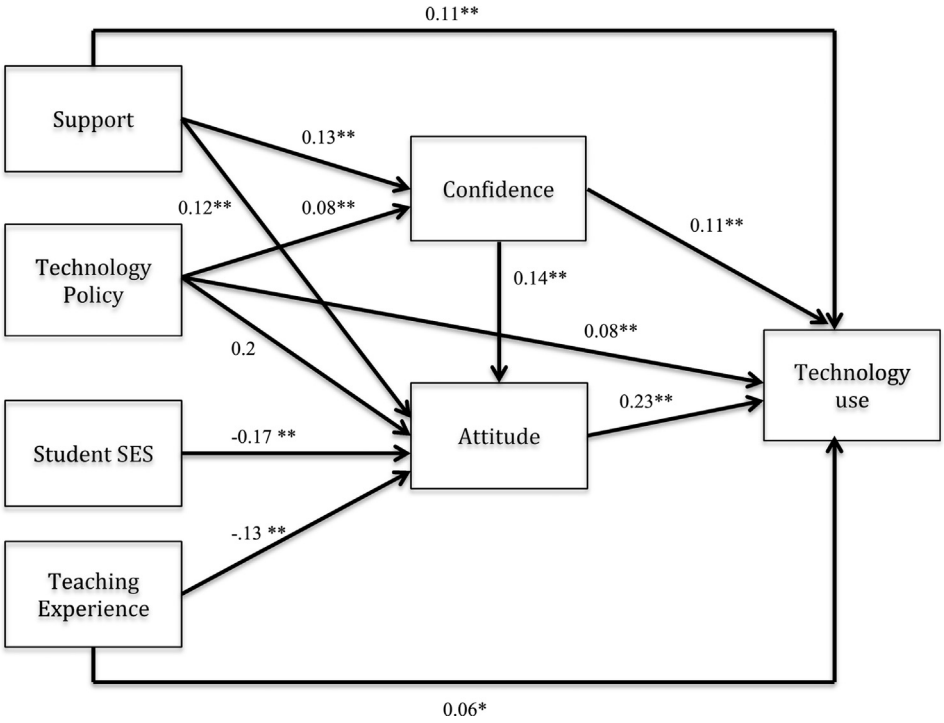

Fig. 2. Results of path analysis. $^{*}p < .05$, $^{**}p < .01$.

Instead, only *support for children's learning* from technology and *attitudes toward children's learning* were used in the final model. We tested the model fit using a variety of goodness-of-fit statistics: chi-square, Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and the Standardized Root Mean Square Residual (SRMR). The chi-square test was insignificant ($p = .35$) and the estimate (3.31) was close to the degrees of freedom (3), both of which exemplify a good fit between the hypothesized model and data (Hu & Bentler, 1999). The RMSEA was less than 0.05 (0.01), and the CFI (0.99) and TLI (0.99) were close to 1, all suggesting a good model fit (Bentler, 1990). The SRMR was 0.008, much below the acceptable 0.08 value, again indicating a good model fit (Hu & Bentler, 1999). Thus, results for this final model are described conceptually in Fig. 2 and a quantitative description of the standardized direct, indirect, and total effects are described in Table 2.

4.1. Technology use

Five variables explained 11% of the variance in technology use. All hypothesized paths were positively significant. Attitude had the strongest direct effect on technology use (beta = 0.23), followed by support (beta = 0.11), confidence (0.11), technology policy (0.08), and teaching experience (0.06). There were also significant indirect effects of support via confidence (0.02) and attitudes (0.03), as well as indirect effects of teaching experience (−0.03) and student SES (−0.04) via attitudes.

4.2. Attitudes

Five variables explained 9% of the variance in teacher attitudes toward the value of technology for children's learning. Having a technology policy was the only non-significant variable. Student SES had the strongest effect on attitudes (−0.17), followed by confidence (0.14), teaching experience (−0.13), and support (0.12). Both student SES and teaching experience had negative effects, as hypothesized.

4.3. Confidence

Two variables explained 3% of the variance in confidence. Support had the largest effect (0.13), followed by technology policy (0.08), both in the positive direction as hypothesized.

5. Discussion

The current study used a path analysis to describe the direct and indirect effects of various extrinsic and intrinsic factors on teachers' use of technology in early childhood education. While prior models have been proposed and tested using data from teachers of older children (e.g., Inan & Lowther, 2010b; Karaca et al., 2013), this is the first model to investigate the relationship between first- and second-order barriers to technology integration for early childhood education teachers.

