Center for Open Access in Science ▪ https://www.centerprode.com/ojer.html
Open Journal for Educational Research, 2017, *1*(1), 1-14.
ISSN (Online) 2560-5313 ▪ https://doi.org/10.32591/coas.ojer.0101.01001n

Evaluation of Instructional Technology: A Case Study of Early Childhood Teacher Candidates

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Received 17 November 2017 ▪ Revised 28 November 2017 ▪ Accepted 30 November 2017

Abstract

With the rise in technology use in early childhood classrooms, there is need to explore the strategies used to evaluate the effectiveness of such technology. Research indicates the proliferation of unvetted technology tools on the market and in online open source formats. Meaningful technology evaluation needs to be completed before, during, and after implementation in the lesson. Using a qualitative research design, data were collected from teacher candidates' post-practicum reflective essays and one-on-one interviews. Findings indicate that during practicum a few teacher candidates used sound pedagogical strategies to evaluate the appropriateness and effectiveness of instructional technology. Findings also reveal the need for cooperating teachers to have strong technology pedagogical strategies in order to help teacher candidates who may be struggling with technology integration and assessment strategies. Based on the findings it is recommended that early childhood teacher preparation and professional development programs address alternative ways to assess the effectiveness of instructional technology tools used in the classrooms.

Keywords: instructional technology, assessment, early childhood, teacher education, in-service teachers.

1. Introduction

Technology has transformed pedagogy in early childhood learning environments. Most early childhood classrooms today are equipped with some type of technology including but not limited to the following; smart boards, projectors, computers, and iPads. Fairly recent statistics indicate that more than 95% of teachers in the U.S. have access to computers and Internet in the classroom (NCES, 2010). In 2013, NCES reported that 71% of the U.S. population 3 years and over used the Internet. Inferring from the statistics, one can conclude that more than 90% of early childhood teachers (K-3rd grade) use computer technology with young children today. Today's early childhood technology research, debates and commentaries no longer question (see *Fool's gold, A critical look at computers in childhood*, 2000) whether technology should be fully integrated in childhood education but encourage it. Some encourage it through integration of STEM into early learning (Dossani, 2016). Major research funding agencies (such as the Caplan Foundation for Early Childhood Education, National Science Foundation (NSF), U.S. Department of Education, etc.), support research in early childhood education that seeks to increase knowledge and skills on how best to integrate STEM concepts in early learning curriculum. Some of the

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central questions now are: what type(s) of instructional technology tools are developmentally appropriate and effective to use with young children? How do teachers use technology with young children to enhance STEM concepts? These questions could be answered when teachers are consistent in collecting and analyzing instructional technology assessment data. Of all the concepts of STEM, this paper focuses on technology integration and use with young children.

Early childhood teachers integrate computer technology in the classroom using interactive software and media (McManis & Gunnewig, 2012; NAEYC, 2012; Zaranis, Kalogiannakis & Papadakis, 2013) to support activities such as; virtual field trips, simulations, webquests, and educational games (Jenkinson, 2009; ISTE, 2002; Ntuli & Kyei-Blankson, 2010; NAEYC, 2012). Research indicates that in addition to school district-purchased software, early childhood teachers spend time sifting through the Internet in search of additional online programs (or open source software) that are developmentally appropriate to infuse in their classroom activities (Shamburg, 2004). With all the effort that teachers are making to integrate technology, little is known about the effectiveness of such technology in young children's learning process and ability to transfer knowledge (Jenkinson, 2009; Ntuli & Kyei-Blankson, 2012; Shields & Behrman, 2000). The following summary of literature review is on technology integration in the classroom and evaluation of instructional technology.

2. Literature review

2.1 *Technology integration in the classroom*

The bulk of literature related to technology integration in the classroom focuses more on the theoretical design of instruction that integrates technology. It is assumed by such theoretical designs that evaluation of instructional technology is considered and embedded within the instructional planning process. Instructional technology design theory (ITDT) taught during teacher preparation follows such assumptions and it is insufficient; most teacher candidates on field experience/internship and some novice teachers struggle with application of the theory in authentic classrooms because they lack both personal and vicarious experiences (Brown, 2006; He & Cooper, 2011; Ertmer, 2005; Judson, 2006; Ma, Williams, Perejean, Lai & Ford, 2008). The reality is that most technology courses offered in teacher prep programs lack a meaningful field experience component (Bucci & Petrosino et. al., 2004; Ma, et al., 2008). In most cases, teacher candidates take field experience courses after completing technology courses which are mostly theoretical in nature. In ITDT there are integration models (such as the dynamic instructional design (DID) model by Lever-Duffy and McDonald (2011) and the technological pedagogical content knowledge (TPACK) model by Mishra and Koehler (2006)) that if applied appropriately in authentic classrooms, they result in effective technology integration. Based on the aforementioned theoretical frameworks, it is important to study how teacher candidates apply theory in the classroom, specifically, how they decide on the types of technology to use and/or how they evaluate the effects of such technology before, during, and after lesson implementation. Such feedback is important in order to evaluate the impact of instructional technology models used to teach technology integration and assessment/vetting/evaluation of instructional technology tools. This study is timely because millions of dollars are being invested in learning with technology in P-12 schools to boost STEM education (Amiel & Reeves, 2008; Bohlin, 2002; Chen, 2004; STEM for All, 2016); therefore, practical knowledge of how to evaluate the effectiveness of instructional technology tools invested in schools is necessary. Without the practical knowledge, lot of STEM funding and time will be wasted on tools that are not effective.

