

FINAL REPORT

Uses of Technology to Support Early Childhood Practice



Use of Technology to Support Head Start Practice



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Overview

Technology has become increasingly prevalent in early care and education settings, yet little is known about the effectiveness, function, and requirements for technologies that are available to early childhood programs. As such, the Administration for Children and Families (ACF) Office of Planning Research and Evaluation (OPRE) contracted with NORC at the University of Chicago to review the knowledge base related to the use of technology to support the practice of early childhood practitioners who work directly with children and families.

The review was designed to examine uses of technology among four Topic Areas of interest to ACF/OPRE. The first three Topic Areas focused on early childhood practitioners' use of technology to support 1) instruction and assessment, 2) parent, family and community engagement (PFCE), and 3) professional development and informal learning. The fourth Topic Area outlined barriers to and facilitators of practitioners' effective use of technology to support early childhood practice. NORC employed three methods to complete the review: a web search to obtain a broad sampling of both common and cutting-edge uses of technology; a search of academic databases to establish an evidence-base for the technologies; and interviews with 16 experts who have built, used, or evaluated these technologies. This report presents findings from this review.

Key Findings

- **The integration of curricula and assessments via technology is enabling practitioners to better track child progress and individualize instruction.** Developers are building software packages that can capture assessment data, score it, and provide data-based instructional suggestions instantaneously. Results can be used to differentiate instruction to an individual child or aggregated across multiple children to form small groups. The technologies allow for objective data based decision making for instruction.
- **Video and traditional software are the two most common technologies to support PFCE.** The prevalence of these technologies is consistent with the two primary objectives for PFCE technology use – to develop and maintain positive relationships through regular communication, and to build parents' skills by sharing facts, ideas, and exemplars with children's parents.
- **Effective professional development products/programs use a variety of video technologies to communicate with practitioners, model behavior, and critique practice.** Video had the strongest evidence base for a professional development technology. Live video conferencing connects practitioners with expert coaches remotely. Recordings of high quality teaching provide practitioners with quality exemplars to model practice. Video recordings of one's own practice allow for self-reflection and third party review and critique.
- **Administrators play a key role in either encouraging or hindering practitioners' use of technology.** Providing adequate resources, training, and technical support, leading by example, and recognizing high performing staff, are among the most effective strategies to encourage successful practitioner use of technology.

Strong empirical evidence demonstrating effectiveness can engender support for technology use among administrators and practitioners. However, the existing evidence base for the use of current technologies to support early childhood practice is sparse. To inform practice, studies that produce evidence of effectiveness for current technologies in a timely manner are needed.

Executive Summary

Over the past two decades, technology has become increasingly prevalent in early care and education settings, growing out of the recognition that technology may be used to improve program practice and, ultimately, children’s learning and development (Barron, Kemker, Harmes, & Kalaydjian, 2003; Diamond, Justice, Siegler, & Snyder, 2013; NAEYC, 2012). Unfortunately, little is known about the effectiveness, function, and requirements for technologies that are available to early childhood programs. Prompted by this gap in knowledge and the increasing prevalence of technology in early childhood settings the Administration for Children and Families (ACF) Office of Planning Research and Evaluation (OPRE) contracted with NORC at the University of Chicago to conduct a literature review and expert consultations to better understand how technology can be used to support and improve the quality of practice of early childhood practitioners.

The goal of the project was to review the knowledge base related to the use of technology to support the practice of early childhood professionals who work directly with children and families. To accomplish this goal, the review answers seven specific research inquiries within four Topic Areas of interest to ACF/OPRE (see Table 1). The first three Topic Areas describe early childhood practitioners’ use of technology while the fourth Topic Area outlines barriers and facilitators of practitioners’ effective use of technology to support early childhood practice.

Table 1.1 Specific Research Inquiries by Topic Area

Topic Area	Research Inquiry
1. Instruction and Assessment	1.1 What technologies are commonly used in early childhood settings with children to support instruction and assessment?
	1.2 How do practitioners use technology with children for instruction and assessment?
	1.3. How is technology used to track progress and individualize instruction/services to children?
2. Parent, Family, and Community Engagement (PFCE)	2.1 What technologies are commonly used to support parent, family and community engagement (PFCE)?
3. Professional Development and Informal Learning	3.1. In what ways has technology been used effectively to provide professional development and training for early childhood practitioners (e.g., product-specific training, prescribed coaching and mentoring)?
	3.2. How do early childhood practitioners use technology to support informal learning (e.g., independent learning, peer collaboration)?
4. Facilitators and Barriers	4.1. How did early childhood programs (Head Start in particular) that successfully implement technology overcome barriers to implementation?
	4.2. Is staff development a factor limiting the fidelity of implementation of technology in early childhood settings?

Methodology

The review team employed three methods to address these research inquiries. First, the team conducted a web search to obtain a comprehensive sampling of both common and cutting-edge uses of technology that support early childhood practice. Second, the team conducted a search of academic databases, establishing an evidence base through the identification of literature that evaluated the impact of the technologies and/or technology using programs on child, family, or practitioner outcomes. Finally, the team interviewed sixteen early-childhood and technology experts (i.e., researchers and developers) who have built, used, or evaluated these technologies and associated technology-mediated programs. These experts provided first-hand descriptions of the facilitators and barriers to effective technology use by early childhood practitioners.

Findings and Conclusions

Below, the evaluation team offers our conclusions from our review of the knowledge base on the use of technology to support the practice of early childhood professionals who work directly with children and families. The results are intended to fill a knowledge gap regarding what technologies are currently available to early childhood programs; how practitioners are using these technologies on a regular basis; the effectiveness of these technologies to improve practitioner, child and family outcomes; and the requirements necessary for practitioners to use these tools effectively. As such, the search was guided by seven research inquiries focused on four primary areas of interest to ACF/OPRE: 1) Topic Area 1: Instruction and Assessment, 2) Topic Area 2: Parent, Family and Community Engagement (PFCE), 3) Topic Area 3: Professional Development and Informal Learning; and 4) Topic Area 4: Facilitators and Barriers to Technology Use. A brief summary of the results for each Research Inquiry within Topic Area is provided below.

Topic Area 1 – Instruction and Assessment

Topic Area 1 explored the potential of current and emerging technologies to support practitioners' instruction and assessment of young children.

1.1 What technologies are commonly used in early childhood settings with children to support instruction and assessment?

Our web-search identified 12 technologies (i.e., hardware, software and video) that early childhood practitioners are currently using to support instruction and assessment. Hardware includes: computers, interactive books, interactive whiteboards, mobile devices, movement sensors, multi-touch tables, and proprietary computers. Software includes: apps for mobile devices, eBooks, software as a service (SaaS), in which software is delivered via the Internet and a service provider hosts, maintains, and provides technical support remotely, and traditional software.

Because the instruction and assessment Topic Area is so broad, we present the use of these technologies within three more focused categories: 1) curricula and instructional tools; 2) assessments; and 3) integrated curricula and assessments. Curricula frequently use computers and traditional software to deliver content to children. More cutting edge curricula feature web-based materials in the form of SaaS. Instructional tools are intended to assist practitioners with direct instruction, often with the ability to engage multiple children at once. Instructional tools and technologies are generally one in the same. That is, an instructional tool is a technology; it does not use a technology to perform another task. Examples of instructional tools include interactive whiteboards and multi-touch tables. Assessments use computers and SaaS, typically to enter data

and report results. Newer technology is allowing practitioners to collect assessment data directly on mobile devices and upload the data directly to the SaaS via the Internet. Integrated curricula and assessments also commonly use computers and software (particularly SaaS). The software for these products/programs requires immediate access to assessment data so it can make accurate instructional suggestions. Given this interdependence, integrated curricula and assessments often require the use of technology (i.e., it is not optional). As with standalone assessments, developers of integrated curricula and assessments are actively adapting their products/programs for use on mobile devices.

1.2 How do practitioners use technology with children for instruction and assessment?

In order to learn how practitioners use technology to support instruction and assessment, we searched for products/programs that use the 12 technologies described in 1.1. The 53 resulting products/programs are concrete examples of how practitioners use technology to instruct and assess children. Technology was an integral component of two-thirds of the products/programs (i.e., technology-first), meaning that the product/program could not function properly without the use of technology. Of the 53 products/programs, 20 used technology with a curriculum or as an instructional tool, 11 with an assessment, and 22 with an integrated curriculum and assessment. The 22 integrated curricula and assessments enable practitioners to simultaneously track progress and individualize instruction and are therefore discussed in more detail under Inquiry 1.3.

The search identified 20 curricula and instructional tools. In regard to curricula, practitioners frequently use computers and traditional software to deliver curricular content to children. More cutting edge curricula feature web-based content, often as SaaS. The advantage of a web-based curriculum is that it can be made available to both practitioners and families (e.g., *ABCMouse.com*). It can also be updated more frequently than paper-based curricula. Whereas practitioners use technologies to convey information within a specific curriculum to children, they also use instructional tool technologies to facilitate general instruction. For example, practitioners can use interactive whiteboards to involve children in interactive lessons provided by curriculum developers. They can also use whiteboard software to develop their own lessons. The touch-activated nature of interactive whiteboards and multi-touch tables are particularly engaging for young children.

With respect to the 11 assessments, practitioners typically use computers and SaaS to enter data and obtain outcome reports. In the absence of technology, practitioners must conduct an assessment with paper and pencil, and then score the results on the paper record form. Some assessments may have a paper report template that the practitioner must also complete. With technology, practitioners enter data into the assessment's software package. The software then scores the assessment data and produces a report. Computerized scoring and reporting reduces potential for error. Newer technology is allowing practitioners to collect assessment data directly on mobile devices, eliminating the need to transfer data from a paper form. Some cutting edge assessments are eliminating data entry altogether by having children respond to assessment items directly, typically on a mobile device's touchscreen (e.g., *mCLASS:CIRCLE*).

1.3 How is technology used to track progress and individualize instruction/services to children?

Integrated curriculum and assessment packages are designed specifically to track student progress and individualize instruction to children. Integrated curricula and assessments are typically powered by traditional software or SaaS, and operate on non-proprietary hardware (e.g., a computer, a mobile

device). Practitioners collect assessment data on a mobile device (e.g., tablet computer) or desktop computer, which is then saved to a web-based SaaS. The software automatically scores the assessment and offers the practitioners instructional suggestions based on assessment results.

Advances in technology have allowed these packages to provide practitioners with timely and accurate information that supports effective data-based decision making. These packages often have the ability to track progress and provide instructional suggestions for a single child or for multiple children. Aggregating data across multiple children allows the program to suggest small groups based on objective data. The algorithms that make these suggestions, either for groups of children or for a single child, are typically based on scientific research. Overall, the intentional integration of an assessment and curriculum via technology allows the practitioner to not only instantaneously assess, score, and obtain reports on child outcomes, but also receive immediate, evidence-based instructional suggestions. Fully-integrated technology-first curricula and assessments are becoming widely available to early childhood practitioners. Given that these potential advantages afforded by this cutting-edge technology, many developers, researchers and companies are currently working to create new or integrate existing curricula and assessments.

Topic Area 2 – Parent, Family, and Community Engagement

Topic Area 2 focused on technologies practitioners use to support parent, family, and community engagement (PFCE). Given the broad range of activities that constitute PFCE, we focused our review on those technology-enhanced products/programs that support parent learning, parent engagement with their children, and parent engagement with early childhood programs and practitioners. In keeping with the scope of this review, we examined only those technology-enhanced PFCE products/programs that require the direct involvement of an early childhood practitioner. As such, PFCE products/programs that do not require direct practitioner involvement were not reviewed.

2.1 What technologies are commonly used to support parent, family and community engagement (PFCE) for children?

The web search identified seven technologies that early childhood practitioners use to support PFCE. Hardware included: computers, mobile devices, and the Language ENvironment Analysis (LENA) system, which consists of a digital audio recorder and analytic software package that objectively measures a child's home language environment. Software included: traditional software, SaaS, and apps. An additional technology used to support PFCE was video. Of the 13 PFCE products/programs identified through the web search, the majority required technology for proper use (i.e., 70% technology-first). The most frequently utilized technologies included video and traditional software, which were designed to operate on existing hardware (i.e., computer or mobile device, not proprietary hardware). The prevalence of these two technologies is in keeping with the two primary objectives for PFCE technology use – to build and maintain positive social relationships through more regular communication, and to share facts, ideas, and exemplars or build skills with parents or families. Almost 40% of the PFCE products/programs used video technology to 1) model ideal parent behaviors (pre-recorded video), and/or 2) serve as an objective measure for self-critiquing a parent's behavior or a source for coaching. Another 40% used software to enhance PFCE activities, particularly to present parent educational materials (e.g., power point presentations).

While the goals and therefore outcomes of the two PFCE exemplars (i.e., *Play and Learning Strategies* and *Thirty Million Words Initiative*) differed, they both shared the same theory of change – home

visitors educated parents in an effort to change parent behavior so as to improve child outcomes. The empirical evidence from their evaluative studies suggests that high quality PFCE interventions, particularly those that use video exemplars and video feedback, have a positive impact on a variety of both parent outcomes (e.g., parental responsiveness, emotional well-being) and child outcomes (e.g., language, cognitive function, attachment).

Topic Area 3 – Professional Development and Informal Learning

Topic Area 3 focused on technologies practitioners use to support their own professional development (e.g., in-service programs for pedagogical strategies and subject areas; training on product-specific implementation and enrichment) or engagement in informal learning (e.g., independent learning and peer collaboration).

3.1 In what ways has technology been used effectively to provide professional development and training to early childhood practitioners (e.g., product-specific training, prescribed coaching and mentoring)?

