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Adoption and use of technology in early education
The interplay of extrinsic barriers and teacher attitudes

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ABSTRACT

The increased access to, but continued under-use of, technology in education makes it imperative to understand the barriers teachers face when integrating technology into their classrooms. While prior research suggests teachers encounter both first-order extrinsic barriers and second-order personal barriers, much of this research has focused on K-12 teachers, not early childhood educators. Applying the Unified Theory of Acceptance and Use of Technology to early childhood education, the current study examines predictors of early childhood educators' access to and use of traditional technologies and newer mobile devices. Findings from 1329 teachers of 0–4-year-olds reveal that while extrinsic barriers influence access to a range of technologies, positive beliefs in children's learning from technology significantly predicted actual use of technology. Overall, the study provides new insight into factors influencing technology integration specifically for early childhood educators, a subgroup that has not been represented in much of the literature on technology integration in formal education.

1. Introduction

Previous promises of a technological revolution in education have failed to produce much change (Buckingham, 2007). Despite increased access to computers and newer mobile devices, the actual use of technology in the classroom remains infrequent, especially in early childhood education (Wartella, Schomburg, Lauricella, Robb, & Flynn, 2010). While studies have explored how teacher beliefs and attitudes toward technology influence infrequent use (e.g., Ertmer, 1999; Ifenthaler & Schweinbenz, 2013; Pynoo et al., 2013; Wood, Specht, Willoughby, & Mueller, 2008), few large-scale quantitative analyses have been performed investigating teachers of young children, an important group given the current debate of the place of technology in the lives of children. Extending the Unified Theory of Acceptance and Use of Technology (UTAUT; Venkatesh, Morris, Davis, & Davis, 2003) to an education setting, the current study draws on surveys from 1329 early childhood educators to explore how school environment and personal attitudes toward the affordances and barriers of technology integration predicted use of various devices, including both universally available technologies (i.e., TV/DVD, computer, digital cameras) and newer mobile technologies (i.e., iPod/MP3 players, iPod touch devices, e-readers, tablet computers).

1.1. Technology in education

Despite general resistance to using technology, in-school computer access is now relatively universal (Gray, Thomas, & Lewis, 2010). In a national 2009 survey of 3150 teachers, 97% of teachers reported access to computers, with 96% of computers in schools having Internet access (Gray et al., 2010). While computers were once thought of as the silver bullet to education reform, the technology itself has done little to alter the education landscape or to provide enhanced outcomes for students. This may be due to the continued under-use of technology in

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the classroom across all grade levels (National Education Association, 2008) and the failure to use technology for instructional purposes (Gray et al., 2010). This is even more pronounced in the early education settings. While 55% of in-home care providers and 59% of classroom teachers report access to computers, 34% and 35% of educators, respectively, report never using a computer with young children in their childcare (Wartella et al., 2010).

1.2. Unified Theory of Acceptance and Use of Technology

Venkatesh et al. (2003) proposed the Unified Theory of Acceptance and Use of Technology (UTAUT) to explain what encourages people to accept and use technology in the workplace. Venkatesh et al. (2003) posited four major constructs that influence acceptance and use of technology: *performance expectancy*, which describes how much users believe the technology will aid them in their work; *effort expectancy*, or the perceived ease of using the technology; *social influence*, which describes subjective norms relating to technology use within the social environment; and *facilitating conditions*, or the structural features of the environment, such as training, support, and access to technology. In addition to these, the UTAUT posits four individual factors that moderate the relationship between the four main constructs and actual use. These include the user's age, gender, and prior experience with technology, as well as whether or not using technology in the workplace is voluntary. Overall, the UTAUT has been shown to explain 70% of the variance in behavioral intentions for using technology (Venkatesh et al., 2003).

While the UTAUT provides a sound theoretical basis for explaining how people adopt and use technology, few studies have applied it to an education environment. To provide a more education-specific model, it is imperative to understand how the four main constructs of the model relate to prior literature on teacher barriers to technology integration. Ertmer (1999) described two types of barriers at the teacher level that prevent the successful integration of technology into the classroom. On the one hand, first-order extrinsic barriers prevent teachers from integrating technology into their classrooms because they lack time, training, professional development, access to sufficient hardware and software, and support (Ertmer, 1999). These extrinsic limitations relate to the UTAUT construct of facilitating conditions (Venkatesh et al., 2003). On the other hand, second-order personal limitations, including teaching beliefs, perceived value of technology for education, and comfort with technology also affect whether or not teachers embrace technology in their classrooms (Ertmer, 1999). These personal limitations correspond to the remaining three UTAUT constructs, namely performance expectancy, effort expectancy, and social norms (Venkatesh et al., 2003). Others have supported Ertmer's (1999) distinction, showing that teachers feel both limited by the structural elements of their environment and their personal beliefs (Mueller, Wood, Willoughby, Ross, & Specht, 2008; Parette, Quesenberry, & Blum, 2010; Wachira & Keengwe, 2010), thus supporting the use of a modified version of the UTAUT to understand teacher practices with technology in the classroom.

1.3. Teacher barriers to technology integration

With the increase in schools' general access but the continued under-use of technology, some have noted that personal barriers may play a more important role in changing whether and how much teachers integrate technology into their classroom (e.g., Ertmer, Addison, Lane, Ross, & Woods, 1999; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012; Zhao, Pugh, Sheldon, & Byers, 2002). Ertmer (2005) distinguished between beliefs and knowledge by using Calderhead's (1996) definition: beliefs refer to "suppositions, commitments, and ideologies," while knowledge is "factual propositions and understandings." A teacher may have the knowledge of how to use a technology, which results from breaking down first-order barriers, but this does not necessarily lead a teacher to believe in the value of the technology for her teaching practices. Indeed, researchers have found that individual attitudes, such as confidence with or anxiety about using technology, have been correlated with actual use of technology, such that those more in favor of technology or more open and willing to try it are more likely to adopt technology in their classroom (e.g., Calderhead, 1996; Clark & Peterson, 1986; Pajares, 1992). As Cuban (1993) concluded, "It is a belief system, not an economic or empirical warrant, that determines failure or success" (p. 194) when integrating technology into the classroom.

Research is mixed on whether or not teacher beliefs and attitudes are significant predictors of use above and beyond first-order extrinsic barriers. Some empirical evidence exists supporting the predictive power of beliefs to shape behavior (Kagan, 1992; Pajares, 1992), but others have noted inconsistencies between teacher beliefs and actual practices, which tend to result from extrinsic constraints (e.g., Ertmer, 2005; Ifenthaler & Schweinbenz, 2013; Wood et al., 2008). While belief systems impacted their practice with technology, the teachers also felt constrained by extrinsic factors. Similarly, Ifenthaler and Schweinbenz (2013) found variations in attitudes across teachers implementing tablet PC devices, where attitudes toward technology in addition to performance expectancy and extrinsic conditions influenced their actual use of the devices. Inan and Lowther (2010) found that while personal efficacy and beliefs about the benefits of technology influenced actual use, extrinsic factors, such as school support and professional development, helped shape teacher readiness and attitudes toward technology, suggesting that use stems from the relationship between first-order extrinsic barriers and second-order personal barriers.