2.2 *Evaluation of instructional technology*

The issue of evaluating the effectiveness of educational technology tools has been raised mostly by researchers beyond the early childhood discipline (Karolcik, Cipkova & Hrusecky, 2015; Jenkinson, 2009; Robson & Schraw, 2008). Karolcik et al. (2015: 243) note that "despite the fact that digital technologies are more and more used in the learning and educational process, there is still lack of professional evaluation tools capable of assessing the quality of digital teaching aids in a comprehensive and objective manner". Jenkinson (2009: 263) argued that the current ways of evaluating the efficacy of educational technology are failing to "capture complex interactions that occur between the learner and the object". Robson and Schraw (2008) note that current studies that attempt to measure the effectiveness of educational technology report varied results. Some of the empirical research that supports the use of certain types of technology in learning is not founded on good research design and the results are flawed and biased. Though some of the results from such research are generalizable, the studies that led to the results have not been replicated to find out if the findings are reliable. Along the same lines, Reeves (2007: 274) argued that many of such studies are "one of quasi-experimental studies that are not linked to any particular research agenda". Chingos and Grover (2012) indicated that determining the effectiveness of any type of instructional materials through large-scale randomized experiments is rare because it is expensive and time consuming. In addition, they (*ibidem*: 6) argued that "many instructional materials have not been evaluated at all, much less with studies that produce information of use to policymakers and practitioners…this problem … worsens with the explosion of open-source web-based instructional materials". Most importantly, most of the studies have not considered this issue from the perspectives of early childhood teachers and very few of the studies have been carried out through the conduct of qualitative research. This article is based on the qualitative research conducted with pre-service early childhood teachers on how they evaluate the technology tools they use at K-3rd grade level during field experiences. The study sought to find out the ability of teacher candidates to apply theory into practice, specifically, the methods and process utilized in the evaluation of instructional technology tools before, during, and after implementation with students.

2.3 *Research question*

The overarching question that guided the study was: What strategies do early childhood teacher candidates use during internship to evaluate the effectiveness of the instructional technology materials before, during, and after use in their classrooms?

2.4 *Significance of the study*

This study is essential in that it contributes to the literature on teacher evaluation of technology tools by exploring this issue from the early childhood teacher candidates' perspective. It is important that teacher candidates learn from cooperating teachers alternative ways in which they might evaluate technology tools and programs, especially, in regards to open source web-based instructional materials that have so much to offer in the instruction and learning process. In addition, this study may help early childhood teacher preparation and technology professional development programs to reflect on how they infuse evaluation methods of instructional technology in the curriculum.

3. Method

3.1 *Research design, context, and participant selection*

In this study, a purposeful qualitative study which used typical sampling was employed to explore the strategies teacher candidates use to evaluate the effectiveness of instructional technology during internship (or field experience). Typical sampling in a purposeful study involves the selection of participants that best represent the population and the phenomenon under study (Edmonson & Irby, 2008; Merriam, 2009). It is important to note that early childhood refers to children from birth through age 8 (NAEYC, 2012). This study purposefully selected teacher candidates preparing to teach 5-8 year olds (K-3rd grade). Participants of the study included fifteen K-3 teacher candidates (three kindergarten, four 1st grade, three 2nd grade, and five 3rd grade teachers) who were enrolled in the college of education in a southeast Idaho university and had completed an instructional technology methods course and their first field experience. During field experiences, the teacher candidates were paired with a mentor teacher (or cooperating teacher). It is important to note that among the participants, four (one 1st grade, one 2nd grade, and two 3rd grade candidates) were in a blended early childhood program preparing to certify to teach in both general education and special education classrooms. The four candidates were placed in special education classrooms. The assumption in this study was that by collecting data from teacher candidates who were supervised by cooperating teachers (CTs), somehow, the study would capture what the pre-service teachers observed from CTs. (Informed consent was obtained from all participants of this study). Participation in the field experience required that the teacher candidates spent a total of 150 hours in the classroom. The candidate was to help with designing and planning for technology integrated lessons and activities, and implement at least six activities while being monitored by the CT (two of the six activities were formally evaluated by university supervisors). The field experience internship provided the teacher candidates with an opportunity to apply new technologies and technology integration methods learned from the instructional technology course into a real-life classroom, and to observe and learn how CTs integrate and evaluate the effectiveness of such technology tools.