The web-search uncovered 21 technologies that early childhood practitioners use to support formal professional development. These technologies were classified into four main categories: video-enabled professional development, online coursework, social media networking, and other. Video-enabled professional development technologies included: video exemplars, multi-media or email feedback from a coach or trainer based on video review, case-based hypermedia resources, which include web-links to and/or digital copies of articles and video exemplars written for an early childhood audience, web-mediated coaching, video self-reflection, product training and implementation videos. Practitioners used video-centered professional development technologies for learning and communication. Social media networking technologies included common commercial social networking sites, community specific social networking sites, blogs, forums and photo/video sharing technologies. Practitioners used social media networking technologies to connect with other early childhood professionals. Practitioners used other technologies for formal professional development including: audio self-reflection, online document libraries and user guides, online reliability exercises/tests, user resource exchanges, audio recordings, teleconferences, online peer-to-peer interaction, and webinars (live and/or archived).

In addition to identifying technologies, a broad but not exhaustive web-search identified 50 unique products/programs that use one or more of the technologies to support professional development. The most common technologies among professional development products/programs were: webinars, online document libraries and user guides, online courses, product training and implementation videos, and video exemplars. To understand which technologies have been used *effectively* to support professional development, we examined the evaluative literature for all 50 products/program. Despite the prevalence of webinars within professional development, we found no evaluative literature describing the effects of webinars on practitioner or child outcomes. Instead, the vast majority of literature examined video-enabled professional development technologies; specifically video exemplars and video feedback provided by a coach or trainer. The results of these evaluations suggest that video-enabled professional development can have a positive impact on both practitioner and child outcomes.

3.2 How do early childhood practitioners use technology to support informal learning (e.g., independent learning, peer collaboration)?

Our web search identified 15 technologies that early childhood practitioners use to support informal learning. These technologies were classified into four main categories: video-enabled professional development, online coursework, social media networking, and other. Video-enabled informal learning technologies included: video conferences, video exemplars, and product training and implementation videos. Online-coursework included both online courses and online learning modules. Social media networking technologies included: alternative social media networking sites, blogs, forums and photo/video sharing technologies. Practitioners used other technologies for informal learning including: online document libraries and user guides, user resource exchanges, audio recordings, teleconferences, online peer-to-peer interaction, and webinars (live and/or archived).

To better understand how practitioners use these technologies to support informal learning, we conducted an additional search to identify products/program that use these technologies. We found only eight sample products/programs. Among the eight, the most common technologies used for informal learning were: online peer-to-peer networks, alternative social media sites, blogs, forums, and photo or video sharing tools. We also conducted an academic search that failed to find any evaluative articles for early childhood practitioner's use of technology to support informal peer professional learning.

Topic Area 4 – Facilitators and Barriers to Technology Use

Topic Area 4 examined the facilitators and barriers to practitioners' effective use of technology to support early childhood practice. It differed from the other Topic Areas in that 1) the primary data source was the 15 expert interviews rather than web searches or academic searches, and 2) the scope of the inquiry area encompassed all three other topic areas.

4.1 How have early childhood programs (Head Start in particular) that have successfully implemented technology into their programs overcome barriers to implementation?

To answer inquiry 4.1, it was first necessary to identify the barriers that programs needed to overcome when trying to implement technology with early childhood practitioners. Based on our findings from the expert interviews, early childhood programs face many common obstacles to effective uses of technologies to support instruction and assessment, PFCE or professional development and informal learning. The most common barrier to successful implementation was staff technological literacy. Providing adequate professional development/training and technology support services were two of the most commonly mentioned facilitators for successful implementation and thus solutions to this challenge. An expanded discussion of this barrier is provided in 4.2 below.

Other common barriers included lack of access to technology resources, lack of support from administrators for the use of technology, and lack of time to learn and use the technology. Experts continually highlighted the critical role early childhood administrators play in either encouraging or hindering practitioners' use of technology. When administrators support practitioners' use of technology by providing adequate funding, technological infrastructure, hardware, software, training and professional development, technical support, and explicit encouragement, they are best able to affect positive practitioner outcomes in regard to technology use. If, however administrators are indifferent or hostile towards their practitioners' use of technology, even the most self-motivated

practitioners find it difficult to use technology with fidelity. Building upon early childhood practitioners' intrinsic desires for self-improvement and to produce the best outcomes for their children, leading by example, and providing adequate resources and recognition for high performing staff are among the most effective strategies that proactive administrators can engage in to encourage successful practitioner use of technology for instruction and assessment, PFCE, and professional development and informal learning.

4.2 Is staff development a factor limiting the fidelity of implementation of technology in early childhood settings?

As noted in 4.1 above, the experts consistently stated that staff development is one of the most common barriers to successful use of technology among early childhood practitioners. They noted that many practitioners often have low-levels of technological literacy. Lack of knowledge and experience leads to feelings of discomfort and unease, and hinders adoption and use of new technologies. Providing adequate professional development/training and technology support services were two of the most commonly mentioned solutions to this challenge. Experts also noted, however, that this obstacle is rapidly becoming less prevalent as new and more familiar technologies are being harnessed for use in early childhood instruction and assessment, PFCE and professional development and informal learning. Two common examples are the increasing use of mobile devices and social media in early childhood products/programs and services. The majority of early childhood practitioners are familiar with these technologies from their own personal uses (e.g., smartphones, iPads/tablets, and Facebook/LinkedIn). By incorporating technologies that practitioners are familiar with, that are designed to be intuitive to use and that are user friendly, early childhood product/program developers can best ensure that their technologies will be used with fidelity.

Recommendations for Research, Policy and Practice

This review has outlined both the opportunities and obstacles associated with increasing the use of technology among early childhood programs, with a particular focus on Head Start and Early Head Start programs. Given the ubiquity and integration of technology in modern society's every-day activities (e.g., internet, social media, and personal mobile devices), the proliferation of technology in practice at all levels of the education system will likely only accelerate. As such, the need for better access to technological advances is becoming increasingly important to the success of the Head Start program.

As noted by experts, a common site-level barrier among individual early childhood programs is an absence of agency/site-level leadership embracing and modeling the importance and necessity of technology to support practice. Faced with a limited research literature on the impact of technology-enhanced programs to support early child development practice, a lack of technological literacy among site staff, and dearth of financial resources to acquire and support technology, site and program directors are both conceptually and fiscally challenged to actively work to incorporate technology into their daily practice. In order to overcome this barrier, the site's leadership must choose to transform itself into a high-performance system driven by the Digital-Age learning needs of all students and staff. Administrators need to prepare themselves to model the use of technology effectively and work with colleagues to guide their site towards more effective uses of technology in teaching, learning and management (Partnership For 21st Century Skills, n.d.).

It is important for administrators to recognize that technology is a tool – a means to more efficiently and effectively achieve the ultimate goal of improving child outcomes. As such, the success of any technological implementation will require prior thoughtful consideration of appropriate educational and/or engagement goals and approaches. These decisions will impact the choice of assessment, curriculum, instructional approaches, engagement strategies and finally technologies. Adopting a technology without thoughtful consideration of its relationship to educational goals will not likely produce hoped for outcomes.

Once a site's leadership has made the commitment to incorporate technology at a site, the next barrier to overcome is the lack of preparation to use technology with young children among individual practitioners. As noted above, a common individual barrier to practitioners becoming proficient users of the wide variety of technologies available today is their own knowledge and competency to use technology (i.e., technological literacy). Technological literacy among today's diverse community of early childhood practitioners varies greatly, often hindering the adoption and use of even the most effective technology. Some argue that young adults are best positioned to incorporate technology because they are “digital natives” and have the intuitive skills to use technology. However, that argument assumes that knowing how technology works is sufficient to make informed decisions about choosing and then applying technology to positively influence practice. Effective practice is the result of much trial and error. Learning how to use technology is a required first step in its implementation, followed by multiple iterations of trial and error. Whether an individual is a digital native or not, effective practice comes about because she is willing to try a new approach and learn what works and what does not.

As mentioned previously, practitioners not only need to learn to use technology, but they often lack the time, resources and expertise to identify effective technologies in the first place. Finding and sharing such resources can be a time consuming task for an individual practitioner working in her own classroom or conducting home-visits. Professional development is one mechanism through which practitioners can take the first step in learning how to use technology to improve their practice. Typical education technology professional development has been delivered in face-to-face classes where the technology skill is presented, but often without the context of how it fits into teaching and learning. As the results of our professional development inquiry demonstrated, current effective trends utilize blended-learning approaches, which combine some online content such as videos or webinars for at home review. Online videos have the advantages of being accessible at any time of day and available for later reference. They typically showcase model examples of technology in actual classroom use; something that is difficult to replicate in typical professional development settings. The Results Matter Video Library is an excellent example of just such an existing video collection.¹ Blended-learning approaches have the added benefit of providing practitioners with experience using technology and building valuable technology skills.

Given the cost (i.e., time, money, effort) associated with adopting a new technology, support from administrators for the implementation of technology oftentimes requires strong empirical evidence demonstrating effectiveness. However, as is clear from the results of this review, the existing literature on the use of technology is sparse. Below, we briefly review the results and highlight promising areas for future research and evaluation.

¹ http://www.cde.state.co.us/resultsmatter/RMVideoSeries_UsingTechnology.htm#top

In the Instruction and Assessment Topic Area, very little literature examines the effectiveness of instructional tools and very few studies were designed to explicitly isolate the impact of using a technology. As such, it is unclear whether and to what extent technology helps practitioners instruct and assess children. Yet, a number of technologies and technology-enhanced products/programs are currently in widespread use and/or growing in popularity.

For example, among Curricula and Instructional Tools, numerous free and downloadable apps are available for mobile devices and are widely utilized due to their convenience and ease of use. Many of these are based on software for traditional desktop computers. However, there is little or no evaluative literature on the effectiveness of either product in improving student or practitioner outcomes. Similarly, in the area of Integrated Curricula and Assessments, apps for mobile devices are being developed based on existing products, many of which have limited evaluative research.

In addition, among Curricula and Instructional Tools, multi-touch tables and whiteboards are growing in popularity. Multi-touch tables in particular are new and innovative technologies. However, no evaluative literature assesses their effectiveness as an instructional tool. A potential evaluation might examine whether the addition of a multi-touch table in a classroom leads to better outcomes for students compared to a traditional classroom setting.

In the area of Assessments, little evaluative literature exists to determine whether use of any of the Software as a Service (SaaS)-enhanced assessment products can affect practitioner or student outcomes. Ten of the eleven assessments highlighted in the report offer SaaS features, in which assessment software is delivered via the Internet and a service provider hosts, maintains, and provides technical support remotely.² Practitioners can use the SaaS features of these assessments to input assessment results into an online database for storage and scoring, and then often receive individual or aggregate reports of students' outcomes. Among these products, those that are available as both a paper-based assessment as well as a technology-enhanced SaaS would be suitable for an evaluative study isolating the effects of SaaS on practitioner and student outcomes. Such an evaluation would provide evidence of whether SaaS supported or dependent assessments increase practitioner assessment efficiency, quality and reliability, as well as instructional quality and effectiveness.

In order to rigorously assess the impact of stand-alone curricula, instructional tools, and assessments, as well as integrated curricula and assessments, on student and/or practitioner outcomes, future research should first examine implementation and effectiveness of these curricula, instructional tools or assessments *independent* of the technology. Once established, an evaluation of the technology-enhanced product/program can be conducted to isolate the effect of the technology. Among the latest integrated curricula and assessment products/programs, it is often impossible to separate the technology from the product/program. The integrated nature of the technology may therefore preclude experimental manipulation of the technology to isolate its impact. In such instances, it may be necessary to identify comparable products/programs that have similar content in order to estimate the differential impact of the products/programs (e.g., two products that have an integrated emergent literacy curriculum and assessment; one with technology and one without).

² Because SaaS providers store student data, it is important for SaaS subscribers to know and understand providers' data use policies (e.g., for marketing, research) and data security protections (e.g., encryption, compliance with state or federal regulations).

Within the Professional Development and Informal Learning Topic Area, webinars were identified as the most common form of professional development among early childhood educators, yet we found no evidence base describing the effectiveness of webinars to support early childhood professional development. Likewise, despite the widespread use of social media in the general population, we found no evaluative literature on the use of peer collaboration technologies to support informal professional learning.

The rapid pace of technology development and evolution may be a key reason for the lack of literature. Many of these technologies are relatively new to the market, and especially to the field of early childhood education (e.g., multi-touch tables, tablet computers, SaaS, interactive whiteboards). The often protracted process of funding, developing, conducting, and publishing academic research studies typically takes a longer time than the products/technologies (in their current state) are in use. Considering the speed with which technology evolves, by the time a typical academic article is published the technology in question may be out of date and the findings of little value to users. A more rapid evaluation mechanism is likely needed to provide administrators, practitioners and policy makers with objective data to help them know which technology-enhanced products and programs are most effective.

1. Introduction

Over the past two decades, technology has become increasingly prevalent in early care and education settings, growing out of the recognition that technology may be used to improve program practice and, ultimately, children’s learning and development (Barron, Kemker, Harmes, & Kalaydjian, 2003; Diamond, Justice, Siegler, & Snyder, 2013; NAEYC, 2012). A recent joint position statement published by the National Association for the Education of Young Children (NAEYC, 2012) discussed the promising opportunities technology provides early childhood practitioners to improve practice. In particular, NAEYC highlighted three benefits of practitioners’ use of technology. First, practitioners can use technology to promote children’s learning and self-expression through engaging interactive curricula. Second, practitioners can use technology to strengthen home-school connections and encourage families’ digital literacy via social networking media and mobile communications. Finally, practitioners can use technology to improve their own skills through internet-enabled professional development programs.

In addition to highlighting technology’s promise, NAEYC also cautioned against potential challenges to successful integration of technology in early childhood settings, such as inequity in access to innovative technologies as well as disparities in practitioners’ knowledge and inability to identify and use effective technologies in practice. The opportunities and challenges described in the NAEYC white paper are particularly relevant to Head Start as a program designed specifically to reduce disparities in school readiness among disadvantaged children.