1.4. Technology in early childhood education

Research on teacher barriers to technology use has primarily focused on K-12 education, often making generalizations about how first-order and second-order barriers influence technology integration across teachers of all grades. While this research provides a background for investigating early childhood educators, it is important to note that early childhood educators are different than K-12 teachers in several ways. First, teachers of young children tend to be less educated than K-12 teachers. The most recent National Institute for Early Education Research (NIEER, 2013) report, *The State of Preschool 2012*, reported only 58% of state preschool programs required teachers to have a bachelor's degree and only 29% required assistant teachers to have a Child Development Associate (CDA) credential. Additionally, 85% of state-funded preschool teachers have specific training in early childhood education (NIEER, 2013). Second, early childhood programs are varied in quality (e.g., Hynes & Habasevich-Brooks, 2008), and despite new initiatives to provide a more universal quality measure (i.e., the Quality Rating and Improvement System), there remains no required quality assessment for programs. Third, teacher turnover rate is estimated at 20–50% annually in early childhood education (Barnett, 2003).

Finally, and perhaps most pertinent to technology in education, the historical debate over the place of technology in the lives of young children has likely structured some educators' belief systems. While technology has been shown to increase learning in many circumstances (e.g., Huston, Anderson, Wright, Linebarger, & Schmitt, 2001; Jennings, Hooker, & Linebarger, 2009; Plowman & Stephen, 2003; Vernadakis, Avgerinos, Tsitskari, & Zachopoulou; Wu & Zhang, 2010), others have highlighted the potential negative impact (e.g., Christakis & Zimmerman, 2007; Christakis, Zimmerman, DiGiuseppe, & McCarty, 2004; National Research Council and Institute of Medicine, 2006). The American Academy of Pediatrics (AAP, 2001, 2011) continues to recommend no screen time for children 0–2 and no more than 2 hours of screen time a day for older children. In light of these guidelines, the National Association for the Education of Young Children (NAEYC, 2012) recently released a position statement supporting the thoughtful integration of technology in developmentally appropriate ways in early childhood education. This mismatch in advice from research and major organizations may lead to more insecurity over using technology with young children, which then could impact teachers' actual use.

Research has shown that first-order and second-order barriers are important to early childhood educators' use of technology. Lindahl and Folkesson (2012) found preschool teachers' attitudes influenced their technology adoption, as teachers fell into two groups, those that embraced the technology and those that felt the technology threatened their traditional beliefs and teaching philosophies. In a focus group study of 50 early childhood educators, Wood and colleagues (2008) found teachers reported both positive and negative attitudes to integrating computers into their classrooms, with the main barriers being personal comfort with technology, physical resources, financial resources, and current teaching philosophy. Teachers were also concerned with children's access, experience, skills with technology, and parent support for technology integration (Wood et al., 2008). However, few studies have specifically investigated how first- and second-order barriers influence early childhood educators' adoption and use of technology.

The inconsistency in findings and lack of large-scale empirical evidence of how first- and second-order barriers influence early childhood educator technology practices provide the foundation for the current study. Applying the UTAUT model to education and the interplay of first- and second-order teacher barriers to technology acceptance and use, we ask the following research questions:

RQ1. How do extrinsic and personal teacher demographic characteristics influence a teacher's access to technology?
RQ2. How do teachers' personal beliefs about the affordances of technology and their real and perceived extrinsic constraints influence whether and how much they use technology?

2. Method

2.1. Participants

This study uses online survey data collected in fall, 2012 from 1329 early childhood educators who taught children age 4 and younger. Participants were all associated with NAEYC and were recruited to participate by email through the NAEYC listserv. The majority of teachers who took the survey were female (98%) and White (86%), with 5% African American, 4% Hispanic, 2% Asian American, <1% Native American/Alaskan Native, <1% Hawaiian Native/Pacific Islander, and 3% of mixed racial background. The average age of participants was 48 years (SD = 10.9), with a range from 20 to 76 years. The median annual family income was between $61,000 and $70,000, which is slightly higher than the national average family income of $50,054 (U.S. Census Bureau, 2012). Participants represented 48 states (excluding Mississippi and West Virginia) and Puerto Rico, as well as Canada and Europe. Almost half (45%) of participants taught in suburban areas, while 35% taught in urban settings, and 20% taught in rural settings.

In terms of educational attainment, 36% had a graduate degree, 53% had a 4-year college degree, 11% had a high-school degree or less, while 26% of participants either had no training or only some coursework in early childhood education. Teachers in the survey had been working in the classroom for an average of 20.3 years (SD = 10.7). There was variation in the program type, with 49% of participants working in center-based care (i.e., for- or non-profit non-school-based care, such as a YMCA, a Montessori, or a Bright Horizons), 33% in school-based care (public or private programs within K-12 school programs), 11% in Head Start centers, and 7% in home-based childcare. The majority of participants taught 3–4-year-olds (57%), 7% taught 0–2-year-olds, and just over a third (37%) taught both 0–2- and 3–4-year-olds.

2.2. 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 and beliefs toward technology in early childhood education and professional development. Technologies were chosen based on prior research indicating use in early childhood environments (Wartella et al., 2010) as well as to include both traditional platforms, such as TV/DVDs and computers, and newer mobile technologies, including iPods, iPod touch devices, e-readers, and tablet computers. Given the increased interest in these newer mobile devices and the lack of prior research on differential access and use in early childhood settings, these technologies were important additions from prior work in the field.

Researchers worked with NAEYC and the Fred Rogers Center to email an online survey link to the NAEYC membership database in fall, 2012. Because NAEYC membership is open to early childhood educators as well as professionals and higher education faculty, participants were screened at the beginning of the survey to ensure that they were early childhood educators working with children 0–4 years old. This resulted in 1329 completed surveys.

2.3. Measures & coding

2.3.1. Dependent variables

Teachers were asked how often they used each technology for instructional purposes in their classroom (e.g., TV/DVD, computer/laptop, digital camera, iPod/MP3 player, iPod touch, e-reader, and tablet computer) on an eight-point scale: never/no access, never/access, less than once a month, once a month, 2–3 times a month, once a week, 3–4 times a week, and daily. Two outcome variables were created for each technology. First, teacher's access to each technology in the classroom was created as a dichotomous variable indicating 1 for access and 0 for

no access. The second outcome variable measured use for only those teachers with access to the technology using the seven-point scale that was converted to the number of days a month a teacher uses the technology: never (0), less than once a month (.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). This variable was treated as a continuous variable given that the underlying concept of frequency of use is continuous and the scale has seven points, which research has shown valid for using this method (e.g., Johnson & Creech, 1983; Zumbo & Zimmerman, 1993).