3.2 *Summary of technology evaluation process*

Teacher candidates were expected to apply what they learned in instructional technology courses. There are processes that teachers should take before they integrate technology in the classroom. Table 1 summarizes the processes expected from early childhood teachers to ensure that they collect functional data about the appropriateness and effectiveness of tools they use with young children. The summary is developed from extensive research-based literature review that focuses on developmentally appropriate technology and early childhood technology evaluation instruments (Children's Technology Software Review, 2014; NAEYC, 2012; Haugland, 2005; Haughland & Wright, 1997; Haugland & Shade, 1994; Ntuli & Kyei-Blankson, 2012; Ntuli & Kyei-Blankson, 2013; Wardle, 2002). Information in Table 1 was used to develop the coding instrument to be discussed under data collection and analysis.

Table 1. Summary of the processes to be completed, before, during, and after technology implementation

Criteria	Processes
Before Implementation	Discuss with other teachers in the building the technology you want to implement or technology used by other (question what makes it developmentally appropriate or effective). Search for information about the tool on the Internet (specifically how to operate the tool with young children, whether the tool is developmentally appropriate* and could be customized). Read reviews online about how other teachers have used the tool (write down positives and negatives) Read peer-reviewed practitioner journals on the use of such technology with young children. Reflect on how to minimize the negatives if you were to use it in your classroom context. If the negatives can be minimized, plan for integration of the tool using an instructional design model. Develop an observational tool that will allow documentation of information about the tool as students use. (Include a checklist with desired behaviors or skills that students should be able to attain as they use the tool).
During Implementation	Monitor the students by moving around and observe how they use the tool. Use the observational tool to document what you see and hear. (The observational tool can include a checklist with pre-determined desired behaviors or skills that the teacher wants the student to attain as a result of using the tool, on the same observational tool, space for open-ended comments can be provided to document what the teacher sees/hears). As you move round, ask students if the tool is helping them to complete their task with ease or not.
After Implementation	Review students' final products. Review students' grades before and after implementation of the tool Interview students about the tool in groups and individually. Review students' journal entries about the tool. Guided reflection questions are important at elementary level. For instance, I like spellingcity.com because… or I had a difficult time using… Develop a rubric with students for self-evaluation after using the tool.

*Developmentally appropriate software is based on the following criteria: The content is age appropriate, the vocabulary is age appropriate, the software provides problem solving opportunities, the program begins with what children already know and gradually introduces the concepts, the software does not provide undesirable behaviors, the software encourages active involvement and stimulates the child's interest, the instructions are easy to follow, the program is easy to navigate and allows children to use the program independently, and the software allows children to make changes in the environment without receiving threatening feedback. The described criteria align with official description of age appropriate materials (NAEYC, 1996) and technology and media for young children (NAEYC, 2012).

3.3 *Data collection and data analysis*

Qualitative data were collected in two phases. In the first phase, data were collected from the teacher candidates' field experience reflective essays. Specifically, the researcher used a section of the reflective essays which required candidates to address the assessment/evaluation of instructional technology materials before, during, and after implementation. In the first phase data were coded and themes were generated and organized into categories and subcategories (Saldana, 2009). It is important to note that information in Table 1 was used to further organize themes into categories and subcategories. In the second phase, one-on-one semi-structured interviews were conducted to clarify data collected from reflective essays. The interviews with teacher candidates lasted approximately forty-five minutes each. Probing questions were used to acquire an in-depth understanding of the phenomenon under study. Data from the interviews were coded and analyzed for themes and patterns using open coding (Creswell, 2011; Saldana, 2009).

3.4 *Establishing credibility and trustworthiness of data collected*

To establish credibility and trustworthiness of qualitative data, the researcher used "triangulation" of data and "member checking" (Edmonson & Irby, 2008). Triangulation is a technique where the researcher engages in cross checking of data sources, and interpretation (Kreftings, 1991). In this study, triangulation involved cross checking data from the reflective essays, and interview data. Member checking involves giving the participants data to review for accuracy and check for inconsistencies (Edmonson & Irby, 2008; Kreftings, 1991; Lincon & Cuba, 1985). In this study the participants reviewed the transcribed interview data to confirm or disconfirm the reliability of the interpretations derived from the qualitative data. The reflective essay assignment guidelines were reviewed by a panel of instructional technology instructors to ensure content validity, and alignment with the program standards and ISTE technology standards for teachers. The interview protocol was reviewed by subject matter experts to ensure reliability and validity of the study (Cuba, 1981).