If Head Start, Early Head Start, and other early childhood program administrators and practitioners must make “informed, intentional and appropriate choices about if, how and when technology and media are used in early childhood classrooms” (NAEYC, 2012), they will need access to scientific research on the impact of technology on child, family and practitioner outcomes of interest. Unfortunately, little is known about the effectiveness, function, and requirements for technologies that are available to early childhood programs. Prompted by this gap in knowledge and the increasing prevalence of technology in early childhood settings the Administration for Children and Families (ACF) Office of Planning Research and Evaluation (OPRE) contracted with NORC at the University of Chicago to conduct a literature review and expert consultations to better understand how technology can be used to support and improve the quality of practice of early childhood practitioners.

The goal of the project was to review the knowledge base related to the use of technology to support the practice of early childhood professionals who work directly with children and families. To accomplish this goal, the review answers seven specific research inquiries within four Topic Areas of interest to OPRE (see Table 1.1). The first three Topic Areas describe early childhood practitioners’ use of technology while the fourth Topic Area outlines barriers and facilitators of practitioners’ effective use of technology to support early childhood practice.

Table 1.1. Specific Research Inquiries by Topic Area

Topic Area	Research Inquiry
1. Instruction and Assessment	1.1 What technologies are commonly used in early childhood settings with children to support instruction and assessment?
	1.2 How do practitioners use technology with children for instruction and assessment?
	1.3. How is technology used to track progress and individualize instruction/services to children?
2. Parent, Family, and Community Engagement (PFCE)	2.1 What technologies are commonly used to support parent, family and community engagement (PFCE)?
3. Professional Development and Informal Learning	3.1. In what ways has technology been used effectively to provide professional development and training to early childhood practitioners (e.g., product-specific training, prescribed coaching and mentoring)?
	3.2. How do early childhood practitioners use technology to support informal learning (e.g., independent learning, peer collaboration)?
4. Facilitators and Barriers	4.1. How did early childhood programs (Head Start in particular) that successfully implement technology overcome barriers to implementation?
	4.2. Is staff development a factor limiting the fidelity of implementation of technology in early childhood settings?

The review team employed three methods to address these research inquiries. First, the team conducted a web search to obtain a comprehensive sampling of both common and cutting-edge uses of technology that support early childhood practice. Second, the team conducted a search of academic databases, establishing an evidence base through the identification of literature that evaluated the impact of the technologies and/or technology using programs on child, family, or practitioner outcomes. Finally, the team interviewed sixteen early-childhood and technology experts (i.e., researchers and developers) who have built, used, or evaluated these technologies and associated technology-mediated programs. These experts provided first-hand descriptions of the facilitators and barriers to effective technology use by early childhood practitioners.

After describing the research methodology in detail (Chapter 2), Chapter 3 presents the results for each Topic Area. The appendices include an extensive bibliography for the web searches and the academic searches, organized by Topic Area. The report concludes with a summary of key findings and suggestions for future research (Chapter 4). The results of the expert interviews and the review of the small but growing body of evaluative research studies suggest that with adequate training, practitioners' intentional use of well-designed technologies, in conjunction with evidence-based programs, can lead to: improved outcomes for children and their families, increased family engagement, and more effective and efficient methods to engage professionals in training.

2. Methodology

Overview of the Review Methodology³

The overarching goal of the literature review was to conduct a broad but not exhaustive review of the knowledge base regarding the use of technology to support early childhood practitioners who work directly with children and families. The review prioritized *evidence-based* products/programs that use technology to improve child, family, or practitioner outcomes. However, the review also included products/programs that are either commonly used in early childhood programs or new but lacking in evidence of effectiveness.

The review team began by constructing specific research inquiries targeting three broad topic areas of interest to ACF: instruction and assessment; parent, family, and community engagement (PFCE); and professional development and informal learning. A fourth topic area examined the facilitators and barriers to practitioners' effective use of technology to support early childhood practice. Within these four topic areas, ACF identified seven specific research inquiries (see Table 1.1). This set of research inquiries served to both focus and organize the subsequent review. The review team used three methods to conduct the review, two complementary Internet searches and a series of in-depth expert interviews with developers or evaluators of the products/programs found through the Internet searches.

The first Internet search was a broad, web search to identify common and cutting edge uses of technology to support early childhood practice. The second Internet search was a focused academic literature search to find articles and reports describing the evidence base for the products/program identified during the web search. During the web and the academic searches, the review team applied inclusion criteria to both identify products/programs relevant to the scope of the project and to exclude those that were irrelevant. After the web search, the review team conducted in-depth interviews with experts who develop or study technology for use by practitioners in early childhood settings. The review team used these responses to answer the fourth Topic Area's research inquiries concerning facilitators and barriers to practitioners' technology use. Below are more detailed descriptions of the three review methods and the review criteria.

Web Search Process

The objective of the web search was to generate a broad, though not exhaustive, sampling of technology-mediated products/programs early childhood practitioners currently use to support instruction and assessment, PFCE, and professional development and informal learning. Primary selection criteria were use in early childhood settings and direct practitioners involvement in implementation. The results of the web search included commonly used technologies as well as innovative and trending technologies. As such, at this stage in the search process, empirical evidence of effectiveness was not required for inclusion in the search results. Within each Topic Area, the results of the web search were classified by type of technology used (e.g., mobile device, computer, app, video, LENA) and whether the technology was an *integral* part of the product/program or (defined as "technology-first") or whether the technology was an *optional* feature (defined as "technology-enabled"). The

Technology-First: A product/program that requires the use of technology; technology is an integral feature.

Example: A program that *requires* practitioners to video tape their implementation of a lesson and review the video via web interface with a remote coach.

³ See Appendix A for a more detailed description of the search methodology.

search terms entered for each of Inquiries 1.1 through 3.2 are outlined in Tables 2.1.1, 2.1.2., and 2.1.3 below.

The review team used four different types of search terms to focus the web search on specific products/programs and technologies: 1) Topic Area Terms, 2) Sub-topic Terms and/or Domain Terms, 3) Exclusionary Terms, and 4) Additional Search Terms.

Technology-Enabled: A product/program for which the use of technology is optional.

Example: An assessment that can be delivered either with paper and pencil or via a tablet-based app.

First, at the broadest level, the review team entered Topic Area Terms reflecting one of the three substantive areas of interest in the review: early childhood instruction and assessment, PFCE, and professional development and informal learning. Second, to narrow the results within each topic area, the review team entered Sub-topic Terms, if applicable, and Domain Terms. For example, within the topic area of instruction and assessment, Sub-topic Terms included “assessment” and “curriculum,” and within the assessment sub-topic, Domain Terms focused on specific types of assessments (e.g., formative assessments, summative assessments, and progress monitoring tools). Third, the review team added Exclusionary Terms to exclude products/programs that fell outside of the scope of the review. For example, products/programs designed for use with special-education students fell outside of the review’s scope. The review team also excluded results related to formal, degree-granting programs of study, such as bachelor’s degree programs. Finally, the review team used Additional Search Terms to narrow results to specific types of products/programs, such as software applications (“apps”) and webinars.

Table 2.1.1. Search Terms for Topic Area 1: Instruction and Assessment

<i>1.1 What technologies are commonly used in early childhood settings with children to support instruction and assessment?</i>			
<i>1.2 How do practitioners use technology with children for instruction and assessment?</i>			
Topic Area Terms	Sub-topic Terms (Domain Terms)	Exclusionary Terms	Additional Search Terms
Head Start / early childhood education; technology; practitioner / teacher; child / children	curriculum / curricula (language, literacy, math, science, social-emotional); assessment (formative, progress monitoring, summative)	special education; exceptional education; bachelor; degree; facilities; career; course description	app; assessment technology; camera; child assessment; developmentally appropriate; digital; digital media; digital technology; educational technology; enrichment program; formative assessment; information and communication technologies / ICT; innovative learning; instruction; iPad; learning environment; netbook; school readiness; social media; STEM; summative assessment; tablet
<i>1.3 How is technology used to track progress and individualize instruction/services to children?</i>			
Topic Area Terms	Domain Terms	Exclusionary Terms	Additional Search Terms
Head Start / early childhood education; technology	academic outcomes; data-driven / data systems / decision making; individualized instruction; measurement; online assessment tools; progress / progress monitoring	bachelor; career; disabilities; special education	app; classroom; customized; data-driven instruction; development; early communication indicator; educational technology; iPad; longitudinal; preschool; Response to Intervention; web-based reporting;

Table 2.1.2. Search Terms for Topic Area 2: Parent, Family, and Community Engagement (PFCE)

<i>2.1 What technologies are commonly used to support parent, family and community engagement (PFCE) for children?</i>			
Topic Area Terms	Domain Terms	Exclusionary Terms	Additional Search Terms
Head Start / early childhood education; parent engagement / PFCE; technology	child development; family partnership / community partnership / school-family partnership; home visiting; parenting	bachelor; continuing education; internship; special education; technical education	cell phone; community engagement; conjoint behavioral consultation; e-literacy; e-mail; family engagement; family engagement / family development; intentional use / intentional teaching; iPad / Nook; parenting education; social media / Twitter / Facebook / LinkedIn / blog; text message; video camera; volunteering

Table 2.1.3. Search Terms for Topic Area 3: Professional Development and Informal Learning

<i>3.1. In what ways has technology been used effectively to provide professional development and training to early childhood practitioners (e.g., product-specific training, prescribed coaching and mentoring)?</i>			
Topic Area Terms	Sub-topic Terms (Domain Terms)	Exclusionary Terms	Additional Search Terms
Head Start / early childhood education; technology; professional development	professional development (assessment, curriculum / initiative, implementation, technical support, training)	bachelor; degree; internship; special education	customized / customizable; customized training; developmentally appropriate practice; distance learning; facilitated; online / online module; online learning; online learning / online module; online professional development; professional learning community; remote; school readiness; technical assistance; ; technology integration; trainer; training; training videos; webcam; webinar; workshop;
<i>3.2. How do early childhood practitioners use technology to support informal learning (e.g., independent learning, peer collaboration)?</i>			
Topic Area Terms	Sub-topic Terms (Domain Terms)	Exclusionary Terms	Additional Search Terms
Head Start / early childhood education; technology; professional development	peer collaboration (personal learning network, social media)	bachelor; degree; internship; special education	app; digital literacy; Facebook; facilitated; LinkedIn; media literacy; professional learning community; technology integration; Twitter; webcam

Web Search Review Criteria

The review team ensured that the products/programs it found through the web search were relevant to the use of technology to support the practice of early childhood professionals who work directly with children and families. To do so, the review team applied two inclusion criteria as it conducted the web search.

Focuses on Early Childhood. The initial web search focused on products/programs intended for practitioner use with either children of preschool age or younger (i.e., 0-5 years old) who attend Head Start, Early Head Start, or other early childhood programs appropriate for their age, or their parents. Products/programs intended for use with Kindergarten-aged students or older and their parents were excluded from the scope of the review.

Requires Direct Practitioner Involvement. Since the goal of the project was to examine the use of technology to support early childhood *practice*, the web search included only those products/programs that required direct early childhood practitioner involvement. That is, they were designed to support practitioners' (a) work with children (e.g., instruction or assessment) or their parents (e.g., PFCE), or (b) own professional development (e.g., coaching or peer collaboration). These criteria excluded technology-mediated products/programs for which the intended users were children or parents and which did not require substantive practitioner involvement. For example, instructional video games or apps designed specifically for child-directed use with no practitioner feedback or instructional implications were excluded from the review. If, however, the technology product was designed to provide practitioners with formative assessment data that could be used to inform instruction, it was included in the review.

Academic Search Process

The project's goal was to identify *effective* uses of technology to support early childhood practice (i.e., technology use that is associated or causally related to positive outcomes). Therefore, the next step was to employ an academic search to obtain, if available, "evaluative literature" on the products/programs and technologies that were identified through the web search.

We first searched for articles across a variety of academic databases, and then classified the resulting articles as either "evaluative" or "non-evaluative." Non-evaluative articles were excluded from the academic search results. The review team applied two inclusion criteria as it conducted the academic search.

Evaluative Literature: Any literature that describes a product/program or technology that underwent evaluation (with or without a comparison group) or validation.

Examples: conference papers and presentations, book chapters, government reports, peer-reviewed journal articles

Describes Findings from Evaluation or Validation Studies. "Evaluative literature" was defined as any literature that describes a product/program or technology that underwent evaluation (with or without a comparison group) or validation. Evaluative literature took many forms, including conference papers and presentations, book chapters, government reports, and peer-reviewed journal articles. For the purpose of this review, we included findings from studies of effectiveness that use a **comparison group** that was created randomly (randomized controlled trials) or through a process that was not random (quasi-experimental designs), as well as **single group pre-/post-test** designs. In addition, studies that evaluated the **reliability and validity** of assessments were included as evaluative literature.

Focuses on Practitioner, Child, or Parent Outcomes. Evaluative articles focused on practitioner, child, or parent outcomes to assess the effectiveness of the product/program or technology or to assess the reliability and validity of assessments.

In general, the review team considered articles to be “non-evaluative” if they failed to have either a comparison group or a within-group pre-post measure of some practitioner, child, or parent outcome. For example, Summers, Funk, Twombly, Waddell, and Squires (2007) report findings from a qualitative study of an infant mental health initiative in which mentors support home visitors through the use of videotape feedback during one-on-one consultations. Although technology is a central feature of the program, the review team classified the article as non-evaluative because it does not include a comparison group or a pre/post measure.