2.3.2. Independent variables

To investigate both extrinsic properties and internal teacher characteristics and attitudes, independent variables were distinguished using Ertmer's (1999) categories of first-order and second-order properties.

2.3.2.1. First-order properties. Extrinsic properties of the teacher's school environment were included as independent variables. First, *school type*, which has been shown in prior research to be an important control variable for access and use of technology (Wartella et al., 2010), was used to distinguish between Head Start, school-based (private or public kindergarten within a school), center-based (for- or non-profit care not associated with a school, such as a YMCA or Bright Horizons), and home-based childcare (in-home care). Second, research suggests that student income level may be correlated with access to and use of technology, given that schools with lower student SES often have lower access to more pricy technology due to limited funding (Zickuhr & Smith, 2013), and teachers in these schools report using technology less often (Gray et al., 2010). Thus, teachers were asked to describe their students' income level (*student income level*) as low-income, lower-middle income, middle income, upper-middle income, or upper income (McManis, Simon, & Nemeth, 2012). *Technology policy* described whether or not the school has a technology policy, which may influence how much technology teachers use in the classroom. Finally, *professional development* described how often the school offers professional development opportunities specifically targeting technology integration, which has been theorized as an important mechanism for teacher acceptance and use of technology (Inan & Lowther, 2010). This was measured on a seven-point scale: (0) never, less than once a year, once a year, several times a year, once a month, 2–3 times a month, weekly (6). Additionally, factor scores representing teachers' perceived extrinsic barriers were used and are described in further detail below.

2.3.2.2. Second-order properties. Personal properties of teachers were defined as two types. First, demographic variables were examined and included *highest level of education*, defined as having a high-school degree or less, having a bachelor's degree, or having a graduate degree (MA, PhD, or EdD). Prior research uses this as a proxy for socioeconomic status with the understanding that education is highly correlated with income (Sirin, 2005). Thus, level of education may be associated with access to technology if teachers are using their own devices in the classroom or may be reflective of the community socioeconomic status in which they work. Age of the teacher was also a demographic variable, given that younger and older teachers may have different attitudes toward and confidence levels of technology use (Venkatesh et al., 2003).

Second, factor scores representing attitudes and beliefs toward the affordances and personal barriers to technology use were examined. Measures of attitudes and beliefs drew on two indices, one of teachers' perceived affordances and one of perceived barriers to technology integration. The researchers developed original indices influenced by the theoretical underpinnings of the UTAUT but specific to teachers to create factor scores. All items were measured on a five-point scale that assessed agreement with the statement, anchored by strongly disagree and strongly agree. Both the affordances (Cronbach's alpha = .89) and the barriers scale (Cronbach's alpha = .9) were highly reliable. Exploratory factor analyses with varimax rotations were conducted for both indices to create the factor loadings.

The affordances index resulted in two dimensions with eigenvalues greater than 1 and accounted for 69% of the variation. All items fell on either dimension with a factor loading of .6 or greater on one component and .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.

Five items loaded on the first factor, which we called *children's learning from technology*, as each item described how technology could be useful to children's cognitive and social development: "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 was called *technology for administration* and had three items load on the factor: "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." These items described how technology can aid the teacher in more administrative tasks. Both affordances factors represent second-order properties as they describe teachers' personal attitudes toward technology use.

The barriers index resulted in three dimensions with eigenvalues greater than 1 and accounted for 61% of the total variance. All items fell on their respective dimension with a factor loading of .6 or greater on one component and .4 or smaller on the other component, with the exception of three statements, which did not load on any of the factors: "Technology use is limited by children's inability to appropriately use technology," "Technology use is limited by a lack of appropriate digital content for my students," and "Technology use is limited by technology changing too fast."

The first factor loaded five items and was called *teacher inhibitions* as the items described teachers' lack of self-efficacy and preparedness for integrating technology into the classroom, making this factor a second-order property: "Technology use is limited by insufficient or lack of training," "Technology use is limited by my lack of time to learn technology," "Technology use is limited by my lack of time to use technology in my early childhood classroom/program," "Technology use is limited by my lack of comfort with technology," and "Technology use is limited because I am unsure of how to make technology relevant to subject areas."

The second factor was called *lack of access and support*, as the three items that loaded on the factor described how access to technology and perceived school support limit teachers' actual use of technology in the classroom: "Technology use is limited by insufficient or lack of technical support," "Technology use is limited by insufficient or inadequate software," and "Technology use is limited by insufficient or inadequate hardware."

The final factor had two items and was called *gatekeepers* because the items described two key groups of people who hold power to limit technology integration, namely parents and school leadership: "Technology use is limited by the lack of parent approval of technology in my

early childhood classroom/program" and "Technology use is limited by my school/program's policy that prohibits technology use." Both the *lack of access and support* and *gatekeepers* factors represent first-order properties because they indicate perceived extrinsic constraints to teachers' use of technology in the classroom.

Factor scores were created for the two affordances factors and three barriers factors. Scores were computed by first multiplying the raw score of each item by its factor loading score and then summing these weighted scores by their respective factor. Thus, each individual participant had a weighted factor score for each of the five factors, which were then used in subsequent regression analyses pertaining to teachers' actual use of technology in the classroom.

2.3.3. Technology

Two types of technologies were explored, those that were universally available to teachers in the sample as determined by 75% or more of teachers indicating they had access to the devices and non-universal newer mobile devices as indicated by less than 30% of teachers who said they had access to them. Universally available technologies were TV/DVDs (79%), laptop or desktop computers (83%), and digital cameras (92%). Newer mobile technologies were non-video iPods/MP3 players (21%), iPod touch devices (15%), e-readers (15%), and tablet computers (28%). While technology access and use were measured individually for each technology, exploring both universal and non-universal accessible technologies provided a conceptual framework for exploring differences in access and use among early childhood educators.

3. Results

3.1. RQ1

How do extrinsic and personal teacher demographic characteristics influence a teacher's access to technology? A series of Pearson's chi-square analyses were used to investigate whether program type, student SES, or teacher education were associated with access to each technology.

3.1.1. Program type

Results in Table 1 show that teachers from home-based programs were significantly more likely to have access to e-readers compared to teachers from any other program type ($\chi^2 = 20.7$, $df = 3$, $p < .01$). School-based programs had significantly more access to tablet computers compared to center-based programs ($\chi^2 = 25.5$, $df = 3$, $p < .01$). Finally, Head Start programs had significantly less access to TV/DVDs compared to all other programs ($\chi^2 = 14.5$, $df = 3$, $p < .01$), while center-based programs had significantly less access to computers compared to all other program types ($\chi^2 = 30.8$, $df = 3$, $p < .01$).