4. Findings

Data from the study were coded and used to answer the research question: What strategies do early childhood teachers use to assess the effectiveness of the instructional technology materials/tools before, during, and after instruction? Table 2 summarizes the major findings to be discussed in detail.

Table 2. Summary of technology evaluation strategies before, during, and after implementation

Criteria: Evaluation of instructional materials		**Kinder-garten (n=3)**		**First grade (n=4)**		**Second grade (n=3)**		**Third grade (n=5)**		**Evaluation strategy used**
Before lesson implementation	Reflective Essays	**x**		**x**		**x**		**x**		No information was provided
	Interviews	**x**		**x**		**x**		**x**		Interviews confirmed no teacher candidates took part in evaluation before implementation

During the lesson	Reflective Essays	✓		✓		✓		✓		Observations only
	Interviews	**x**	G	**x**	3G		2G		3G/ 2S	Observations and anecdotal notes Checklists
				✓	1S	**x**	1S	✓		
After lesson implementation	Reflective Essays	✓		✓		✓		✓		Review student products
		✓		✓		✓		✓		Review student grades
	Interviews	**x**		**x**		**x**		✓	3G	Student on-on-one or group interviews

✓ - indicates use of some evaluation strategy; **x -** no evaluation strategy reported; G - general education classroom; S - special education classroom.

4.1 *How do you evaluate the appropriateness and effectiveness of technology before integration in the lesson?*

The findings from the reflective essays show that irrespective of the grade level, none of the teacher candidates were involved in evaluating the technology tools prior to it being incorporated in the lesson. In the reflective prompt they were asked to explain how they evaluate technology tools before integration in the lesson. The following excerpts come from teacher candidates' reflective essays:

> **Excerpt 1** - Kindergarten teacher candidate: *"It was my assumption that the technology that was used in the classroom was evaluated by the CT [cooperating teacher] during the planning process. I did not get to use any of the tools that we compiled during in our course [instructional technology course]. The CT was not sure if my tools would be effective, she* [CT] *did not have time to review them. Because of that I used what she planned for".*

> **Excerpt 2** - Third grade teacher candidate: "*The technology that we used was recommended by other early childhood teachers in the same grade level … if the technology was a success in their class it meant we could use it. Teachers in our building usually share tools that they evaluated for appropriateness".*

It was surprising to read Excerpt 1, because all teacher candidates were expected to participate in the planning process. A follow up in the interview revealed that the teacher candidates had minimal participation in the planning process (except for a few lessons that the candidate actually implemented) as that was completed during the weekends or after hours by the CT.

One teacher candidate said:

> *"… most of the time I spent observing … she [CT] planned the lessons during the weekends … sometimes she worked on her lesson plans after school when I had to be back at ISU* [college] *for my evening classes … for those lesson plans that I designed and implemented, … I honestly forgot to use the evaluation rubric that you gave us in EDUC 3311 [instruction technology course].*

Another candidate said:

> "*I planned only for the lessons that were formally observed by the university supervisor … yes, I could have Googled and read what other teachers say about the tool but that skipped my mind".*

Excerpt 2 indicates that the teacher candidate believed an evaluation was completed by another teacher before implementation; therefore, the tool is appropriate for use in the same grade level. This is contrary to early childhood best practices which advocate for the need to engage in reevaluation of instructional materials by individual teachers (Aldridge & Goldman, 2007; Coople & Bredekamp, 2009; NAEYC, 2009). It is important to note that being developmentally appropriate does not imply that the tool is effective. The process of reevaluating instructional materials ensures that materials are adapted to meet the needs of individual students in a particular classroom context. All learning is situated, therefore, what works for one teacher may not work for another depending on the needs of the students.

4.2 *How do you assess the effectiveness of technology during lesson implementation?*

Findings from reflective essays corroborated by teacher candidate interviews show that, typically teacher evaluations during implementation were in the form of observations.

In a follow up interview, one first grade teacher candidate said:

> *"As students worked on the computers, I moved around monitoring if they were able to play the game … sometimes, I played the game to demonstrate how they should do it …".*

One kindergarten teacher candidate said:

> *"… at the technology center there is always someone to help monitoring the kids to complete the task … we were three in the classroom [the CT, teacher candidate, and an aid)".*

Though most teacher candidates indicated that they used observations, third grade teacher candidates and two special education candidates in 1st and 2nd grade indicated that they documented their observation data using checklists and anecdotal notes.