In addition to identifying evaluative literature for products/programs and technologies resulting from the web search, the review team also conducted academic searches to obtain evaluative literature for specific programs or instruments commonly used in Head Start or Early Head Start (e.g., Creative Curriculum, Ages & Stages Questionnaire) or relevant to current policy initiatives (e.g., Thirty Million Words Initiative).

Expert Interviews

The final stage of the review was to conduct interviews with experts who researched, used or developed effective products/programs that use technology to support early childhood practice. The objective of the expert interviews was twofold. The first objective was to obtain additional information about technologies that support instruction and assessment, PFCE, and professional development and informal learning. Through interviews, the review team refined its understanding of specific products/programs discovered during the web and academic searches. In particular, we learned precisely how practitioners use the technologies that are part of the product/program. The second objective was to obtain insights about factors that support and hinder early childhood practitioners’ successful use of technology. Experts’ knowledge and firsthand experiences developing and evaluating products/programs, as well as implementing them with practitioners, allowed them to provide informed responses to Inquiries 4.1 and 4.2. As such, the expert interviews are the primary data source for Topic Area 4 which focuses on facilitators and barriers to technology use and implementation.

Table 2.2 lists the names of our 16 experts, their institutional affiliation, role, product/program, and Topic Area discussed during the interview. Experts included academics and individuals from both private and nonprofit organizations. Experts spoke specifically about the products/programs that the review team identified through the Internet searches. They also discussed plans for modifications and improvements to their products/programs, if any. We conducted all interviews with experts either individually or jointly over the telephone.

The review team designed the interview protocol to obtain experts’ views about the research inquiries within each of the Topic Areas. During the first part of the interview, experts answered a set of questions for one or more Topic Area(s) that corresponded with their particular product/program. For example, Dr. McConnell, developer of the myIGDI assessments, answered the Topic Area 1 set of interview questions focusing on assessment. During the second part of the interview, all experts answered a set of questions focused on technology implementation barriers and facilitators. The complete expert interview protocol, containing all four Topic Area question sets, is included in Appendix B.

Table 2.2. Expert Interview Participants

Expert	Affiliation	Role	Product/Program	Topic Area		
				Instruction and Assessment	PFCE	Professional Development and Informal Learning
Kai-lee Berke	Teaching Strategies, LLC.	Chief Product Officer	<i>Teaching Strategies</i>	x		
Jay Buzhardt	University of Kansas	Developer and Researcher	<i>MOD: Making Online Decisions</i>	x	x	
Judith Carta	University of Kansas	Developer and Researcher	Web-based Resources to Support IGD Implementation, Cell Phone-Enhanced Home Visitation Parenting Intervention	x	x	
Douglas Clements*	University of Buffalo	Developer and Researcher	<i>Building Blocks Mathematics Curriculum</i>	x		
Carol Connor	Arizona State University	Developer and Researcher	Individualizing Student Instruction (ISI) Lab	x		
Karen Diamond	Purdue University	Developer and Researcher	<i>Classroom Links to Vocabulary and Phonological Sensitivity Skills</i>		x	x
Chip Donohue	Erikson Institute	Developer and Administrator	Distance Learning for Early Childhood Practitioners	x		x
Bridget Hamre	University of Virginia	Developer and Researcher	<i>MyTeachingPartner</i>			x
Jason Hustedt	University of Delaware	Researcher	<i>Promoting First Relationships</i>		x	
Susan Landry	Children’s Learning Institute at the University of Texas Health Science Center at Houston (UTHealth)	Developer and Researcher	<i>mCLASS:CIRCLE, Play and Learning Strategies, Play and Learning Strategies, eCIRCLE Online Professional Development</i>	x	x	x
Scott McConnell	University of Minnesota-Twin Cities	Developer and Researcher	myIGDIs	x		

Expert	Affiliation	Role	Product/Program	Topic Area		
				Instruction and Assessment	PFCE	Professional Development and Informal Learning
Caroline Roben	University of Delaware	Developer and Researcher	<i>Infant Caregiver Project: Attachment Biobehavioral Catch-Up Intervention</i>		x	
Julie Sarama*	University of Denver	Developer and Researcher	<i>Building Blocks Mathematics Curriculum</i>	x		
Cybele Raver	New York University	Researcher	<i>Play and Learning Strategies</i>		x	x
Susan Walker	University of Minnesota-Twin Cities	Developer and Researcher	<i>SoCS: Collaborative Research: Novel Algorithms and Interaction Mechanisms to Enhance Social Production</i> (parenting and social media technologies); Parent Technology Use; Online Graduate Parent Education Programs		x	x
Carolyn Webster-Stratton	University of Washington; The Incredible Years, Inc.	Developer and Researcher	<i>Incredible Years Teacher Classroom Management Program</i>		x	x

*Denotes joint interview

3. Findings by Topic Area

Below we provide summaries of our findings for each of the primary areas of interest to ACF/OPRE: 1) Topic Area 1: Instruction and Assessment, 2) Topic Area 2: Parent, Family and Community Engagement (PFCE), 3) Topic Area 3: Professional Development and Informal Learning; and 4) Topic Area 4: Facilitators and Barriers to Technology Use. Each section begins by presenting the goal(s) and Research Inquiries associated with each Topic Area search. The presentation of findings are then provided and organized by the Research Inquiries within each Topic Area. Finally, to better understand how practitioners use specific technologies, within each Topic Area we present in-depth descriptions of technology-first exemplars. Exemplars were chosen because they represent products/programs that Head Start or Early Head Start practitioners commonly use, are relevant to current policy initiatives, and/ or have an empirical evidence base in the literature.

Topic Area 1 – Instruction and Assessment

Topic Area 1 explores the potential for technology to enhance assessment and instruction, providing a review of current and emerging technologies practitioners use to support instruction and assessment of young children. The goals of this section are to: 1) describe technologies that early childhood practitioners use to support instruction and assessment of young children, 2) provide a broad sampling of products/programs that use these technologies for instruction and assessment, and 3) provide exemplars that illustrate how practitioners are currently using these technologies with specific instruction and assessment products/programs. In keeping with these goals, both the web search and academic search were guided by three specific inquiries:

- 1.1 What technologies are currently used in early childhood settings with children to support instruction and assessment?
- 1.2 How do practitioners use technology with children for instruction and assessment?
- 1.3 How is technology used to track progress and individualize instruction/services to children?

Through our broad but not exhaustive review we identified 12 technologies that early childhood practitioners are currently using to support instruction and assessment. These technologies included hardware (e.g., interactive whiteboards, multi-touch tables, movement sensors, mobile device, computers), software (e.g., apps for mobile devices, eBooks, software as a service), and video. In order to find out how practitioners are using these technologies to support instruction and assessment, we identified a sample of 20 curricula or instructional tools and 11 assessment products/programs. We also identified 22 integrated curriculum and assessment products/programs that use technology to track child progress and individualize instruction. To better understand how these products/programs use technology, we also provide detailed descriptions of a few exemplar curricula or instructional tools, assessments, and integrated curriculum and assessments.

Curricula frequently used computers and traditional software to deliver content to children, though more cutting edge curricula also featured web-based software as a service (SaaS). Instructional tools were intended to assist teacher in direct instruction, and often with multiple children at once (e.g., interactive whiteboards and multi-touch tables). Assessments used computers and SaaS, typically for entering data and reporting results. Newer technology is allowing practitioners to collect assessment data directly on mobile devices. Finally, the category of integrated curricula and assessments uses

computers and software (particularly SaaS) to instantaneously assess, score, and report child outcomes, allowing for immediate data-based decision making. As with standalone assessments, integrated curricula and assessments are adapting their products/programs for use on mobile devices.

1.1 Technologies that Support Instruction and Assessment

The web-search uncovered 12 technologies that early childhood practitioners use to support instruction and assessment. The technologies can be classified broadly as hardware (i.e., physical electronic devices), software (i.e., programs that run on hardware) or video. All twelve technologies are used either alone or in combination with a variety of instruction and assessment products/programs. The 12 technologies and sample uses within the instruction and assessment Topic Area are listed in Table 3.1. Detailed definitions for each of the technologies are available in the Appendix C: Glossary.

Table 3.1. Technologies that Support Instruction and Assessment

Technology	Definition	Example(s) of Practitioner Use	Example(s) of Child Use
Apps for Mobile Devices	Self-contained software packages typically downloaded from the Internet, intended for use on a mobile device, and designed to serve a defined role.	<ul style="list-style-type: none"> • Access instructional materials or input assessment results in real-time • Access features of a software program that are primarily used on a standalone device 	<ul style="list-style-type: none"> • Access online instructional materials • Access features of a software program that are primarily used on a standalone device
Computers	Electronic hardware that practitioners use to support instruction and assessment, and often enable other technologies.	<ul style="list-style-type: none"> • Connect to an interactive whiteboard display • Download instructional materials from the Internet • Enable entry of assessment results • Send e-mail messages to staff or children's parents 	<ul style="list-style-type: none"> • Access lesson activities associated with an online curriculum
eBooks	A digital version of a print copy book.	<ul style="list-style-type: none"> • Use as part of shared or group reading • Access lesson activities 	<ul style="list-style-type: none"> • Use as part of shared or group reading
Interactive Books	Typically touch activated, include a writing implement, and are programmed to read text aloud (i.e., sound out words or letters) in response to touch.	<ul style="list-style-type: none"> • Use simultaneously with children 	<ul style="list-style-type: none"> • Use as part of participatory learning
Interactive Whiteboards	A wall-mounted board with an attached projector to display output from a computer; have interactive touch capabilities (i.e., the projections can be manipulated by hand or with specially designed writing implements).	<ul style="list-style-type: none"> • Present instructional information 	<ul style="list-style-type: none"> • Use as part of instructional activities

Technology	Definition	Example(s) of Practitioner Use	Example(s) of Child Use
Mobile Devices	Portable electronic hardware that typically has Wi-Fi or cellular internet access (e.g., cell phones, tablets).	<ul style="list-style-type: none"> • Use primarily to administer assessments 	<ul style="list-style-type: none"> • Complete app-based lesson activities associated with instructional products or programs
Movement Sensors	Stationary devices that track children's movements, which in turn control a game or activity.	N/A	<ul style="list-style-type: none"> • Interact with movement sensors to control a game or activity
Multi-Touch Tables	Devices that lie flat or at an angle (like an easel) and feature a large, embedded touch screen display.	N/A	<ul style="list-style-type: none"> • Touch sensitive screens enable interactive activities, either simultaneously with other children or alone
Proprietary Computers	Computers that run only pre-loaded, proprietary software. Proprietary computers are a type of standalone device.	N/A	<ul style="list-style-type: none"> • Access pre-loaded, proprietary software
Software as a Service (SaaS)	An Internet-based method of software delivery where a service provider hosts, maintains, and provides technical support remotely. As an Internet-based service, SaaS requires continuous internet access in order to use the software and cannot be downloaded to hardware or used offline. SaaS is typically subscription-based: one pays for a license to gain access to the software via a web browser or a user-interface specially designed to access the product or program.	<ul style="list-style-type: none"> • Access instructional materials or accomplish tasks associated with a product 	<ul style="list-style-type: none"> • Access instructional materials associated with their curricula
Traditional Software	Computer programs that allow a user to complete a defined task. Traditional Software is typically stored on a CD, DVD, or other portable memory storage medium, and can be downloaded directly onto a hardware device.	<ul style="list-style-type: none"> • Install applications or access instructional materials associated with a particular product or device 	<ul style="list-style-type: none"> • Access materials associated with a product, program, or assessments
Videos	Recordings that may be streamed digitally through the web or stored directly on a computer and viewed using a video viewing app or software (e.g., flash, QuickTime). Pre-recorded video may also be played directly from a cassette tape or DVD on a TV or computer.	<ul style="list-style-type: none"> • Use pre-recorded video exemplars to model for children targeted behaviors 	N/A

1.2 Applications of Technologies for Instruction and Assessment

The objective of the Topic Area 1 search was to obtain a comprehensive, though not exhaustive, sampling of the types of technology-enhanced products/programs that practitioners are currently using to support early childhood instruction and assessment. Because Topic Area 1 covers a wide range of products/programs, the results were classified into one of three categories: 1) curricula and instructional tools; 2) assessments; and 3) integrated curricula and assessments. For each of these broad areas, we present both our overall findings and specific exemplars, which illustrate how practitioners are currently using technology. Exemplars were chosen because they represent instruction and assessment products/programs that Head Start or Early Head Start practitioners commonly use, are relevant to current policy initiatives, or have an empirical evidence base in the literature.

Curricula and Instructional Tools

Table 3.2 presents technologies that early childhood practitioners are currently using to support early childhood instruction, as well as sample products/programs that use these technologies. The table identifies the programs'/products' content focus: comprehensive (i.e., covering more than one content area); social-emotional development; science; or language and literacy. It also provides information about four important product/program features: 1) level of technology integration; 2) type of instructional product/program (i.e., curriculum or instructional tool); 3) readiness for use "out of the box;" and 4) whether it is a standalone device. Definitions for each feature are provided in Appendix C: Glossary. The table shows that the five most common technologies used with curricula and instructional tools were: computers (12 instances); traditional software (11); apps (6); software as a service (5); and interactive whiteboards (4).