3.1.2. Student SES

Results in Table 1 indicate teachers in programs with middle-income students had less access to several technologies compared to other teachers. First, teachers of middle-income students had less access to iPod/MP3 players compared to teachers of upper-middle-income students ($\chi^2 = 17.7$, $df = 4$, $p < .01$). Second, these teachers also had less access to tablet computers compared to those with upper-income students ($\chi^2 = 12.5$, $df = 4$, $p = .01$). Finally, teachers of middle-income students also had significantly less access to computers compared to teachers of low-income students ($\chi^2 = 10.8$, $df = 4$, $p = .03$).

3.1.3. Teacher education

Results in Table 1 show that having a graduate degree was associated with more access to computers ($\chi^2 = 17.9$, $df = 2$, $p < .01$) and digital cameras compared to teachers with a high-school degree or less ($\chi^2 = 8.6$, $df = 2$, $p = .01$). Significantly more teachers with graduate degrees also had access to iPod/MP3 players ($\chi^2 = 13.3$, $df = 2$, $p < .01$) and iPod touch devices ($\chi^2 = 12.8$, $df = 2$, $p < .01$) compared to teachers with a 4-year college degree. Further, significantly more teachers with graduate degrees had access to tablet computers compared to both teachers with a 4-year college degree and those with a high-school degree or less ($\chi^2 = 17.9$, $df = 2$, $p < .01$).

Table 1
Pearson's chi-square tests for a teacher's access to technology by program type, student SES, and teacher education.

	TV/DVDs	Computer	Digital camera	iPod/MP3 player	iPod touch	E-reader	Tablet Computer
Program type							
Home-based care	94.6[a]	92.6[a]	91.4[a]	23.9[a]	16.9[a]	30.4[a]	33.7[a,b]
Head Start	75.9[b]	92.1[a]	94.9[a]	19[a]	13.2[a]	11[b]	23.9[a,b]
School-based care	78.7[a]	86.1[a]	92.8[a]	23.7[a]	16.9[a]	12.8[b]	35.7[b]
Center-based care	78.8[a]	77.7[b]	90.5[a]	19.5[a]	12.5[a]	14.7[b]	22.4[a]
Student SES							
Low-income	80[a]	86.5[a]	92.7[a]	18.5[a]	13.1[a]	13.6[a]	29.9[a,b]
Middle income	81.5[a]	79.5[b]	89.4[a]	19.1[a]	12.5[a]	13.8[a]	23.6[b]
Upper income	75.9[a]	81.1[a,b]	93.1[a]	29.4[b]	20.3[b]	19.7[a]	31.5[a]
Teacher education							
High school or less	80.9[a]	76.6[a]	87.3[a]	19[a/b]	13.5[a,b]	14.2[a]	22.5[a]
4-Year college degree	78.6[a]	80.4[a]	90.8[a,b]	18.2[b]	11.7[b]	14.1[a]	24.7[a]
Graduate degree	79.8[a]	88.6[b]	94.3[b]	26.9[a]	19.2[a]	16.7[a]	35.2[b]

Note: All numbers are reported as percentages. Statistical significance should be read separately for program type, student SES, teacher age, and teacher education. Differing subscript letters indicate a significant difference at $p < .05$ level between subgroups. For example, more home-based centers have access to TV/DVDs compared to all other types of childcare programs.

Table 2
Regression analyses measuring frequency of use of a technology by attitudes for technology, controlling for program type, technology policy, frequency of professional development, teacher age, and teacher education.

	TV/DVDs		Computer		Digital camera		iPod/MP3		iPod touch		E-reader		Tablet computer	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Constant	8.2 (2.97)	11.24 (4.62)	7.68 (4.96)	5.11 (7.1)	14.8 (4.62)	14.07 (7.26)	19.03 (9.22)	4.79 (12.97)	−.75 (12.14)	5.69 (15.13)	14.98 (8.84)	1.41 (12.07)	13.07 (8.18)	14.23 (10.92)
Head Start	−1.73 (2.2)	−3.75 (2.39)	1.04 (3.63)	−1.22 (3.69)	3.46 (3.49)	2.29 (3.85)	−8.84 (8.06)	−3.26 (8.22)	2.49 (10.11)	8.74 (10.13)	−17.27 (5.94)*	−14.31 (6.93)*	−6.53 (5.59)	−3.54 (5.17)
School-based care	−3.36 (1.96)	−5.17 (2.16)	4.18 (3.29)	1.08 (3.38)	5.74 (3.21)	4.19 (3.54)	−8.72 (7.43)	−5.88 (7.42)	1.96 (9.39)	6.94 (9.31)	−14.36 (4.87)*	−12.0 (5.57)*	−5.71 (4.8)	−3.51 (4.32)
Center-based care	−3.94 (1.93)*	−5.14 (2.12)	−.08 (3.25)	−.89 (3.34)	5.49 (3.16)	4.27 (3.54)	−6.67 (7.52)	−2.55 (7.66)	4.02 (9.45)	11.19 (9.68)	−15.53 (4.94)*	−10.12 (5.82)	−8.35 (4.84)	−5.6 (4.39)
Student low SES	−.94 (.99)	−1.77 (1.06)	4.51 (1.59)**	2.68 (1.61)	−2.01 (1.47)	−3.31 (1.61)*	4.21 (3.0)	4.85 (3.11)	−4.45 (3.46)	−3.43 (3.46)	−.39 (2.97)	−2.39 (3.8)	1.86 (2.53)	−1.15 (2.43)
Student middle SES	−1.24 (1.05)	−2.04 (1.12)	−1.41 (1.72)	−1.99 (1.69)	−2.81 (1.57)	−3.17 (1.67)	3.2 (3.32)	2.79 (3.38)	−1.69 (3.66)	−.58 (3.62)	−2.5 (3.18)	−2.95 (3.66)	−2.81 (2.96)	−4.26 (2.74)
Tech policy	−1.82 (.75)*	−2.19 (.81)	2.24 (1.22)*	2.59 (1.23)	.43 (1.12)	1.81 (1.22)	.89 (2.49)	.81 (2.65)	8.3 (2.85)	6.5 (3.15)*	1.52 (2.45)	.88 (2.82)	3.25 (1.99)	2.36 (1.92)
Professional development	.33 (.3)	.1 (.33)	1.93 (.49)**	1.32 (.48)**	.01 (.45)	−.06 (.48)	.63 (1.02)	.02 (1.1)	2.46 (1.05)	1.53 (1.07)	1.04 (.88)	.49 (1.05)	1.54 (.75)*	.82 (.71)
Teacher age	.02 (.04)	.004 (.04)	.04 (.06)	.4 (.06)	−.9 (.05)	−.08 (.06)	−.14 (.11)	−.14 (.12)	−.1 (.13)	.03 (.14)	−.05 (.11)	−.03 (.13)	−.02 (.1)	.11 (.09)
4-Year college degree	−1.78 (1.58)	−1.25 (1.64)	−4.87 (2.65)	−3.97 (2.56)	.64 (2.43)	.09 (2.54)	1.85 (5.66)	−1.3 (6.21)	1.73 (6.12)	−4.06 (7.09)	4.81 (6.16)	4.87 (6.77)	−2.45 (4.41)	−4.03 (4.34)
Graduate degree	−2.1 (1.57)	−.94 (1.65)	−5.5 (2.63)*	−4.05 (2.55)	2.55 (2.43)	2.18 (2.56)	3.86 (5.39)	2.77 (5.83)	3.58 (6.05)	−1.99 (6.77)	4.51 (5.77)	6.29 (6.44)	−.61 (4.29)	.13 (4.18)
Child learning factor		.48 (.12)**		1.51 (.18)**		.23 (.18)		.16 (.39)		.78 (.42)		.92 (.42)*		1.64 (.31)**
Administration factor		−.71 (.3)*		−1.47 (.45)**		.02 (.45)		1.66 (.92)		.25 (.98)		.11 (.93)		−2.08 (.8)*
Personal inhibitions factor		.08 (.14)		.18 (.04)		.08 (.2)		.45 (.49)		−.19 (.55)		.36 (.56)		−.32 (.31)
Access/support factor		−.4 (.2)*		−.45 (.3)		−.12 (.3)		−.54 (.72)		−.65 (.81)		−.87 (.82)		−.11 (.49)
Gatekeepers factor		.5 (.35)		−.23 (.53)		−.32 (.52)		−1.86 (1.17)		−2.18 (1.34)		−.31 (1.17)		−1.04 (.88)
Change in R^2		.05		.14		.01		.1		.15		.12		.24