A 3rd grade teacher candidate in a special education classroom said:

> *"We [the CT and teacher candidate] planned ahead and wrote the skills on a checklist that students should be able to meet when they play the game … here is a checklist from my lessons [displaying a sample checklist (using an Ipad) from her technology integration e-portfolio]. This is very effective because when we looked at the checklist information [data], say over a period of two weeks, we were able to tell if the game is working [effectively] for the kids or not".*

A 2nd grade special education candidate said:

> *"My CT advised me to write anecdotal notes as I moved around observing the students. At times we needed to reflect on what we saw students doing or the questions that students asked as they worked on the computer. If we did not write notes we wouldn't remember exactly the problems we saw".*

Looking at the fact that all those placed in special education classrooms used some form of documentation of what they observed leads one to falsely believe that special education teachers are expected to track their students' growth more than general education teachers. Anecdotal records and checklists are highly encouraged at early childhood level when collecting data through observations (McAfee & Bodrova, 2006; McDevitt & Ormorod, 2013) because they

allow the teacher to have data for reflective thinking and decision making on whether the technology tool is effective or not.

4.3 *How do you evaluate the effectiveness of technology after lesson Implementation?*

Findings show that evaluation of the effectiveness of technology after lesson implementation involved reviewing and grading students' assignments (or products) to make decisions concerning the effectiveness of the technology used.

In the reflective essays, one kindergarten teacher candidate wrote:

> "*…after grading I check to see if students' scores are high. If the performance is high it means the technology is working."*

A first grade teacher candidate wrote:

> *"…it depends on the quality of what the students are able to produce using the technology …".*

Relying on such strategies alone is limited because teachers are not able to account with certainty if the objectives were met as a result of using the technology. It could be that objectives were met due to other instructional materials that supplement the instructional technology materials used in the class.

Interviews also provided another dimension that was not mentioned by teacher candidates in K-2 grade level. Teacher candidates at third grade general classrooms indicated that they interviewed their own students to learn the extent to which students thought the technology was effective.

One teacher candidate said:

> *"After using technology … I usually have a one-on-one interview with students … I sample students … I can't interview all the students…only the high achieving, the mediocre, and the low achieving. I ask questions such as - was the game [technology tool] helpful? Did you learn anything [new skills] as a result of playing the game? Tell me three things [skills] you learned. Were you able to finish your task? Questions vary depending on the tool that students used".*

Another teacher candidate said:

> *"My question after the lesson is-will you use it [the tool] again? If not why … and if yes why? This question is powerful because I get to know what makes the technology effective. If I hear the same [negative] answer from more than half of the students … that tool is out … I try another one".*

Interviewing or questioning students to determine the effectiveness of the technology tools in the classroom is one way that is highly recommended (Robyler & Doering, 2013). It is important to introduce higher-order questioning from kindergarten so that young children develop critical thinking skills that help them make good and appropriate choices. Questioning students about the technology tools should not only come at the end of the lesson; teachers should ask questions about how the tool is working during the lesson (Lever-Duffy & McDonald, 2011). Lever-Duffy and McDonald emphasize the need for continuous feedback from students when teaching with technology. This helps with the overall feedback required to make decisions on whether to continue integrating that specific technology tool. In some cases, teachers may decide to continue with the integration, however, with the use of scaffolds depending on what the student interview data would have suggested.

Assessment of instructional materials after the lesson should provide a holistic picture of the effectiveness of the instructional materials. In addition to what the candidates mentioned, teachers may use alternative strategies such developing rubrics and electronic portfolios (Barret, 2001; Roblyer & Doering, 2012). Teachers need to be encouraged to develop technology rubrics that may be used by both the students and the teachers to evaluate the effectiveness of the technology (Ntuli & Kyei-Blankson, 2013). Electronic portfolios where students' work is collected over time should include artifacts such as reflective notes on instructional technology tools that helped the students to accomplish the task. With young children the teacher can use guided reflective prompts (such as, "I like using … to learn my letter sounds or the program … was helpful in learning about fractions"). Such kind of portfolio artifacts helps the teacher when reflecting on the effectiveness of technology tools integrated in the classroom over time.

4.4 *Unique findings*

One reflective essay documented one kindergarten special education teacher's way of assessing the effectiveness of technology during and after the lesson. The teacher candidate described how the CT adapted concurrent time series probe approach (CTSPA) which has been found to help teachers with technology outcomes documentation (Parette, Blum, & Boeckmann, 2009; Smith, 2000). The CTSPA has been used in documenting the effectiveness of assistive technology and it involves the teacher in collecting performance measures of a child completing a specific activity; both with and without technology over a period of time, with the teacher making a decision about a reasonable length of time to collect the data (Edyburn, 2002). The candidate observed the CT collecting student performance data with and without technology for a month to find out the difference (increase or decrease) in the number of students meeting objectives. Collection of authentic assessment data about the tool and student performance over a period of time for decision making is highly recommended in early childhood education (Johanson, Bell, & Daytner, 2008; McAfee, Leong & Bodrova, 2006). In this case, not only did the candidate learn about and evaluation strategy but the importance of having a data storage system in place to easily store and analyze the effectiveness of the instructional technology tools. Such kind of unique experiences during practicum is enriching to teacher candidates.