Exemplars for Curricula and Instruction Tools

The academic search of the 20 curricula and instructional tools listed in Table 3.2 returned only three evaluative articles; one each for the KidSmart Early Learning Program, Second Step Early Learning Program, and Teacher Classroom Management and Child Social and Emotion curriculum (Dinosaur School). The findings from these three studies suggested positive impacts of the products/programs on practitioners and child outcomes. However the rigor of the studies varied greatly, limiting the confidence with which we can draw conclusions. The most compelling results came from a RCT examining the impact of the Incredible Years Teacher Classroom Management and Child Social and Emotion curriculum (Dinosaur School) on practitioner and child outcomes (Webster-Stratton, Reid, & Stoolmiller, 2008). The findings indicated that teachers using the intervention exhibited more positive classroom management strategies than business as usual controls. Their students showed more social competence and emotional self-regulation and fewer conduct problems than control teachers and students. Intervention teachers also reported more involvement with parents than control teachers. Results from a single-group, pre-posttest evaluation of the Second Step: A Violence Prevention Program were mixed (McMahon, Washburn, Felix, Yakin, & Childrey, 2000). Interview and observational data suggest that preschool children make significant gains in knowledge and exhibit significant decreases in problem behaviors. Practitioner ratings, however, did not change significantly across time. A QED examining the impact of IBM KidSmart Early Learning Program on teacher and student outcomes reported increases in teaching and learning with Information and Communications technologies (Siraj-Blatchford & Siraj-Blatchford, 2001). However the study presented only descriptive statistics and did not conduct any tests of statistical significance to assess impact.

To better understand how practitioners are currently using technology associated with curricula and instructional tools, next we present below in-depth descriptions of three technology-first exemplars: ABCmouse.com, Inspire-NG multi-touch table, and interactive white boards. Given the lack of evaluative literature for curricula and instructional tools, we chose to highlight these three exemplars because they appeared frequently in our web search, which we interpreted as an indicator of popularity. However, no studies have been conducted to date to assess the effectiveness of any of these three exemplars on student or practitioner outcomes.

***ABCMouse.com.*⁴**

ABCMouse.com is a technology-first, comprehensive online curriculum that covers a wide range of topics, including: art, math, reading, science, and music. The curriculum contains approximately 450 interactive lessons spread across six levels. It is designed to guide children through lessons in sequence, tracking children's progress and providing them with virtual rewards as they go. For the practitioner, ABCmouse.com has online lesson planners as well as progress monitoring features that track children's performance as they complete interactive lessons. The internet-based nature of the program also allows children and parents to complete activities at home. As a technology-first program, ABCmouse.com is accessible via computer, whiteboard, or app on a mobile device, and requires an internet connection to function. ABCmouse.com is a software-as-a-service (i.e., SaaS) with a subscription price of roughly \$8/month at the time of this writing. No evaluative studies have examined the effectiveness of ABCmouse.com to increase child outcomes.

⁴ <https://www.abcmouse.com/>

*Inspire-NG multi-touch table.*⁵

The Kaplan Early Learning Company's Inspire-NG multi-touch table is a technology-first instructional tool that consists of a 40-inch HD touchscreen mounted on a pivoting, height-adjustable, hydraulic platform on wheels. The pivot allows the table to be set at virtually any angle, and can thus be rotated 90 degrees to be used as a whiteboard. The Inspire-NG's touch screen can recognize as many as 50 individual touches simultaneously (either fingers or objects such as a stylus), allowing multiple children and adults to interact with the technology together. The Inspire-NG comes pre-loaded with proprietary software in the form of nine activities referred to as "Explorations", which allow children to engage in open-ended activities that teach literacy and language (e.g., letter recognition and letter sounds) and build early math concepts (e.g., grouping, counting), to name a few. The Inspire-NG also includes nine activities (i.e., the Shine Software Suite) for practitioners to use during circle time or collaborative play and that focus exclusively on math concepts. No evaluative studies have examined the effectiveness of the Inspire-NG multi-touch table to increase child outcomes.

Interactive whiteboards.

Both the SMART Board⁶ and the Promethean ActivTouch⁷ are two examples of whiteboards, a technology-first instructional product. These two interactive whiteboard systems aim to raise student engagement and interest in lessons by allowing them to use touch to manipulate digital displays (e.g., dragging objects across the screen using their hands or writing with pens designed specifically for use with the interactive white boards). Practitioners use their own computers to access the white board software (i.e., SMART Notebook or ActiveInspire's ClassFlow), which in turn allows them to develop or download lessons and instructional materials. Practitioners can also access instructional materials using proprietary apps on their own mobile devices. No evaluative studies have examined the effectiveness of whiteboards to increase child outcomes.

Assessments

Table 3.3 presents technologies that early childhood practitioners are currently using to support early childhood assessment, as well as sample products/programs that use these technologies. The table identifies the goal of the assessment (i.e., formative, progress monitoring, screening), as well as the content focus of the assessment (i.e., comprehensive, social-emotional development, language and literacy, developmental). It also provides information about two important assessment product/program features: 1) level of technology integration; and 2) inclusion of practitioner-to-parent communication tools. Definitions for each feature are provided in Appendix C: Glossary. The table shows that technology-enhanced assessments employed five primary technologies: computers (11 instances); SaaS (9); traditional software (6); mobile devices (5); and apps (2).

⁵ <http://www.kaplanco.com/Inspire-NG/>

⁶ <http://education.smarttech.com/en/products/hardware>

⁷ <http://www.prometheanworld.com/us/english/education/products/interactive-whiteboard-systems/>

Type of Assessment	Content Area	Assessment	Company, Publisher, or Developer(s)	Product Features				Technologies																	
				Technology-First	Build Your Own	Practitioner-to-Parent Communication	Standalone Device	Hardware							Software										
								Computer	Interactive Book	Interactive Whiteboard	Language Environment Analysis (LENA) System	Mobile Device	Movement Sensor	Multi-touch Table	Proprietary Computer	App for Mobile Devices	eBooks	Software as a Service (SaaS)	Traditional Software	Video	Social Networking Media	Online Coursework	Other		
Screening	Developmental	9. Ages and Stages Questionnaire (ASQ)*	Paul H. Brookes Publishing Co.					x											x	x					
	Social-Emotional	10. Ages and Stages Questionnaire Social-Emotional (ASQ-SE)	Paul H. Brookes Publishing Co.					x											x	x					
	Social-Emotional	11. Devereux Early Childhood Assessment (DECA)*	Devereux Foundation					x				x							x	x					
Total		11	11	4	0	5	0	11	0	0	0	4	0	0	0	3	0	10	5	0	0	0	0	0	

Note. Products/programs that have evaluative literature are identified by *. See Appendix D for a list of relevant references, categorized by product/program.

Exemplars for Assessments

The two technology-first assessments selected as featured exemplars below, myIGDIs and mCLASS:CIRCLE, are examples of how practitioners are currently using technology to assess children. These assessments were selected due to their widespread use, their use of technology (current and planned)⁸, and the presence of evaluative literature associated with these assessments. Key results from the evaluative literature for each of the exemplars are discussed in Appendix E, and a product/program-categorized references list is provided in Appendix D.

myIGDIs.^{9,10}

The Individual Growth and Development Indicators (myIGDIs) are a technology-first, comprehensive set of response to intervention (RTI), curriculum-based measurements (CBMs). MyIGDIs are designed to monitor and promote the growth and development of emergent literacy and numeracy skills among 3- to 5-year-old preschool-aged children with and without disabilities. Emergent literacy measures include oral language and vocabulary, phonological awareness, alphabet knowledge, and comprehension. Numeracy measures include oral counting, number naming, quantity comparison, and one-to-one correspondence counting.

After recording children's assessment results on paper, practitioners enter scores into a cloud-based web portal (i.e., online data management system), which can output individual- and group-level assessment results reports. In addition, the portal allows for continuous progress monitoring (e.g., comparing students' progress on one measure to the benchmark for that measure), collaborative decision-making, screening for developmental delays, and measuring the effectiveness of instructional efforts (e.g., intervention plans). Currently, the online data management and reporting system are the two primary technology-first features of myIGDIs. During an expert interview however, Dr. McConnell described the ongoing development of a new version of myIGDIs, in which technology is an even more integral feature. This new version will have three technology-enabled advantages over its predecessor. First, item presentation and data collection will occur directly on a mobile device (e.g., smartphone or tablet). Direct data entry will eliminate the need to transfer assessment data from paper forms to the online data management system, saving practitioners time, reducing data entry errors, and thus increasing efficiency. Second, the new version will use item-response theory (IRT) data to create student-specific computer adaptive testing models currently not possible in the paper and pencil version of the assessment. Finally, the new version will be integrated into the broader classroom management system, for example, allowing the practitioner to group students by proficiency levels.

While this new version of myIGDIs is currently under development and does not yet have any evaluative literature describing its effect on child outcomes or benefits to practitioners, it will build upon existing evidence base for myIGDIs. This literature consists of nine validation studies of myIGDIs as a comprehensive progress monitoring tool. These studies focus primarily on the sensitivity of myIGDIs to assess development of early literacy and numeracy skills (e.g., vocabulary, phonological awareness, number naming, one-to-one correspondence), predictive validity, and psychometric properties. The literature confirms that myIGDIs are a valid and reliable comprehensive progress monitoring tool (Bradfield et al., 2014; Floyd, Hojnoski, & Key, 2006;

⁸ During an expert interview, developer Dr. McConnell described plans to design myIGDIs to be used on smartphones. The current version of the assessment uses a computer-based online data management system only.

⁹ <http://www.myigdis.com/why-myigdis/research/>

¹⁰ myIGDIs was developed by Dr. McConnell and Mary McEvoy at the University of Minnesota.

Hojnoski, 2009; McCormick & Haack, 2010; K. N. Missall & McConnell, 2004; K. Missall et al., 2007; Moyle, Heilmann, & Berman, 2013; Roseth, Missall, & McConnell, 2012; Wackerle-Hollman, Schmitt, Bradfield, Rodriguez, & McConnell, 2013). However, no studies evaluate the effectiveness of myIGDIs to improve practice or child outcomes.

mCLASS:CIRCLE.^{11,12}

mCLASS:CIRCLE¹³ is a technology-first, comprehensive progress monitoring assessment system designed to cover all 11 Head Start Domains of child development and early learning¹⁴, including but not limited to: language and literacy, math, science, and social-emotional development. Originally designed for use on a personal digital assistant, mCLASS:CIRCLE is now available for computers, netbooks (e.g., Chromebook), and mobile devices. Practitioners administer the 30 minutes assessments three times a year. Assessment data is recorded directly onto practitioners' devices, or children can enter their answers directly into a device. Upon completing one round of assessments, practitioners have immediate access to reports with multi-level aggregation capabilities. Reports include children's scores, suggestions for grouping children, and links to recommended instructional activities in the CIRCLE curriculum activity manual.

The academic search produced two evaluative sources¹⁵ establishing the evidence base for mCLASS:CIRCLE (Buysse, Peisner-Feinberg, & Burchinal, 2009; Mason-Arruda, 2012). Both sources present evaluations of the impact of mCLASS:CIRCLE on child outcomes. The evaluations estimate the effect of mCLASS:CIRCLE on 4-year-old children's emergent literacy outcomes (i.e., letter identification, vocabulary, and phonological awareness) in comparison to a business as usual control (i.e., no assessment). The 2012 article did not provide sufficient statistical information (i.e., effect sizes, significance levels) to reliably determine the impact of mCLASS:CIRCLE on student outcomes. The results from the 2009 study suggest that mCLASS:CIRCLE may have statistically significant ($p < 0.01$) moderate effects on child vocabulary ($d = 0.40$). However, a sub-analysis of children whose pre-test scores were in the bottom half of all scores, showed no statistically significant impact of mCLASS:CIRCLE on any of the three outcomes. Additional research is needed to confidently assess the impact of mCLASS:CIRCLE – a SaaS in which a computer, mobile device, and app are central features – on child emergent literacy outcomes.

1.3 Technologies for Tracking Progress and Individualizing Instruction with Integrated Curricula and Assessments

In addition to understanding the types of technology-enhanced programs/product that practitioners are currently using to support early childhood instruction and assessment, Topic Area 1 also explored how technology is being used to track progress and individualize instruction to children. These products/programs include highly integrated assessment and curriculum packages designed to track student progress with curriculum-specific assessments and to provide instructional suggestions tied to the associated curriculum. Table 3.4 lists 22 sample technology-enhanced, integrated curricula and assessments found during the web search. The large majority of integrated curricula and

¹¹ <http://www.childrenslearninginstitute.org/our-programs/program-overview/tx-school-ready/mclass-circle/>

¹² <http://www.amplify.com/assessment/mclass-circle>

¹³ mCLASS:CIRCLE was developed at the Children's Learning Institute at the University of Texas Health Science Center at Houston (UTHealth) and is marketed by Amplify Education, Inc.

¹⁴ [https://eclkc.ohs.acf.hhs.gov/hslc/ta-system/teaching/eecd/Assessment/Child%20Outcomes/HS_Revised_Child_Outcomes_Framework\(rev-Sept2011\).pdf](https://eclkc.ohs.acf.hhs.gov/hslc/ta-system/teaching/eecd/Assessment/Child%20Outcomes/HS_Revised_Child_Outcomes_Framework(rev-Sept2011).pdf)

¹⁵ One source is a poster presented at a conference. The other is a presentation given at a conference.

assessments were comprehensive in content coverage (19). The five most common technologies used among integrated curricula and assessments included: computers (18); SaaS (11); traditional software (11); standalone devices (8); and apps (6).

Content Area	Integrated Curriculum-Assessment	Company, Publisher, Developer(s)	Product Features				Technologies																		
			Technology-First	Build Your Own	Practitioner-to-Parent Communication	Standalone Device	Hardware							Software											
							Computer	Interactive Book	Interactive Whiteboard	Language Environment Analysis (LENA) System	Mobile Device	Movement Sensor	Multi-touch Table	Proprietary Computer	App for Mobile Devices	eBooks	Software as a Service (SaaS)	Traditional Software	Video	Social Networking Media	Online Coursework	Other			
Language or Literacy	19. Literacy Instruction and Assessments	Imagine Learning	x				x									x		x							
	20. Making Online Decisions (MOD) Clinical Decision Support System*	Jay Buzhardt, Judith Carta, Dale Walker	x				x										x								
	21. Ready, Set, Leap*	LeapFrog	x			x		x											x						
Math	22. Building Blocks*	Douglas Clements and Julie Sarama	x				x										x								
Total	22	22	15	1	5	8	18	1	1	0	5	0	1	0	6	4	11	11	0	0	0	0	0	0	0

Note. Products/programs that have evaluative literature are identified by *. See Appendix D for a list of relevant references, categorized by product/program.