Note: $^{*}p < .05$, $^{**}p < .01$.

3.2. RQ2

How do teachers' personal beliefs about the affordances of technology and their real and perceived extrinsic constraints influence whether and how much they use technology? A series of step-wise linear regression analyses were used to explore if and how often teachers use universally accessible technology and newer mobile devices in their classrooms. Extrinsic characteristics (school type, student SES, technology policy, and frequency of professional development) and personal demographic (teacher education and teacher age) variables were entered on the first step, and factor scores for teacher attitudes on the affordances of technology and beliefs about barriers to integration were entered on the second step (Table 2).

3.2.1. TV/DVDs

The overall first-step model was not significant. Adding factor scores in the second step resulted in a significant model ($F = 2.48$, $df = 15$, $p < .01$), with significant values for both affordances factor scores. The *children learning from technology* factor was positively predictive of using TV/DVDs, while the *technology for administration* and *access/support* factors were negatively predictive.

3.2.2. Computers

The first-step model was statistically significant in predicting use of computers ($F = 6.82$, $df = 10$, $p < .01$). Results showed that receiving more professional development and working in a school with a technology policy were positively associated with computer use. Additionally, teachers who work in schools with lower-income students use computers in the classroom more frequently than teachers who work in schools with high-income students. Having a graduate degree, on the other hand, was negatively associated with computer use. Adding factor scores resulted in a significant model ($F = 9.8$, $df = 15$, $p < .01$). Both affordances scale scores predicted use, with *children learning from technology* a positive predictor and *technology for administration* a negative predictor. Frequency of professional development also remained significant.

3.2.3. Digital cameras

The first-step model was not significant in predicting use of digital cameras, nor did the addition of factor scores result in a significant model.

3.2.4. iPod/MP3 players

The first step of the analysis resulted in no significant predictors of iPod/MP3 player use, nor did the addition of the affordances and barriers factor scores.

3.2.5. iPod touch

The first-step model was not significant. However, when factor scores were added to the analysis, the model became significant ($F = 2.25$, $df = 15$, $p = .01$). Having a technology policy was a positive predictor of using iPod touch devices.

3.2.6. E-readers

The first-step model was not significant in predicting use of e-readers, nor did the addition of factor scores result in a significant model.

3.2.7. Tablet computers

The first-step model was not significant. The addition of factor scores resulted in a significant overall model ($F = 4.72$, $df = 15$, $p < .01$), where the *children learning from technology* factor was a significant positive predictor and the *technology for administration* was a negative predictor of use.

4. Discussion

The purpose of this study was to explore how various extrinsic and personal properties influence teachers' access to and use of technology as a way to understand general use of technology in early childhood education. Grounded in Venkatesh and colleague's (2003) UTAUT, this study highlights the interplay between extrinsic and personal properties that influence whether and how much early childhood educators use technology in their classroom.

4.1. Access

While prior studies have compared all types of classroom teachers to home-based providers (Wartella et al., 2010), this is the first study to examine more granular differences in access between certain types of classroom teachers (i.e., Head Start, school-based, and center-based) and home-based providers. Extrinsic properties of school type and student income level predicted whether or not teachers had access to technologies. Home-based programs were more likely to have access to e-readers compared to all other programs, which may be due to home-based teachers owning these devices for themselves and then using them with the children during program hours. Significantly more school-based programs also had access to tablet computers compared to center-based care, which may be due to the recent increase in local, state, and federally-funded pilot iPad projects across the country (e.g., Chicago, IL Public School District, Guilford County, NC School District; San Diego Public School District; see Kaufman, 2012 for a summary). Head Start programs were less likely to have access to TV/DVDs compared to all other programs. Further, center-based programs had significantly less access to computers compared to all other programs, which is noteworthy given prior research that found no difference in computer access between classroom teachers, including center-based care, and family providers (Wartella et al., 2010). Our study builds on this research by disaggregating classroom teachers to show that there are more granular differences in access. Suggestions that computer access is universal are not necessarily accurate, as our study showed teachers working with middle-income students actually have less access compared to teachers of lower-income students.

Further, middle-income students may also be missing out on access to iPod/MP3 players and tablet computers in their classroom, as significantly fewer teachers of these students had access to these devices compared to teachers of upper-income students. While traditional digital divide literature focuses on lower-income students compared to higher-income students, results from this study provide a more fine-grained analysis and show a potential digital divide emerging for the middle class. This may be due to technology funding initiatives targeted at lower-income students, such that the policies miss children in the middle income who also do not have equal access to technology compared to higher-income students.