Another unique strategy emerged from interviewing a third grade teacher candidate. The candidate indicated that they invented the use of the red-cards-up strategy with students. The candidate described the red-cards-up as a technique where students are required to individually raise a red card during the lesson as a way of alerting the teacher when they need scaffolding. The more the teacher has red cards up in a technology-integrated activity; the more likely it is that the technology tool is not effective. This strategy has a potential to be effective because of the notes in front ("I will use the tool again") and back ("I will not use the tool again"). If one uses the technique appropriately and consistently, they may be able to gather effective assessment data that measures the effectiveness of instructional technology materials. The notes on the cards play an important role in helping young students to decide if they will use the tool again. The teacher collects the cards in two piles at the end of the lesson (organized by students' choice either front or back) for further documentation about the tool.

5. Discussion

In this study, all teacher candidates did not participate in the evaluation of technology tools before implementation. It is troubling considering the fact that teacher candidates learned (in technology integration course) about the processes they need to take to ensure the appropriateness and effectiveness of the tools they use with young children. In addition, the teacher candidates were paired with CTs so that they could learn from them. However, data

indicates that some teacher candidates had little interactive planning time with the CTs. This defies the main purpose of field experience for teacher candidates; that is to have authentic classroom experience with mentorship. Intentional and focused communication between the CT and instructional technology instructors is needed to clarify the role of teacher candidates in the classroom, and a discussion of the nature of reflective essays or any other artifacts from the field experience is necessary. Not taking away the credit from some CTs who had unique strategies that they shared with teacher candidates, it is expected that CTs provide more of such opportunities for candidates. If the CTs have limited technology pedagogical and assessment knowledge, they need to be encouraged to take technology professional development.

While data from this study did not yield information on how teachers evaluate instructional technology prior to the lesson, early childhood education research strongly encourage evaluation of technology before implementation to ensure that it is aligned with early childhood curriculum and integration methods. Though most teacher candidates used observation strategy to evaluate technology during implementation, they did not practice rigor in documentation of the observed data, and there is no consistency across grade levels in terms of the strategies used. Overall, the study reveals that teacher candidates have limited strategies and skills to evaluate technology in real classrooms despite comprehensive preparation during teacher training. One teacher said they forgot to use the evaluation instrument that they learned about in one of the technology courses. Early childhood teacher training programs need to encourage teachers to engage in the process of evaluating instructional technology all the time to ensure that instructional materials are developmentally appropriate, and that they are helping diverse students to achieve the learning outcomes. The argument this study brings forth is that early childhood cooperating teachers need to apply assessment strategies and techniques consistently with teacher candidates; the strategies should align with what is advocated by early childhood research and best practices when it comes to the evaluation of the effectiveness of early childhood instructional technology materials. This should be reinforced in professional development programs. The professional development curriculum may infuse alternative evaluation strategies such as those presented in Table 1 that are based on extensive review of early childhood educational technology and media materials (Buckleitner, 1999; NAEYC, 2012; Haugland, 2005; Haughland & Wright, 1997; Haugland & Wright, 1997; Haugland & Shade, 1994; Ntuli & Kyei-Blankson, 2012; Ntuli & Kyei-Blankson 2011).

5.1 *Conclusion and recommendations*

Teacher preparation and professional development programs have a task to bring awareness to teacher candidates and in-service teachers about the importance of evaluating instructional technology materials, before, during, and after technology integration. Even though literature reveals how challenging it is to assess the impact of instructional technology materials, that should not encourage early childhood teachers to adopt instructional technology materials without individually assessing if they are effective enough to meet the diverse needs of the students in different classroom contexts. Given the potential that technology has to increase cognitive developmental gains in early childhood, and to support a variety of learning styles, empirical research that examines alternative strategies currently used to evaluate the effectiveness of early childhood instructional technology materials is crucial. Such feedback is not only necessary to compile evaluation strategies that work but also to categorize efficient early childhood instructional technology tools. Those who make software would be more focused in developing functional technology for early childhood education.

References

Aldridge, J., & Goldman, R. (2007). *Current issues and trends in education* (2nd ed.). Boston, MA: Pearson Education, Inc.