Exemplars for Integrated Curricula and Assessments

To better understand how practitioners are currently using technology in assessment and instruction in early childhood, we present in-depth descriptions of three such technology-first exemplars: Teaching Strategies' Creative Curriculum and TS GOLD/GOLD PLUS, Building Blocks, and Making Online Decisions (MOD). Key results from evaluative literature for each of the exemplars are discussed in Appendix E, and a product/program-categorized references list is provided in Appendix D.

As evidenced by the large number of programs and products identified through our web search, and verified by experts during interviews, integrating curricula and assessments via technology is a cutting-edge area where many researchers, developers, and companies are currently engaged. One example provided below is Teaching Strategies, which is currently pilot testing a fully-integrated curriculum and assessment SaaS designed to be used on a tablet. Likewise, the Making Online Decisions (MOD), also described below, is currently being adapted to be a fully-integrated SaaS optimized for use on a smartphone. These cutting-edge developments are responses to advances in technology that allow for instantaneous assessment, scoring, reporting and data-based decision making in early childhood. Due to the novelty of these technological capabilities, the evidence-base for fully-integrated technology-first curricula and assessments is relatively sparse.

***Teaching Strategies: The Creative Curriculum System for Preschool, Teaching Strategies Gold (TS GOLD), and GOLD PLUS (PLUS).*¹⁶**

The Creative Curriculum and TS GOLD are technology-first, curriculum and assessment products, respectively. The Creative Curriculum and TS GOLD were designed as an integrated package that function best when used together. They are based on the 38 objectives for development and learning, which align with the Common Core State Standards, state early learning guidelines, and the 11 Domains of the Head Start Child Development and Early Learning Framework. The Creative Curriculum is a comprehensive early childhood curriculum that currently uses three primary technologies: eBooks (e.g., for group reading activities), computers and traditional software (i.e., a Getting Started DVD). TS GOLD is an authentic, evidence-based, ongoing observational assessment system that covers the following areas of development and learning: social-emotional, language, physical, cognitive, literacy, mathematics, science and technology, social studies, arts, and English language acquisition. The TS GOLD online learning management system (LMS) can be accessed over the internet via computer or mobile device. A Documentation app helps practitioners capture observations and send documentation to the TS GOLD LMS. Electronic portfolios securely store photos, videos, and samples of children's work. Online functions allow practitioners to generate reports; analyze documentation on children's progress; and evaluate children's knowledge, skills, and behaviors, by comparing them to expected levels by age. The system also has a parent engagement technology, Family Central, which enables practitioners to communicate directly with parents.

During an expert interview with Kai-lee Berke, Chief Product Officer at Teaching Strategies, we learned about Teaching Strategies' latest technology-first product called PLUS. PLUS is an online SaaS that will be accessible on mobile devices and computers. It is currently undergoing pilot testing on Apple iPad minis. PLUS is designed to integrate in a single program the content of the Creative Curriculum (i.e., the lessons and activities) with the TS GOLD assessment system. PLUS has an online, interactive, weekly instructional planner that is automatically populated with content from

¹⁶ <http://teachingstrategies.com/>

the Creative Curriculum. The PLUS iPad app also allows for on-demand updating of TS GOLD observational checklist items. Given the newness of PLUS, no evaluative literature is yet available. Unpublished pilot studies of PLUS suggest that the new platform is more efficient for practitioners to use than either the Creative Curriculum or TS GOLD alone or in combination. Berke noted that that the increased efficiency and hence better fidelity of implementation should hypothetically lead to better student outcomes.

The academic search for the TS GOLD assessment identified three evaluative articles which focused on the validity and reliability of the assessment (Kim, Lambert, & Burts, 2013; Kim & Smith, 2010; Lambert, Kim, & Burts, 2013). No evaluative studies have examined the effectiveness of TS GOLD to increase child outcomes in comparison to similar assessments.

The evidence base for the Creative Curriculum consisted of five evaluative articles assessing a broad range of outcomes which included: children's attitudes towards school, child behavior (e.g., aggressive behavior, problem behavior, social skills), language and literacy (e.g., book reading, oral language, vocabulary, print and letter knowledge, phonological awareness), mathematics (e.g., concepts, shapes, applied problems), practitioner-child interactions (e.g., practitioner detachment, the positivity of interactions), and classroom quality as measured by the Early Childhood Environment Rating Scale (ECRS; Chambers, Cheung, Slavin, Smith, & Laurenzano, 2010; Henry et al., 2004; Kaiser et al., 2011; National Center for Education Research, 2008; What Works Clearinghouse (ED), 2009). Overall, the evidence base for the differential effectiveness of the Creative Curriculum, in comparison to other curricula, on these outcomes was mixed. No statistically significant differences were reported for the large majority of *child outcomes* examined in these studies. Instead, the studies reported statistically significant differences in outcomes related to *practitioner outcomes*, specifically improvements in practitioner-child interactions, classroom quality, and practitioner oral language and writing instruction.

Building Blocks: Real Math PreK.^{17,18,19}

Building Blocks is a technology-first (SaaS), integrated mathematics curriculum and assessment program. The research-based curriculum aims to help children see mathematics in their everyday activities. Its development was informed by research in early childhood mathematics learning and teaching, as well as the Principals and Standards for School Mathematics outlined by the National Council of Teachers of Mathematics (NCTM).²⁰ As such, Building Blocks covers the NCTM content standards (i.e., Number and Operations, Algebra, Geometry, Measurement, Data Analysis and Probability), and process standards (i.e., Problem Solving, Reasoning and Proof, Communication, Connections, Representations). The curriculum has a special emphasis on numeracy and geometry.

Children learn curricular content through a combination of print materials, manipulatives, and computer-based activities available online as SaaS. Children complete both physical activities (e.g., board games, activities using printed items and manipulatives) and similar virtual activities on the computer. For example, children play with a real board game on the floor and then play a virtual version of the same game on the computer. The computer program is designed to give children

¹⁷ http://gse.buffalo.edu/org/buildingblocks/index_2.htm

¹⁸ Building Blocks was developed by Drs. Douglas Clements and Julie Sarama at the University at Buffalo, State University of New York and is marketed by McGraw-Hill.

¹⁹ <https://www.mhonline.com/program/view/4/4/2626/0076BB2012/>

²⁰ <http://www.nctm.org/standards/content.aspx?id=16909>

feedback on errors, based on how they perform. The Building Blocks learning management system (LMS) tracks children's progress as they complete the computer-based games. Based on this formative assessment data, the LMS then directs them to complete activities, suggests appropriate instructional activities based on their progress, and moves students along predefined learning trajectories. The system is flexible enough to allow practitioners to assign specific activities to specific children or to the entire class.

The evidence base for Building Blocks consisted of three evaluative articles (Clements & Sarama, 2008; Clements & Sarama, 2007; Sarama, Lange, Clements, & Wolfe, 2012) and one validation study (Weiland et al., 2012). None of the articles specifically tested the impact of the use of a specific technology (i.e., SaaS computer based activities) on child outcomes, but they did examine the impact of the program as a whole. Child outcomes assessed included math (e.g., numbers, geometry, data analysis, measuring, counting), literacy (i.e., letter recognition) and oral language (e.g., complexity, sentence length). These results suggest that the Building Blocks program, in which a computer and a SaaS are central features, can positively impact child math, language and literacy outcomes.

***Making Online Decisions (MOD).*^{21, 22}**

The Making Online Decisions (MOD) system is a technology-first, web-based Clinical Decision Support System (CDSS) designed to help Early Head Start home visitors make data-based decisions in accordance with children's performance on the Infant and Toddler Individual Growth and Development Indicators (IGDIs), specifically the Early Communication Indicators (ECI). The ECI assesses children's communication, social interactions, problem solving skills, and motor skills. Using the ECI assessment results, the MOD identifies children's developmental strengths and deficiencies by comparing their ECI outcomes with expected outcomes (i.e., outcomes that would be typical for their age). The MOD then recommends a range of appropriate caregiver-led interventions for the home visitor to recommend to the caregiver.

At the time of this writing, the MOD was optimized for use on computers only, and it required home visitors to transfer ECI results from paper forms into the computer-based MOD software to receive recommendations for caregiver-led interventions. During an expert interview, Dr. Buzhardt noted that large amounts of time could pass between home visitors' administration of assessments and entry of ECI data into the MOD software. This time lag was long enough to significantly diminish the value of the assessment data to accurately inform instructional decision making. This challenge led to Dr. Buzhardt's interest in optimizing the MOD for use on mobile devices, especially smart phones. In the new version currently under development, home visitors will conduct the ECI assessment directly on a smartphone and the resulting assessment data will be instantaneously entered in to the MOD. The MOD will then provide immediate recommendations for intervention strategies, allowing for timely data-based instructional decision making.

While the mobile device version of the MOD is currently under development and not yet evaluated for impact on family or child outcomes, it will build upon evidence published on the current version of the system. The academic search returned two evaluative articles on the MOD (Buzhardt, Walker, Greenwood, & Carta, 2011; Buzhardt, Greenwood, et al., 2011). Both articles focused on child

²¹ Buzhardt, J., Greenwood, C., Walker, D., Carta, J., Terry, B., & Garrett, M. (2010). A Web-Based Tool to Support Data-Based Early Intervention Decision Making. *Topics in Early Childhood Special Education, 29*(4), 201–213. doi:10.1177/0271121409353350

²² The MOD was developed by Dr. Jay Buzhardt and colleagues at the Juniper Gardens Children's Project at the University of Kansas.

outcomes, specifically the ECI score. These results suggest that the MOD, in which a SaaS is a central feature, can positively promote child language outcomes.

Topic Area 2 – Parent, Family and Community Engagement (PFCE)

Topic Area 2 focuses on technologies that practitioners use to support parent, family, and community engagement (PFCE). As outlined in the Office of Head Start’s PFCE Framework (2011), effective parent and family engagement fosters quality early care and education and results in improved parent and child outcomes. Given the broad range of activities that constitute PFCE, we focused our review on those technology-enhanced products/programs that support parent learning, parent engagement with their children, and parent engagement with early childhood programs and practitioners. In keeping with the scope of this review, we examined only those technology-enhanced PFCE products/programs that require the direct involvement of an early childhood practitioner. As such, PFCE products/programs designed to facilitate parent networking or independent family learning were not reviewed.

The goal of this section is to describe technology-enhanced products/programs that early childhood practitioners use to support their PFCE efforts, and summarize the results of empirical studies examining their effectiveness. Our web and academic searches were guided by a single research inquiry:

- 2.1 What technologies are commonly used to support parent, family and community engagement (PFCE) for children?

Our broad but not comprehensive search identified seven technologies that early childhood practitioners use to support PFCE. Hardware included: computers, mobile devices, and the LENA system. Software included: apps for mobile devices, SaaS, and traditional software. An additional technology supporting PFCE was video. In addition to identifying technologies, we also found 13 products/programs that use one or more of these technologies to support PFCE. The most frequently used technologies were video and traditional software, which were designed to operate on existing hardware (i.e., computer or mobile device, not proprietary hardware). The prevalence of these two technologies is in keeping with the two primary objectives for PFCE technology use – to build and maintain positive social relationships through more regular communication, and to share facts, ideas, and exemplars or build skills with parents or families.

2.1 Technologies that Support PFCE

The web search identified seven technologies that support early childhood practitioners’ efforts at PFCE. Hardware included: computers, mobile devices, and the LENA system. Software included: traditional software, SaaS, and apps. An additional type of technology employed in PFCE was video. The seven technologies and sample uses within the PFCE Topic Area are listed in Table 4.1. Detailed definitions for each of the technologies are available in the Appendix C: Glossary.