Interestingly, a teacher's highest educational attainment was also predictive of access. Having a graduate degree was consistently positively associated with access to technology, including more access to computers and digital cameras compared to those with a high-school degree or less, and more access to iPod/MP3 players and iPod touch devices compared to teachers with a 4-year college degree. Additionally, more teachers with graduate degrees also reported access to tablet computers compared to all other teachers.

One possibility is that highest level of education represents extrinsic features not captured in the other measures. Thus, teachers with higher levels of education may represent the school culture or the type of community in which the school was located. Additionally, it may be that the personal qualities represent teacher ownership of such devices, with more educated teachers having the means to purchase and use their technologies. Indeed, 17% of teachers use their own computers, 32% their own digital cameras, 42% their own iPod/MP3 players, 38% their own iPod touch devices, 49% their own e-reader, and 35% their own tablet computers. Thus, the digital divide is not simply an extrinsic problem, but one also influenced by the personal means of the teacher. Students with teachers who have higher educational attainment, and thus likely higher-income levels, gain access to more and diverse technologies than their peers in classrooms with lower-income teachers.

4.2. Use

While access to technologies gives teachers the opportunity to integrate them into the classroom, the UTAUT suggests that facilitating conditions—or extrinsic barriers—and performance expectancy, effort expectancy, and social influence—or personal barriers—influence actual adoption and use of the technology. The current study showed both extrinsic facilitating characteristics and personal attitudes toward technology predict use.

The significance of extrinsic characteristics changed depending on the technology. Frequency of professional development predicted increased use of computers and tablet computers, while the presence of a technology policy and the income level of students differentially predicted use depending on the technology. Compared to home-based schools, other schools used e-readers and TV/DVDs less frequently.

However, personal attitudes strongly predicted use across all technologies except digital cameras, iPod/MP3 players, iPod touch devices, and e-readers. The lack of finding for digital cameras may be from ceiling effects given that the overwhelming majority had access to them in their classrooms. For the remaining technologies, if a teacher had strong agreement that technology can benefit children's learning, teachers used technology more often. This makes intuitive sense as the main goal of teachers is to increase student learning, such that any belief in the positive benefit of resources—whether digital technology or traditional tools—is likely to induce use. Prior research with teachers of older children has found that positive beliefs in the affordances of technology for children's learning are an underlying construct of technology use (e.g., Ottenbreit-Leftwich, Glazewski, Newby, & Ertmer, 2010). Interestingly, teachers who believed children could learn from technology were more likely to use TV/DVDs, which has been a historically controversial technology in early childhood settings given the debate over the educational value of television and its potential to displace other necessary preschool activities, such as social interactions with peers and imaginary play (Christakis & Garrison, 2009).

Beliefs about the affordances of technology for administration negatively predicted use for TV/DVDs, computers, and tablet computers. Thus, teachers who agreed that technology in general could help with administrative tasks used these technologies less often. It could be that teachers do not use these technologies for communicating with parents, documenting children's learning, and online professional development, but this only makes sense for TV/DVDs. Computers and tablet computers, on the other hand, are noted as aiding these tasks (Ifenthaler & Schweinbenz, 2013; Lemke, Coughlin, & Reifsneider, 2009), so it could also be that teachers primarily use these technologies for administrative tasks, which they engage in less often than if they were to use the technologies more as a classroom resource.

The barriers factors, on the other hand, did not predict technology use despite prior research indicating personal inhibitions, a lack of access and support, and school and parent buy-in influences teachers' use of technology (e.g., Ertmer, 1999; Mueller et al., 2008; Parette et al., 2010; Wachira & Keengwe, 2010). Only the access and support factor was negatively predictive of TV/DVD use, suggesting that teachers with more access and support actually use this technology less often. These teachers may be supported in more advanced technology and therefore allocate their instructional time to those technologies over TV/DVDs.

In general, while early childhood teachers may feel limited, in actuality these attitudes are not consistent with what happens in the classroom. Because the current study focused on early childhood educators, this finding may represent a key difference between these teachers and K-12 educators, though Ertmer (2001, 2005) has noted inconsistencies in K-12 teacher beliefs compared to actual practices. Another plausible explanation for our findings may be that the barriers index measured perceived barriers, which may capture teachers' feelings about the quality of integration, such that teachers may use technology because they have access to it, but they still feel limited in what they can do with the technology because of the various barrier factors. This does not mean teachers use the technology less, just that they may not be using it in ways and to the extent they desire or feel the technology affords.

It is noteworthy that several models to predict teacher use of technology had moderate R^2 values and predicted a fair proportion of the variance in how often teachers use a certain technology. Indeed, models for teacher use of computers, iPod touch devices, and tablet computers accounted for approximately 27–35% of the variance. Adding factor scores changed these models from insignificant to significant, suggesting the inclusion of attitudes and beliefs factors improved the prediction of teachers' actual use of technology. This reflects Sheingold's (1991) argument that "teachers will have to confront squarely the difficult problem of creating a school environment that is fundamentally different from the one they themselves experienced" (p. 23), such that technology integration becomes not only an access problem but one fundamentally tangled with the personal properties of teachers. Due to the reliability and significance of the affordances and barriers scales found in this study, they would be particularly useful in future quantitative studies of teachers' use of technology.

Finally, evidence from this study shows that while positive attitudes toward technology aiding children's learning is a strong predictor of use above and beyond real and perceived extrinsic barriers, first-order barriers still influenced use for particular technologies. Further, there is no evidence from this study that teachers' inhibitions to using technology predicted actual use, which contradicts current research that shows personal efficacy is a strong second-order predictor of actual use (e.g., Ertmer, 1999, Ertmer et al., 2012; Parette et al., 2010). Given that the early childhood education community is in the state of transition over technology, with evolving, and sometimes conflicting policies affecting classroom integration, this finding may reflect different influences to technology integration particular to this demographic, as prior research has not specifically focused on early childhood educators.

4.3. Limitations

While the current study provides insight into early childhood educators' access to and use of a variety of technologies, findings should be taken in light of three limitations. First, all data are self-reports from teachers of 0–4-year-olds, such that there is the potential for self-response bias, though this is the case in all survey research. Throughout the results, we have emphasized that findings are based on the perceptions of teachers. Second, the survey instrument itself was limited by the amount and depth of the questions we were able to ask. For example, it would be difficult for teachers to report the exact number of days they used a variety of technologies over the last month, such that a less explicit likert scale was used to measure technology use. Similarly, it would be difficult for teachers to exactly assess the income level of their students, but more general categories of low, middle, and high income are easier to answer. While this introduces some vagueness and bias in terms of participants defining "low" versus "middle" income, these types of categories are used in other survey work with this population (McManis et al., 2012). Finally, participants in this study were NAEYC members, such that results may not represent trends in the general population of all early childhood educators. However, given the large sample size and participants from across the nation, along with the dearth of research in general on how attitudes and beliefs shape early childhood educators' use of technology, this study provides an important first step in understanding technology in early childhood education.