5.1. First-order barriers

We hypothesized that the first-order barriers of support, technology policy, student SES, and teaching experience would both directly influence technology use and have indirect effects on use through the second-order barriers of confidence and attitudes (Fig. 1). Indeed, our model showed that support, technology policy, and teaching experience had positive direct effects on technology use. Student SES had a negative indirect effect on use mediated by teacher attitudes. Interestingly, support had the second largest direct effect on technology use, suggesting that this specific first order barrier is critical to technology integration in the early childhood classroom. While others have suggested that second-order barriers play a more pivotal role (e.g., Ertmer et al., 2012; Ottenbreit-Leftwich et al., 2010), the current study shows that support specifically targeting teachers' understanding of how to use technology to aid children's learning is an essential component to helping them use technology in their classrooms. Support also had an indirect effect on technology use via confidence and attitudes, suggesting that the effect of support is mediated by these two variables.

In addition to support, having a technology policy and teaching experience also had positive direct effects on technology use, albeit to a lesser degree. Interestingly, teaching experience had the opposite effect from what we hypothesized, suggesting teachers with more experience use technology more often. There was a negative indirect effect (−0.03) via attitudes, suggesting some mediation, but overall

Table 2
Path analysis results of the direct, indirect, and total effects.

Endogenous variables	Exogenous variables	Direct effects	Indirect effects	Total effects	R^2
Technology use	Support	0.11**	0.05**	0.16**	0.11
	Policy	0.08**	0.01	0.09**	
	Teaching experience	0.06*	−0.03**	0.03*	
	Student SES		−0.04**	−0.04**	
	Confidence	0.11**		0.11**	
	Attitudes	0.23**		0.23**	
Confidence	Support	0.13**		0.13**	0.03
	Policy	0.08**		0.08**	
Attitudes	Support	0.12**		0.12**	0.09
	Policy	0.02		0.02	
	Teaching experience	−0.13**		−0.13**	
	Student SES	−0.17**		−0.17**	
	Confidence	0.14**		0.14**	

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

more experience equated with more use. While these teachers were likely trained in more traditional classroom techniques, having more teaching experience may benefit them by providing a foundational knowledge of early childhood education into which they can then incorporate technology.

5.2. Second-order barriers

Attitudes toward technology for children's learning and confidence had two of the strongest positive effects on technology use, supporting prior research that shows teacher attitudes toward and confidence using technology play a critical role in their use of technology in the classroom (Blackwell, 2013; Ertmer & Ottenbreit-Leftwich, 2013; Karaca et al., 2013). Further, results suggest that teacher confidence plays a large role in shaping attitudes toward the value of technology, as confidence had the second strongest effect on attitudes. This has been documented in prior work (Inan & Lowther, 2010a, 2010b; Karaca et al., 2013; Lui, 2012) and makes intuitive sense, as teachers who are more confident in using technology have better attitudes toward using it with their students. Thus, not only is there an important relationship between second-order barriers and technology use, but there is also a critical relationship between second-order barriers.

Additionally, both confidence and attitudes were influenced directly by the first-order barriers in the model, suggesting a dynamic relationship between first- and second-order barriers to technology integration. Support had a positive effect on both confidence and attitudes, and having a technology policy had a positive effect on confidence, suggesting that schools who offer support that helps teachers understand how to use technology to improve student learning as well as schools that have a specific technology vision have teachers with higher confidence and more positive attitudes toward technology. Indeed, other models have found that support is associated with attitudes and confidence (e.g., Inan & Lowther, 2010b; Karaca et al., 2013), but this is the first model to describe the specific support techniques that are associated with these second-order barriers as well as provide evidence of this relationship for early childhood educators specifically. Particularly, support for integrating technology into specific subject areas and in developmentally appropriate ways, for using technology to document learning and provide individualized learning, and for finding quality digital media content are important to early childhood educators' confidence and attitudes toward technology, which in turn influence their use.

Confirming prior research (Karaca et al., 2013; Russell et al., 2003), teaching experience had a negative direct effect on teacher attitudes, as hypothesized. It is important to note the seemingly incongruous results as teaching experience had a direct positive effect on technology use. Thus, it appears that educators with more experience have less positive attitudes but also tend to use technology more often. Russell et al. (2003) found similar results in their study of K-12 teachers, where newer teachers reported higher levels of comfort with technology, which supported positive attitudes, but older teachers used technology more often. As such, it may be that teachers with less teaching experience have more personal technology use experience, but they do not necessarily know how to effectively integrate it into the classroom, while teachers with more teaching experience have a solid foundation from which to integrate technology.