Alliance for Childhood (2000). Fool's gold: A critical look at computers in childhood. Retrieved January 8, 2016, from http://drupal6.allianceforchildhood.org/fools_gold.

Amiel, T., & Reeves, T. C. (2008). Design-based research and educational technology: Rethinking technology and the research agenda. *Educational Technology & Society, 11*(4), 29–40.

Barrett, H. (2001). *Electronic portfolios*. Retrieved January 20, 2014, from http://electronicportfolios.org/portfolios/encyclopediaentry.htm.

Bohlin, R. (2002). *Avoiding computer avoidance*. Retrieved April 2, 2014, from http://it.coe.uga.edu/itforum/paper35/paper35.html.

Bucci, T.T., Petrosino, A. J., Bell, R., Cherup, S., Cunningham, A., Dickinsion, G., Ervin, J., Hofer, M., & Wetzel, K. (2004). Meeting the ISTE challenge in the field: An overview of the first six distinguished achievement award winning programs. *Journal of Computing in Teacher Education, 21*(1), 11-21.

Buckleitner, W. (2006). The relationship between software design and children's engagement. *Early Education and Development, 17*(3), 489-505.

Buckleitner, W. (1999). The state of children's software evaluation – Yesterday, today and in the 21st century. *Information Technology in Early Childhood Education*, 211-220.

Caplan Foundation for Early Childhood (2016*). ASSET STEM Education,* Retrieved November 19, 2016, from http://earlychildhoodfoundation.org/.

Chen, L.-L. (2004). Pedagogical strategies to increase pre-service teachers' confidence in computer learning. *Educational Technology & Society*, *7*(3), 50-60.

Children's Technology Review (2014). Retrieved May 20, 2014, from http://childrenstech.com/.

Creswell, J. W. (2011). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. Upper Saddle River, NJ: Pearson Education, Inc.

Copple, C., & Bredekamp, S. (2009). *Developmentally appropriate practice in early childhood programs serving children from birth through age 8*. Washington, DC: National Association for the Education of Young Children.

Dossani, R. (2016). Integrating STEM learning in early childhood education. *US. News & World report,* retrieved July 8, 2016, from http://www.rand.org/blog/2016/06/integrating-stem-learning-in-early-childhood-education.html.

Edmondson, S. & Irby, B. (2008). *Ten tips for producing a top qualitative research study*. Boston, MA: Pearson Education, Inc.

Eliason, C., & Jenkins, L. (2008). *A practical guide to early childhood education curriculum* (9th ed.). Upper Saddle River, NJ: Pearson Education Inc.

Flagg, B. N. (2013). *Formative evaluation for educational technologies*. NY: Routledge, Taylor & Francis Group.

Gall, M., Borg, W., & Gall, J. (2006). *Educational research: An introduction*. White Plains: Longman.

Haugland, S. (2005). Selecting or upgrading software and web sites in the classroom. *Early Childhood Education Journal, 32*(5), 329–340.

Haugland, S., & Wright, J. (1997*). Young children and technology: A world of discovery*. New York: Allyn and Bacon.

Haugland, S. W., & Shade, D. D. (1994). Software evaluation for young children. In J. A. Wright & D. D. Shade (Eds.). *Young children: Active learners in a technological age* (pp.63-76). Washington, DC: NAEYC Press.

Herring, M., Mishra, P., & Koehler, M. (2008). *Handbook of technological pedagogical content knowledge (TPCK)*. Routledge, NY: The AACTE Committee on Innovation and Technology.

ISTE. (2002). *Using model strategies for integrating technology into teaching*. Retrieved January 7, 2014, from http://www.iste.org/docs/excerpts/NETTB2-excerpt.pdf.

Jenkinson, J. (2009). Measuring the effectiveness of educational technology: What are we attempting to measure? *Electronic Journal of e-Learning, 7*(3), 273-280.

Johanson, J., Bell, C., & Daytner, K. (2008). *Evaluating the effectiveness of a technology-based preschool literacy project: A final report of the LitTECH outreach project*. Retrieved March 10, 2014, from http://files.eric.ed.gov/fulltext/ED502331.pdf.

Judson, E. (2006). How teachers integrate technology and their beliefs about learning: Is there a connection? *Journal of Technology and Teacher Education, 14*(3), 581-597.

Karolcik, S., Cipkova, E., & Hrusecky, R. (2015). The comprehensive evaluation of electronic learning tools and educational software (CEELTES). *Informatics in Education, 14*(2), 243-264.

Lever-Duffy, J., & McDonald, J.B. (2011).*Teaching and learning with technology* (4thed.). Boston, MA: Pearson Education, Inc.