Table 4.1. Technologies that Support PFCE

Technology	Definition	Example(s) of Practitioner Use	Example(s) of Parent Use
Apps	Self-contained software packages typically downloaded from the Internet, intended for use on a mobile device, and designed to serve a defined role. Apps allow practitioners to accomplish tasks on mobile devices that they would otherwise need to complete at a computer.	<ul style="list-style-type: none"> • Access software programs on a mobile device 	<ul style="list-style-type: none"> • Access software programs on a mobile device
Computers	Electronic hardware that deliver content to children’s caregivers (i.e., parents, guardians, family members), enable practitioners and caregivers to interact with one another at a distance via the internet, or facilitate use of other technologies.	<ul style="list-style-type: none"> • Enable interaction with one another and parents at a distance via the internet • Facilitate the use of other technologies 	<ul style="list-style-type: none"> • Enable interaction with practitioners at a distance via the internet • Facilitate the use of other technologies
Language ENvironment Analysis (LENA) System	The LENA system consists of a digital language processor (DLP) that captures up to 16 hours of audio surrounding whoever wears the device, as well as an analytical software package the automatically codes the recorded audio for language outcomes (i.e., adult word count, conversational turn count, child vocalizations) and electronic noise (e.g., TV time). LENA outcomes have been shared with caregivers to influence linguistic behaviors, and used as an evaluative tool.	<ul style="list-style-type: none"> • Capture audio • Analyze recorded audio. • Share language outcomes with parents and influence linguistic behaviors 	<ul style="list-style-type: none"> • Capture audio
Mobile Devices	Portable electronic hardware that typically has Wi-Fi or cellular internet access (e.g., cell phones, tablets).	<ul style="list-style-type: none"> • Enable interaction with one another or parents from a distance by voice, text message or video conference, or other communication app. • Enable the use of other technologies, primarily apps 	<ul style="list-style-type: none"> • Enable interaction with practitioners from a distance by voice, text message or video conference, or other communication app • Enable the use of other technologies, primarily apps
Software as a Service (SaaS)	An Internet-based method of software delivery where a service provider hosts, maintains, and provides technical support remotely. As an Internet-based service, SaaS requires continuous internet access in order to use the software and cannot be downloaded to hardware or used offline. SaaS is typically subscription-based: one pays for a license to gain access to the software via a web browser or a user-interface specially designed to access the product or program.	<ul style="list-style-type: none"> • Access software on multiple platforms through a web interface 	<ul style="list-style-type: none"> • Access software on multiple platforms through a web interface
Traditional Software	Computer programs that allow a user to complete a defined task. Traditional Software is typically stored on a CD, DVD, or other portable memory storage medium, and can be downloaded directly onto a hardware device.	<ul style="list-style-type: none"> • Deliver content to parents 	<ul style="list-style-type: none"> • View content

Technology	Definition	Example(s) of Practitioner Use	Example(s) of Parent Use
Videos	Videos are recordings that may be streamed digitally through the web or stored directly on a computer and viewed using a video viewing app or software (e.g., flash, QuickTime). Pre-recorded video may also be played directly from a cassette tape or DVD on a TV or computer. New video may be collected using a dedicated video camcorder, or camera equipped mobile device or computer.	<ul style="list-style-type: none"> • Use pre-recorded video exemplars to model target behaviors to parents Record parents practicing target behaviors with their children, for subsequent review (either together face-to-face with parents or via the web) and constructive feedback 	<ul style="list-style-type: none"> • View pre-recorded video exemplars Review videos of their own parent-child interactions and view during receipt of constructive feedback

In addition to identifying technologies, a comprehensive, but not exhaustive, web-search identified 13 unique PFCE products/programs that use one or more of these seven technologies. Table 4.2 offers an overview of the 13 PFCE products/programs and the up to seven technologies they utilize. The products/programs are classified as supporting parent engagement with their children (e.g., children’s learning and development, parent-child relationships) and parent engagement with early childhood programs and practitioners. The majority of the programs incorporated technology as an integral feature (i.e., technology first). Video (5 instances) and traditional software (5) were the most common technologies used by PFCE technology-enhanced programs. These two technologies are particularly useful in communicating new ideas and skills to parents (e.g., through video feedback, video modeling, and curriculum/module presentation). A product/program-categorized references list containing all evaluative articles found during the academic search is included in the Appendix E.

PFCE Dimension	Curriculum, Intervention, or Initiative	Company, Publisher, or Developer(s)	Product Features				Technologies																
			Technology-First	Build Your Own	Practitioner-to-Parent Communication	Standalone Device	Hardware							Software									
							Computer	Interactive Book	Interactive Whiteboard	Language Environment Analysis (LENA) System	Mobile Device	Movement Sensor	Multi-touch Table	Proprietary Computer	App for Mobile Devices	eBooks	Software as a Service (SaaS)	Traditional Software	Video	Social Networking Media	Online Coursework	Other	
	9. Attachment and Biobehavioral Catch-up (ABC) Intervention*	University of Delaware Infant Caregiver Project	x				x												x				
	10. Positive Parenting Program*	Triple P																	x				
	11. Strengthening Families Program for Preschool*	Strengthening Families Program																	x				
Technology to Support Partnerships between Families and Head Start or Early Childhood Staff	12. PreciouStatus Software Program	PreciouStatus, LLC	x		X		x							x			x						
	13. Remind 101 Free and Safe Text Messaging for Teachers	Remind101, Inc.	x		X																		
Total	13	13	9	0	3	0	3	0	0	2	2	0	0	0	2	0	2	5	5	0	0	0	0

Note. Products/programs that have evaluative literature are identified by *. See Appendix D for a list of relevant references, categorized by product/program.

^ The Incredible Years Parent Training Program is a part of the Incredible Years Series, a curriculum that involves both parents and practitioners. We classify the Parent Training Program under PFCE to distinguish it from the curricula used only by practitioners.

Exemplars for PFCE

To better understand how technology is currently being used to support practitioners' PFCE, we present in-depth descriptions of two technology-first PFCE exemplars, Play and Learning Strategies (PALS) and the Thirty Million Words (TMW) Initiative. TMW is a program relevant to current policy initiatives intended to reduce the word gap between children from high versus low socioeconomic status households. PALS is a home visiting program commonly used by Early Head Start practitioners. Both PALS and TMW have an empirical evidence base in the literature.

As is common in PFCE, each program described below employs video modeling and/or feedback as a key mechanism to educate caregivers, promote behavioral change, and improve child outcomes. Collectively, these technology-first PFCE programs produce statistically significant and moderate sized effects on parent and child outcomes. As such, they are evidence-based examples of how practitioners can use technology, particularly video, to have positive impacts on parent and child outcomes through their PFCE activities. Key results from evaluative literature for each of the exemplars are discussed in Appendix E, and a product/program-categorized reference list is provided in Appendix D.

Play and Learning Strategies (PALS).^{23,24}

PALS is a scripted technology-first intervention that supports infants' and toddlers' language, cognition, and social-emotional development. PALS aims to improve child outcomes by increasing responsive parenting behaviors – namely, accepting, warm, and prompt behavioral responses that maintain instead of redirect children's attention. Home visitors help parents practice target parenting behaviors during everyday activities (e.g., playtime with toys, feeding, shared book reading), with the goal of helping them exhibit these behaviors when engaging in the same activities outside of the home visit. The infant version of the program (PALS I – five months to one year of age) is intended to be completed in 10 weeks, whereas the toddler version of the program (PALS II – 18 months to 3 years of age) is intended to be completed in 12 weeks.

Video is an integral component of the PALS program, and it is used in two specific ways: to model ideal parental behaviors, and to provide parents with feedback about their own behaviors. Home visitors watch pre-recorded model videos with parents in a standardized format across all sessions. Sessions typically begin with the home visitor reviewing with the parents their progress and experiences since the previous session. They then discuss the current week's target behavior, and then watch a pre-recorded video exemplar of other mothers displaying the target behavior with their children. Next, the home visitor films the parent and the child interacting during an activity selected by the parent. During the activity, the parent attempts to display the target behavior, with minimal guidance from the home visitor. Finally, the home visitor and the parent review together the newly recorded video of the parent-child interaction. During the review, the home visitor helps the parent self-reflect on both her own behaviors as well as her child's behaviors. Following the joint review of the video of the parent-child interactions, the home visitor and the parent plan the integration of the target behavior over the course of the following week.

²³ <http://www.childrenslearninginstitute.org/our-programs/program-overview/PALS/>

²⁴ PALS was developed by Susan Landry and colleagues at the Children's Learning Institute at the University of Texas Health Science Center at Houston

An even more technology integrated, web-based version of the program called e-PALS is currently under development. Parents participating in e-PALS receive a laptop with Internet access, which they use to view video exemplars and participate in web-mediated coaching sessions. The e-PALS intervention occurs in two phases. First, parents review the content of the sessions online, at their own pace. The second phase involves remote coaching. Parents record videos of their interactions with their children and upload them to a secure server. After the coach reviews the video, he or she schedules a one-on-one phone call and webinar, during which the parent and the coach review the video together.

Since e-PALS is currently under development, no evaluative literature yet exists for the program. The program will build upon the existing evidence base for PALS. The academic search returned five evaluative articles for PALS (Dieterich, Landry, Smith, Swank, & Hebert, 2006; Guttentag, Pedrosa-Josic, Landry, Smith, & Swank, 2006; Landry et al., 2012; Landry, Smith, & Swank, 2006; Smith, Landry, & Swank, 2005). None of the articles tested specifically the impact of the use of video on parent or child outcomes. However, the articles did examine the impact of the PALS program as a whole. Outcomes varied across the studies and focused on mothers (e.g., maternal behaviors, emotional well-being, perceived social support, parent competence) and infants or children (e.g., social skills, communication, responsiveness, affect). The results from these studies suggest that the PALS program, in which video modeling and feedback are central features, can positively impact parent outcomes.

The Thirty Million Words (TMW) Initiative.^{25, 26}

TMW is a technology-first, 12 week home-based intervention that provides parents with information and strategies to empower parents to enrich their home language environment. TMW is designed to improve children's language development and school readiness by enhancing children's early home language environments through parent-centered behavior change techniques.

Three technologies are integral to the TMW intervention: a computer, video modeling and feedback, and the LENA system. First, home visitors use computers to deliver culturally sensitive and unbiased standardized modules that help parents with constructive goal setting, educate them about child development (e.g., conversations with children increases language development), and show parents TMW best practices via video exemplars. Second, during each session the home visitor video records parents implementing a particular TMW strategy. After video recording themselves implementing the TMW strategy, the home visitor and the parent review the video together, reflecting on the parent's implementation of the strategy and challenges the parent experienced.

A third critical technological component of the TMW intervention is the LENA system.²⁷ The LENA digital language processor (DLP) is worn by the child in specially designed clothing, and records all audio within range of the device for up to 16 hours. The LENA analytic software measures three quantitative language outcomes: adult word count, conversational turns, child vocalizations, and electronic noise (e.g., TV time). Home visitors provide parents with this data through a process called quantitative linguistic feedback (Suskind et al., 2013). Quantitative linguistic feedback is a technology-mediated method for parents to see objective data (in the form of graphical reports) about both their linguistic engagement with their children (i.e., number of words spoken to

²⁵ <http://tmw.org/>

²⁶ TMW was developed by Dr. Dana Suskind at the University of Chicago Medicine.

²⁷ <http://www.lenafoundation.org/ProSystem/Overview.aspx>

the child, the number of conversational turns taken with the child), and their child's language production (i.e., child vocalizations). During weekly sessions with parents, home visitors identify language-related goals for parents to achieve over the next week. Home visitors compare these goals with actual language outcomes as measured during a midweek LENA recording, and then coach parents to achieve a new goal the following week.

The combination of these three technological tools is intended to help home visitors help parents improve the home language environment. TMW is a new intervention and no studies have specifically tested the impact of any one of these three technologies on parent or child outcomes. However, one article did assess growth in parent and child language outcomes (Suskind et al., 2013). The results suggest that the TMW intervention, in which video, LENA, and computer presentations are integral technological features, may be effective in improving parents and children's language outcomes.

Topic Area 3 – Professional Development and Informal Learning

Topic Area 3 focuses on technologies practitioners use to support their own “formal” professional development (e.g., through in-service programs for pedagogical strategies and subject areas; training on product-specific implementation and enrichment) and “informal” learning (e.g., independent learning and peer collaboration). The goal of this section is to describe technology-enhanced products/programs that early childhood practitioners use to improve their skills and practice through both formal and informal learning approaches, and summarize the results of empirical studies examining their effectiveness. Both the web search and academic search were guided by two specific inquiries:

- 3.1 In what ways has technology been used effectively to provide professional development and training to early childhood practitioners (e.g., product-specific training, prescribed coaching and mentoring)?
- 3.2 How do early childhood practitioners use technology to support informal learning (e.g., independent learning, peer collaboration)?

In our comprehensive, though not exhaustive, search we identified a sampling of the types of technology-enhanced products/programs that practitioners currently use to engage in professional development and informal learning. We confirmed that early childhood practitioners utilize one or more of 23 different technologies. In addition to identifying technologies, our search also identified 58 unique products/programs that use one or more of these technologies to support formal and informal practitioner learning.

To date, the evidence base for technology-use among early childhood professional development and informal learning programs has largely concentrated on video-enabled professional development. Surprisingly, no evaluative literature was found for webinars – the most commonly employed technology for early childhood professional development. Further research in this area is needed. The academic search also failed to find any evaluative articles for early childhood practitioner’s use of technology to support peer collaboration for informal learning. Given the widespread use of social media networking technologies among the general population, research examining the impact of social media networking on practitioner and child outcomes is a promising, untapped avenue of future study.

3.1 Technologies that Support Professional Development

Our web-search uncovered 21 technologies that early childhood practitioners use to support formal professional development. These technologies were classified into four main categories: video-enabled professional development, online coursework, social media networking, and other. Each of these four categories and their associated technologies and sample uses within the Topic Area are listed in Table 5.1. Detailed definitions for each of the technologies are available in the Appendix C: Glossary.