Student SES had the largest negative direct effect on attitudes, aligning with our hypothesis that teachers who serve higher income students have less favorable attitudes while teachers who work with students from lower SES families have more positive attitudes. This may be because prior research has highlighted the additional benefits technology may have for lower-income students (Buckingham, 2007; Lemke, Coughlin, & Reifsneider, 2009), including research on *Sesame Street* documenting how low-income students can learn key school-readiness skills from watching the program (Ball & Bogatz, 1970; Wright et al., 2001). Additionally, low-income students may not have as much access to technology in their home environment, suggesting that teachers who work with them have more positive attitudes toward using technology because it gives these students learning experiences they would not get at home. Indeed, research suggests that teachers view using technology in the classroom with low-income students as a way to give them these critical technology experiences to help decrease the digital divide (Blackwell, 2013; Buckingham, 2007; Lemke et al., 2009).

6. Limitations

While the current study uses a large sample of early childhood educators to understand the relationship between first- and second-order barriers to technology use, there are several limitations to address. First, while the model has a good overall fit, only 11% of the variance in technology use, 9% in attitudes, and 3% in confidence was explained by the model. Thus, there are other omitted variables that help predict more of the variance in technology use, attitudes, and confidence. One key factor not captured by this model is teachers' general pedagogical beliefs, as teachers who have more traditional teaching beliefs tend to have more negative attitudes toward technology while teachers with more student-centered orientations tend to have more positive attitudes (Inan & Lowther, 2010a; Ertmer & Ottenbreit-Leftwich, 2013). However, provided that the purpose of path analysis is to gain an overall picture of what is going on, the fact that the model achieved good fit and has meaningful implications validates this model as useful for understanding technology use in early childhood education.

Second, participants were NAEYC members, and there may be differences between this population and other teachers more generally. However, given the large sample and diversity of program types as well as alignment with prior research on teachers of older children, we believe that the results have some generalizability to other early childhood educators.

Third, we took a global view of technology use, such that some participants may use a few technologies frequently while others may use many technologies but use each technology less frequently. Importantly, technologies may be qualitatively different, such that a teacher using a digital camera to take pictures and document children's learning is not the same as a teacher having children use the iPad to write and illustrate stories. While it is important to understand the differences in specific technology, which we investigate in our prior work with this sample (Blackwell et al., 2013), we also believe the current study provides a larger picture of technology use in early childhood education that is critical to understanding more generally the factors that affect overall technology use with young children in the classroom.

Finally, due to the cross-sectional nature of the data, our conclusions should not be interpreted as guaranteeing causality, as might be suggested from a path analysis. However, given this is the first study to investigate the associations between extrinsic and intrinsic barriers to technology use for teachers of very young children, we believe that the relationships explored to have important implications for technology use in early childhood education. Future work could address these limitations by including measures of teachers' pedagogical beliefs, sampling from a more diverse population of early childhood educators, investigating specifically how teachers use different technologies in early childhood education, and exploring longitudinal data to provide causal results.

7. Conclusion

The current study used path analysis to investigate the relationship between first- and second-order barriers to technology integration in early childhood education. The dynamic relationship represented in our model suggests the importance for school leaders and teacher educators to help teachers through targeted support and strong technology visions to influence teacher confidence, attitudes, and ultimately use. It is important to remember that the current study does not investigate how technology use impacts student achievement in early childhood education and does not seek to claim that more technology use equates to better outcomes for students. However, with the increased financial investments and focus by the federal government and schools across the country on using technology to increase achievement, it is critical to understand whether and how much teachers are using the technology with which they have access.

As a first step to investigating the effects of technology on student learning, we need to know if technology is being used at all. With the millions of dollars being spent on increasing teachers' access to newer technologies, we need to work with teachers to help them better understand how to effectively integrate technology into their classroom, and the current study points to several ways to improve teacher attitudes and confidence, which can then increase use. Without such support, the tension between attitudes and use will remain, with frustrated teachers, technology not being used to its fullest potential, wasted financial investments, and, importantly, potential consequences for children's learning. Thus, it is critical that if schools are investing so much money on technology that they invest sufficient time to provide support for teachers in understanding how to use technology effectively in their classrooms.

Overall, the current study provides important information on the factors that can help shape early childhood educators' confidence and attitudes toward as well as use of technology. With research continually showing the increased access but underuse of technology (Gray et al., 2010), providing teachers with sufficient support and a strong technology vision may help alleviate this problem (Ertmer & Ottenbreit-Leftwich, 2013). Given the excitement from school districts across the country to integrate newer devices, it becomes crucial for teachers to have positive attitudes and confidence toward using technology to make these initiatives effective.

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