Ma, Y., Williams, D., Prejean, L., Lai, G., & Ford, M. J. (2008). A model for facilitating field experience in a technology-enhanced model pedagogical laboratory. *Journal of Computing in Teacher Education, 24*(3), 105-109.

McAfee, O., Leong, D. J., & Bodrova, E. (2006). *Basics of assessment: A primer for early childhood educators*. Washington, DC: National Association for the Education of Young Children.

McDevitt, T. M., & Ormrod, J. E. (2013). *Child development and education* (5th Ed.). Boston: MA, Pearson Education, Inc.

McManis, L. D., & Gunnewig, S. B. (2012). Finding the education in educational technology with early learners. *Young Children*, *67,* 14-25.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A new framework for teacher knowledge. *Teachers College Record 108*(6), 1017-1054.

National Association for the Education of Young Children (NAEYC). (2012). *Technology and interactive media as tools in early childhood programs serving children from birth through Age 8*. Retrieved August 16, 2014, from http://www.naeyc.org/files/naeyc/file/positions/PS_technology_WEB2.pdf.

National Association for the Education of Young Children (NAEYC). (2009). *Developmentally appropriate practice in early childhood programs serving children from birth through age 8*. Retrieved January 16, 2014, from http://www.naeyc.org/files/naeyc/file/positions/position%20statement%20Web.pdf.

National Association for the Education of Young Children NAEYC. (1996). NAEYC position statement: Technology and young children. *Young Children, 51*(6), 11–16.

National Center for Education Statistics (NCES). (2013). Fast facts: Computer and internet use. Retrieved November 20, 2016, from https://nces.ed.gov/fastfacts/display.asp?id=46.

National Center for Education Statistics (NCES). (2010). *Fast facts: Educational technology*. Retrieved June 14, 2016, from, https://nces.ed.gov/fastfacts/display.asp?id=46.

Ntuli, E., & Kyei-Blankson, L. (2013). Teacher assessment in technology: Integrated early childhood classrooms. In Wang, V. C. X. (Ed.), *Handbook of Research on Teaching and learning in K-20 Education* (pp. 300-316). PA: Hershey, IGI Global.

Ntuli, E., & Kyei-Blankson, L. (2012). Teacher assessment of young children learning with technology in early childhood education. *International Journal of Information Communication and Technology Education, 8*(4), 1-10.

Ntuli, E., & Kyei-Blankson, L. (2010). Teachers' understanding and use of developmentally appropriate computer technology in early childhood education. *Journal of Technology Integration in the Classroom, 2*(3), 23-35.

Parette, H. P., Blum, C., & Boeckmann, N. M. (2009). Evaluating assistive technology in early childhood education: The use of a concurrent time series probe approach. *Early Childhood Education Journal, 35*, 5-12.

Reeves, T.C. (2007). Design research from a technology perspective. In J. Van Den Akker et al. (Eds.), *Educational Design Research* (pp. 52-66). Routledge, New York.

Robinson, D. H., & Schraw, G. (2008). A need for quality research in e-learning. In D. H. Robinson and G. Schraw (Eds.), *Current perspectives on cognition, learning, and instruction: Recent innovations in educational technology that facilitate student learning* (pp. 1-9). Charlotte, NC: Information Age.

Roblyer, M.D., & Doering, A. H. (2012). *Integrating educational technology into teaching* (6th ed.). Boston: MA, Pearson Education, Inc.

Saldana, J. (2009). *The coding manual for qualitative researchers*. Thousand Oaks, CA: Sage Publications.

Scardamalia, M., & Bereiter, C. (2006). Knowledge Building: Theory, pedagogy, and technology. In K. Sawyer (Ed.), *Cambridge Handbook of the Learning Sciences* (pp. 97-118). New York: Cambridge University, Press.

Shamburg, C. (2004). Conditions that inhibit the integration of technology for urban early childhood teachers. *Information Technology in Childhood Education Annual, 2004*(1), 227-244.

Shields, M. K., & Behrman, R. E. (2000). Children and computer technology: Analysis and recommendations. *The Future of Children, 10*(2), 4-30.

Smith, R. O. (2000). Measuring assistive technology in education. *Diagnostique*, *25*, 273-290.

STEM for All. (2016). *Summary: The administration is working to expand STEM education and employment opportunities to all students*. Retrieved February 11, 2016, from https://www.whitehouse.gov/blog/2016/02/11/stem-all.

Wardle, F. (2002). The role of technology in early childhood programs. Retrieved January 28, 2014, from http://www.earlychildhoodnews.com/earlychildhood/article_view.aspx?ArticleID=302.

Zaranis, N., Kalogiannakis, M., & Papadakis, S. (2013). Using mobile devices for teaching realistic mathematics in Kindergarten education. *Creative Education*, *4*(7), 1-10.