4.4. Suggestions for future research

While the current study provides a unique snapshot of early childhood educators' access to and use of technology and how these are mediated by extrinsic and personal factors, future research should focus on more than just frequency of using technology. Instead, studies should consider what quality integration looks like and whether or not teachers are getting the support they need to confidently integrate technology in meaningful and intentional ways. Additionally, future work would benefit from a more diverse population of participants. This information will help move the field forward in understanding how teachers can leverage technology to effectively enhance teaching and learning practices with young children.

5. Conclusions

Overall, early childhood educators' access to technology is influenced by extrinsic properties, but when it comes to actual use, personal properties matter, especially attitudes on the affordances of technology. While the study supports the UTAUT model, there is less support for the belief that personal attitudes matter more than extrinsic ones in predicting teacher use of technology. However, this may represent important differences between early childhood educators and K-12 educators, who have been the focus of prior research, suggesting that future research needs to disaggregate findings for these two teacher demographics.

More broadly, if we adopt the NAEYC position statement for the thoughtful use of technology in developmentally appropriate ways to aid learning in early childhood, this study provides evidence of specific practical considerations to increase quality integration of technology in early childhood education. First, frequency of professional development was associated with higher use, such that providing early childhood teachers with more targeted professional development on using technology in developmentally appropriate ways could help educators more effectively integrate technology into their classrooms. Second, providing a technology policy for early childhood teachers that lays out how to appropriately incorporate technology into their curriculum to meet the developmental needs of students could help educators more effectively use technology with their students. Third, shifting the teaching attitudes of early childhood educators to embrace the positive potential of technology to impact children's learning could go a far way to increase these teachers' actual use of technology in the classroom. As Fisher (2006) argued, the role of technology is not to produce change; rather, teachers are the agent of change, suggesting that concentrated efforts to adjust teacher attitudes toward the benefits of technology could produce more effective use. Professional development initiatives could address this, but increased empirical evidence on the effectiveness of technology to aid children's learning could also alter teachers' beliefs.

References

American Academy of Pediatrics. (2001). Policy statement: children, adolescents, and television. *Pediatrics, 107*(2), 423–426. http://dx.doi.org/10.1542/peds. 107.2.423.

American Academy of Pediatrics. (2011). *Babies and toddlers should learn from play, not screens*. Elk Grove, IL: Author. Retrieved from: http://www.aap.org/pressroom/mediaunder2.pdf.

Barnett, W. S. (2003). *Low wages = low quality: Solving the real preschool teacher crisis*. New Brunswick, NJ: National Institute for Early Education Research.

Buckingham, D. (2007). *Beyond technology: Children's learning in the age of digital culture*. Cambridge, UK: Polity Press.

Calderhead, J. (1996). Teachers: beliefs and knowledge. In D. Berliner, & R. Calfee (Eds.), *Handbook of educational psychology* (pp. 709–725). New York: Macmillan Library Reference.

Christakis, D. A., & Garrison, M. M. (2009). Preschool-aged children's television viewing in child care settings. *Pediatrics, 124*(6), 1627–1632. http://dx.doi.org/10.1542/peds.2009-0862.

Christakis, D. A., & Zimmerman, F. J. (2007). Violent television viewing during preschool is associated with antisocial behavior during school age. *Pediatrics, 120*(5), 993–999. http://dx.doi.org/10.1542/peds.2006-3244.

Christakis, D. A., Zimmerman, F. J., DiGiuseppe, D. L., & McCarty, C. A. (2004). Early television exposure and subsequent attention problems in children. *Pediatrics, 113*(4), 708–713.

Clark, C. M., & Peterson, P. L. (1986). Teachers' thought processes. In M. C. Wittrock (Ed.), *Handbook of research on training*. New York: Macmillan.

Cuban, L. (1993). *How teachers taught: Constancy and change in American classrooms (1980–1990)* (2nd ed.). New York, NY: Teachers College Press.
Ertmer, P. A. (1999). Addressing first- and second-order barriers to change: strategies for technology integration. *Educational Technology Research and Development, 47*(4), 47–61.
Ertmer, P. A. (2001). Responsive instructional design: scaffolding the adoption and change process. *Educational Technology, 41*(6), 33–38.
Ertmer, P. A. (2005). Teacher pedagogical beliefs: the final frontier in our quest for technology integration? *Educational Technology Research and Development, 53*(4), 25–39.
Ertmer, P. A., Addison, P., Lane, M., Ross, E., & Woods, D. (1999). Examining teachers' beliefs about the role of technology in the elementary classroom. *Journal of Research on Computing in Education, 32*(1/2), 54–72.
Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teachers beliefs and technology integration practices: a critical relationship. *Computers and Education, 59*(2), 423–435. http://dx.doi.org/10.1016/j.compedu.2012.02.001.
Fisher, T. (2006). Educational transformation: is it like 'beauty' in the eye of the beholder, or will we know it when we see it? *Education and Information Technologies, 11*(3/4), 293–303. http://dx.doi.org/10.1007/s10639-006-9009-1.
Gray, L., Thomas, M., & Lewis, L. (2010). *Teachers' use of educational technology in US public schools: 2009 (NCES 2010-040)*. Washington, DC: National Center for Education Statistics, Institute for Education Sciences, U.S. Department of Education. Retrieved from: http://nces.ed.gov/pubs2010/2010040.pdf Accessed 30.01.13.
Huston, A. C., Anderson, D. R., Wright, J. C., Linebarger, D. L., & Schmitt, K. L. (2001). Sesame street viewers as adolescents: the recontact study. In S. M. Fisch, & R. T. Truglio (Eds.), *"G" is for growing: Thirty years of research on children and sesame street* (pp. 131–144). Mahwah, NJ: Lawrence Erlbaum Associates.
Hynes, K., & Habasevich-Brooks, T. (2008). The ups and downs of childcare: variations in child care quality and exposure across the early years. *Early Childhood Research Quarterly, 23*(4), 559–574. http://dx.doi.org/10.1007/s10639-006-9009-1.
Ifenthaler, D., & Schweinbenz, V. (2013). The acceptance of tablet-PCs in classroom instruction: the teachers' perspectives. *Computers in Human Behavior, 29*(3), 525–534. http://dx.doi.org/10.1016/j.chb.2012.11.004.
Inan, F., & Lowther, D. (2010). Laptops in K-12 classrooms: exploring factors impacting use. *Computers and Education, 55*, 937–944. http://dx.doi.org/10.1016/j.compedu.2010.04.0004.
Jennings, N. A., Hooker, S. D., & Linebarger, D. L. (2009). Educational television as mediated literacy environments for preschoolers. *Learning, Media, and Technology, 34*(2), 229–242. http://dx.doi.org/10.1080/17439880903141513.
Johnson, D. R., & Creech, J. C. (1983). Ordinal measures in multiple indicator models: a simulation study of categorization error. *American Sociological Review, 48*(3), 398–407.
Kagan, D. (1992). Professional growth among preservice and beginning teachers. *Review of Educational Research, 62*, 129–169. http://dx.doi.org/10.3102/00346543062002129.
Kaufman, M. (2012, December 16). *iPad invading the classroom*. Retrieved from: http://www.ipadinschools.com/author/mkaufman/ Accessed 04.03.13.
Lemke, C., Coughlin, E., & Reifsneider, D. (2009). *Technology in schools: What the research says: An update*. Culver City, CA: commissioned by Cisco Systems. Retrieved from: http://www.cisco.com/web/strategy/docs/education/TechnologyinSchoolsReport.pdf Accessed 25.01.13.
Lindahl, M., & Folkesson, A. (2012). ICT in preschool: friend or foe? The significance of norms in a changing practice. *International Journal of Early Years Education, 20*, 422–436. http://dx.doi.org/10.1080/09669760.2012.743876.
McManis, L. D., Simon, F., & Nemeth, K. (2012). *Voices from the field: 2012 National early childhood technology today survey*. Potomac, MD: Early Childhood Technology Collaborative. Retrieved from: <http://ecetech.net/> Accessed 13.05.13.
Mueller, J., Wood, E., Willoughby, T., Ross, C., & Specht, J. (2008). Identifying discriminating variables between teachers who fully integrate computers and teachers with limited integration. *Computers and Education, 51*(4), 1523–1537. http://dx.doi.org/10.1016/j.compedu.2008.02.003.
National Association for the Education of Young Children. (2012). *Position statement: Technology and young children*. Washington, DC: Author. Retrieved from: http://www.naeyc.org/content/technology-and-young-children Accessed 20.11.12.
National Education Association. (2008). *Access, adequacy, and equity in education technology: Results of a survey of America's teachers and support professionals on technology in public schools and classrooms*. Washington, DC: Author. Retrieved from: http://www.edutopia.org/files/existing/pdfs/NEA-Access, Adequacy, andEquityinEdTech.pdf Accessed 13.02.13.
National Institute for Early Education Research. (2012). *The state of preschool*. New Brunswick, NJ: Author. Retrieved from: http://nieer.org/sites/nieer/files/yearbook2012.pdf, Accessed 3.08.13.
National Research Council and Institute of Medicine. (2006). *Studying media effects on children and youth: Improving methods and measures*. Washington, DC: National Academies Press.
Ottenbreit-Leftwich, A. T., Glasewski, K. D., Newby, T. J., & Ertmer, P. A. (2010). Teacher value beliefs associated with using technology: addressing professional and student needs. *Computers and Education, 55*(3), 1321–1335. http://dx.doi.org/10.1016/j.compedu.2010.06.002.
Pajares, M. F. (1992). Teachers' beliefs and educational research: cleaning up a messy construct. *Review of Educational Research, 62*(3), 307–332. http://dx.doi.org/10.3102/00346543062003307.
Parette, H. P., Quesenberry, A. C., & Blum, C. (2010). Missing the boat with technology usage in early childhood settings: a 21st century view of developmentally appropriate practice. *Early Childhood Education Journal, 37*(5), 335–343. http://dx.doi.org/10.1007/s10643-009-0352-x.
Plowman, L., & Stephen, C. (2003). A 'benign addition'? Research on ICT and pre-school children. *Journal of Computer Assisted Learning, 19*(2), 149–164. http://dx.doi.org/10.1046/j.0266-4909.2003.00016.x.
Pynoo, B., Devolder, P., Tondeur, J., van Braak, J., Duyck, W., & Duyck, P. (2013). Predicting secondary school teachers' acceptance and use of a digital learning environment: a cross-sectional study. *Computers in Human Behavior, 27*, 568–575. http://dx.doi.org/10.1016/j.chb.2010.10.005.
Sheingold, K. (1991). Restructuring for learning with technology: the potential for synergy. *Phi Delta Kappan, 73*(1), 17–37.
Sirin, S. R. (2005). Socioeconomic status and academic achievement: a meta-analytic review of research. *Review of Educational Research, 75*, 417–453. http://dx.doi.org/10.3102/00346543075003417.
U.S. Census Bureau. (2012). *Income, Poverty, and Health Insurance Coverage in the United States: 2011–Current Population Reports*. Washington, DC: Author. Retrieved from: http://www.census.gov/prod/2012pubs/p60-243.pdf, Accessed 03.08.13.
Venkatesh, V., Morris, M., Davis, G., & Davis, F. (2003). User acceptance of information technology: toward a unified view. *MIS Quarterly, 27*(3), 425–478.
Vernadakis, N., Avgerinos, A., Tsitskari, E., & Zachopoulou, E. (2005). The use of computer assisted instruction in preschool education: making teaching meaningful. *Early Childhood Education Journal, 33*(2), 99–104. http://dx.doi.org/10.1007/s10643-005-0026-2.
Wachira, P., & Keengwe, J. (2010). Technology integration barriers: urban school mathematics teachers perspectives. *Journal of Science Education and Technology, 20*(1), 17–25. http://dx.doi.org/10.1007/s10955-010-9230-y.
Wartella, E., Schomburg, R. L., Lauricella, A. R., Robb, M., & Flynn, R. (2010). *Technology in the lives of teachers and classrooms: Survey of classroom teachers and family child care providers*. Latrobe, PA: The Fred Rogers Center.
Wood, E., Specht, J., Willoughby, T., & Mueller, M. (2008). Integrating computer technology in early childhood education environments: issues raised by early childhood educators. *The Alberta Journal of Educational Research, 54*(2), 210–226.
Wu, J., & Zhang, Y. (2010). Examining potentialities of handheld technology in students' academic attainment. *Educational Media International, 47*(1), 57–67. http://dx.doi.org/10.1080/09523981003654977.
Zhao, Y., Pugh, K., Sheldon, S., & Byers, J. L. (2002). Conditions for classroom technology innovation. *Teachers College Record, 104*(3), 482–515.
Zickuhr, K., & Smith, A. (2013). *Digital differences*. Washington, DC: Pew Research Center. Retrieved from: http://www.pewinternet.org/~/media//Files/Reports/2012/PIP_Digital_differences_041312.pdf. Accessed 03.08.13.
Zumbo, B. D., & Zimmerman, D. W. (1993). Is the selection of statistical methods governed by level of measurement? *Canadian Psychology, 34*, 390–400.