Table 5.1. Technologies that Support Professional Development

Technology	Technology Category	Definition	Example(s) of Practitioner Use	Example(s) of Coach/Trainer Use
Case-based Hypermedia Resource	Video-enabled Professional Development	A resource typically dominated by links to video exemplars. It might also include links or digital copies of relevant articles written for an early childhood audience, as well as links to other resources. This resource is designed specifically for practitioners, and might be available on a website or offline on a computer.	<ul style="list-style-type: none"> • Access video exemplars and articles as part of a larger professional development program that includes remote coaching 	N/A
E-mail Feedback from a Coach or Trainer based on Video Review	Video-enabled Professional Development	A practitioner takes video of herself instructing, and mails the video to her coach. After reviewing the video, the coach sends written feedback to the practitioner via e-mail. The e-mail message might follow a template (e.g., all messages begin with a positive statement, followed by three examples of targeted behavior that the coach looked for). Video is not included with the e-mail message.	N/A	<ul style="list-style-type: none"> • Coach sends written feedback to practitioners via e-mail after conducting a classroom observation
Multi-media Feedback from a Coach or Trainer based on Video Review	Video-enabled Professional Development	Practitioners record video of themselves performing an instructional activity. A coach reviews the video recording and provides feedback to the practitioner. A trainer follows a similar procedure when working with a coach.	N/A	<ul style="list-style-type: none"> • Coach (trainer) provides practitioners (coaches) with feedback on implementation and recommendations to improve practice
Product Training and Implementation Videos	Video-enabled Professional Development	How-to videos associated with specific products/programs.	<ul style="list-style-type: none"> • Learn how to access or use a feature of a product or a program 	N/A
Video Exemplars	Video-enabled Professional Development	Recordings that depict model practitioner actions (e.g., execution of a particular instructional strategy with high level fidelity of implementation).	<ul style="list-style-type: none"> • View by oneself as part of an online-course 	<ul style="list-style-type: none"> • Coach shows video exemplars as part of a coaching session

Technology	Technology Category	Definition	Example(s) of Practitioner Use	Example(s) of Coach/Trainer Use
Video Self-Reflection	Video-enabled Professional Development	During individual or small group meetings that are part of an ongoing in-service training, practitioners view video footage of classroom activities captured by themselves or their peers. The small groups might discuss the instructional concepts and strategies observed in the video and their relation to those they have studied as part of a course.	<ul style="list-style-type: none"> • Reflect on instructional concepts and strategies observed in the video and their relation to those they have studied as part of a course 	N/A
Web-Mediated Coaching	Video-enabled Professional Development	Coaching that occurs live (i.e., real-time) between practitioners and coaches via a videoconference over the Internet. Coaches might provide feedback to practitioners during the videoconference, and might recommend resources (e.g., readings, video exemplars in the case-based hypermedia resource) for practitioners to consult.	<ul style="list-style-type: none"> • Receive feedback on their implementation of instructional strategies 	<ul style="list-style-type: none"> • Coach gives feedback to practitioners on their implementation of particular instructional strategies
Online Courses	Online Coursework	Formal courses available through the Internet. Online courses typically follow an academic calendar (i.e., one quarter, one semester or longer) and are led by an instructor.	<ul style="list-style-type: none"> • Complete online courses individually or as part of a larger professional development program 	N/A
Online Modules	Online Coursework	A small/defined instructional unit available through the Internet. Modules are by definition shorter in duration than online courses (e.g., the materials may be viewed in one sitting), designed to be completed independently, typically completed asynchronous within an academic calendar, and usually not led by an instructor.	<ul style="list-style-type: none"> • Complete online modules individually or as part of a larger professional development program 	N/A
Blog	Social Media Networking	A personal, public website or webpage where an individual can regularly post text, web-links and a variety of media for others to read and view. Practitioners maintain blogs to share thought and ideas, and engage in discussions with peers (e.g., via comments on posts). Companies might also maintain blogs on which practitioners write posts and engage in asynchronous conversations with peers.	<ul style="list-style-type: none"> • Share thoughts and ideas and engage in asynchronous discussions with peers 	N/A

Technology	Technology Category	Definition	Example(s) of Practitioner Use	Example(s) of Coach/Trainer Use
Common Social Networking Sites	Social Media Networking	Internet-based software (e.g., Facebook, LinkedIn, Twitter) that allow anyone with an account to connect with any other individuals via private text, photo, audio and/or video messaging, as well as public spaces to post similar content and hold group discussions.	<ul style="list-style-type: none"> • Communicate and collaborate through virtual professional working groups (PWG) or professional learning communities (PLC) from a distance 	N/A
Forums	Social Media Networking	Online discussion boards, typically geared toward a particular audience and designed to engage other members of the online community on a particular issue or topic.	<ul style="list-style-type: none"> • Engage other practitioners in an online community on a particular issue or topic 	N/A
Photo or Video Sharing	Social Media Networking	Enabled by social networking sites or other sites designed specifically for sharing multimedia (e.g., Vimeo, Flickr).	<ul style="list-style-type: none"> • Share with peers photos of their classrooms, videos that they made, or videos they found elsewhere) 	N/A
Audio	Other	Pre-recorded voice recordings or live streamed voice available via the Internet.	<ul style="list-style-type: none"> • Listen to pre-recorded voice recordings or live streamed voice available over the internet 	N/A
Audio Self-Reflection	Other	A practitioner creates audio recording of her conversation with children, transcribes the dialogue, and then analyzes her conversations.	<ul style="list-style-type: none"> • Analyze and reflect upon one's conversations with students to improve practice 	N/A
Online Documents and User Guides	Other	Web-based repositories of user manuals or help files for practitioners to consult if they have questions about how to use a product/program.	<ul style="list-style-type: none"> • Learn to use the features of a technology • Troubleshoot technical problems with a technology 	N/A
Online Peer-to-Peer Interactions	Other	Practitioners interact with one another directly through a website.	<ul style="list-style-type: none"> • Interact with other practitioners in real-time or asynchronously over the Internet (e.g., through private messages). 	N/A
Online Reliability Exercises or Tests	Other	Typically completed individually, these exercises or tests assess a practitioner's or a coach's knowledge of, or facility to use, a particular product (e.g., a classroom observation tool).	<ul style="list-style-type: none"> • Complete reliability exercises or tests to become certified as a trained user of the product 	N/A

Technology	Technology Category	Definition	Example(s) of Practitioner Use	Example(s) of Coach/Trainer Use
Telephone Conference	Other	Conferences consist of two or more participants held over a dedicated telephone line. One-to-one teleconferences (i.e., a consultation) with a coach may occur as part of ongoing support and be included with a subscription to a particular professional development product /program.	<ul style="list-style-type: none"> • Listen to a group presentation or participate in a group discussion 	N/A
User Resource Exchanges	Other	Web-based, member-accessible central repositories where practitioners can freely share resources with one another.	<ul style="list-style-type: none"> • Share instructional resources (e.g., lesson plans, lesson plan materials) with other practitioners. 	N/A
Webinars	Other	A seminar, lecture, presentation, workshop, or other learning session held over the Internet. Organizations and companies offer live and/or archived webinars.	<ul style="list-style-type: none"> • Learn about a product or program • Learn how to use or access features of a product or ask specific questions about the product • View a live presentation on a particular topic • Participate in a discussion with other practitioners. 	N/A

In addition to identifying technologies, a comprehensive, but not exhaustive, web-search identified 50 unique products/programs that support professional development and use one or more of the technologies. The most common technologies used for professional development were: webinars (23 instances of archived webinars and 17 instances of live webinars), online document libraries and user guides (24), online courses (19), product training and implementation videos (16), and video exemplars (13).

Below we present our findings for technologies that support professional development in four separate tables organized by the following four technology categories: video-enabled professional development (Table 5.2); online coursework (Table 5.3); social media networking (Table 5.4); and other forms of technology (Table 5.5). The tables also include information about the primary aim of the professional development product/program. That is, professional development specific to a curriculum, an assessment, a screener; an integrated curriculum and assessment, an instructional tool, a practitioner assessment, or an in-service programs for various pedagogical strategies and subjects. A product/program-categorized references list containing all evaluative articles found during the academic search is included in Appendix D.

Table 5.2. Video: Products and Programs that Support Professional Development, Classified by Types of Video Technologies

Professional Development Aim	Program or Product	Company, Publisher, or Developer(s)	Video Technologies								
			Video Exemplars	Videotape Feedback from a Coach or Trainer	Case-based Hypermedia Resource	Web-mediated Coaching	Videotape Feedback Sent to Practitioners via E-mail by Coach or Trainer	Video Self-reflection	Product Training and Implementation Videos	Video Conference	
Curriculum	1. Head Start Research-based, Developmentally-informed (REDI)*	Pennsylvania State University	x								
	2. Pre-Kindergarten Learning System Videos and Webinar Series	InvestiGator Club	x							x	
Assessment	3. myIGDIs Training¹	Early Learning Labs								x	
	4. The Early Learning Accomplishment Profile (E-LAP)^{1,2}	Chapel Hill Training-Outreach Project, Inc.	x							x	
Screener	5. Ages and Stages Questionnaire Training and Resources¹	Paul H. Brookes Publishing Co.								x	
Integrated Curriculum and Assessment:	6. Comprehensive Customer Support¹	Istation								x	
	7. Galileo Pre-K Online Professional Development^{1,2}	Assessment Technology Incorporated								x	
	8. Literacy Instruction and Assessments Archived Webinars¹	Imagine Learning								x	
	9. Professional Development	Hatch Early Learning								x	
	10. Texas Opening the World of Learning (OWL) Pre-K Curriculum and Assessment Professional Development	Pearson								x	

Professional Development Aim	Program or Product	Company, Publisher, or Developer(s)	Video Technologies								
			Video Exemplars	Videotape Feedback from a Coach or Trainer	Case-based Hypermedia Resource	Web-mediated Coaching	Videotape Feedback Sent to Practitioners via E-mail by Coach or Trainer	Video Self-reflection	Product Training and Implementation Videos	Video Conference	
	11. The DLM Early Childhood Express Resources	McGrawHill	x							x	
Instructional Tool	12. ActivTable¹	Promethean								x	
	13. Boardmaker Support^{1,2}	Mayer-Johnson								x	
	14. Interactive Whiteboard System and ActivInspire Software¹	Promethean								x	
	15. Promethean Planet - The World's Largest Interactive Whiteboard Community¹	Promethean								x	
	16. SMART Board Interactive Whiteboards and SMART Notebook Software^{1,4}	SMART Technologies								x	
	17. SMART Table 442i Collaborative Learning Center^{1,4}	SMART Technologies								x	
Practitioner Assessment	18. MyTeachingPartner³	Teachstone	x	x	x	x					
In-service Programs for Various Pedagogical Strategies and Subject Areas	19. Behavioral, Emotional, and Social Training-- Competent Learners Achieving School Success (BEST in CLASS)	University of Florida and Virginia Commonwealth University	x	x							
	20. Classroom Links to Vocabulary and Phonological Sensitivity Skills (Classroom Links to Early Literacy)	Karen Diamond and Douglas Powell	x	x	x						
	21. Distance Mentoring Model	Florida State University					x				

Professional Development Aim	Program or Product	Company, Publisher, or Developer(s)	Video Technologies								
			Video Exemplars	Videotape Feedback from a Coach or Trainer	Case-based Hypermedia Resource	Web-mediated Coaching	Videotape Feedback Sent to Practitioners via E-mail by Coach or Trainer	Video Self-reflection	Product Training and Implementation Videos	Video Conference	
	22. Early Childhood Learning and Knowledge Center (ECLKC)	Office of Head Start	x								
	23. eCIRCLE Online Professional Development	Children's Learning Institute	x				x				
	24. Learning Language and Loving It - The Hanen Program for Early Childhood Educators	The Hanen Centre	x	x							
	25. Literacy Environment Enrichment Program (LEEP)²	David Dickinson and Linda Caswell	x						x		
	26. Professional Development Products and Resources	Technical Assistance Center on Social Emotional Intervention for Young Children	x								
	27. Teacher Classroom Management Program¹	The Incredible Years	x								
TOTAL	27	27	13	4	2	2	1	1	16	0	

¹Includes technical support or customer service. ²Continuing education credits/clock hours or college credits included or optional. ³Includes coaching and mentoring. ⁴Includes mobile app to request support via one's mobile device.

Table 5.3. Online Coursework: Products and Programs that Support Professional Development, Classified by types of Online Coursework Technologies

Professional Development Aim	Program or Product	Company, Publisher, or Developer(s)	Online Coursework Technologies			
			Online Courses	Online Modules		
				Text	Embedded Video	Details Not Available
Curriculum	1. Second Step Early Learning Program	Committee for Children				x
	2. Teacher Training	International Preschool Curriculum	x			
Assessment	3. Children's Progress Academic Assessment¹	Northwest Evaluation Association	x			x
	4. COR Advantage Webinars¹	HighScope	x			
	5. myIGDIs Training¹	Early Learning Labs	x		x	
	6. The Early Learning Accomplishment Profile (E-LAP)^{1,2}	Chapel Hill Training-Outreach Project, Inc.	x			
Integrated Curriculum and Assessment	7. Comprehensive Customer Support¹	Istation			x	
	8. Core Knowledge Preschool Sequence and Preschool Assessment Tool Implementation Analysis Tools	Core Knowledge Foundation				x
	9. Galileo Pre-K Online Professional Development^{1,2}	Assessment Technology Incorporated	x			
	10. Online Sessions for The Creative Curriculum System for Preschool and Teaching Strategies Gold²	Teaching Strategies				x
	11. Preschool Curriculum and Child Observation Record Assessment^{1,2}	HighScope	x			x
	12. Professional Development	Hatch Early Learning	x		x	

Professional Development Aim	Program or Product	Company, Publisher, or Developer(s)	Online Coursework Technologies			
			Online Courses	Online Modules		
				Text	Embedded Video	Details Not Available
Instructional Tool	13. Boardmaker Support ^{1,2}	Mayer-Johnson	x	x	x	
	14. Promethean Planet - The World's Largest Interactive Whiteboard Community ¹	Promethean	x		x	
	15. SMART Board Interactive Whiteboards and SMART Notebook Software ^{1,4}	SMART Technologies	x			x
	16. SMART Table 442i Collaborative Learning Center ^{1,4}	SMART Technologies	x		x	
In-service Programs for Various Pedagogical Strategies and Subject Areas	17. Early Childhood Learning and Knowledge Center (ECLKC)	Office of Head Start		x	x	
	18. Early Childhood Online Distance Learning Program ²	Colorado Community College	x			
	19. eCIRCLE Online Professional Development	Children's Learning Institute	x			
	20. Center for Early Education and Development: Online Courses ²	University of Minnesota	x			
	21. Learner Services ²	MyCourseRoom	x			
	22. National Director Credential Modules ²	Aim4Excellence	x			x
	23. Online Professional Development Courses ²	Childcare Education Institute	x			
	24. Professional Development Products and Resources	Technical Assistance Center on Social Emotional Intervention for Young Children				x
25. Professional Development ²	Quality Assist	x				
TOTAL	25	25	19	2	7	8

¹Includes technical support or customer service. ²Continuing education credits/clock hours or college credits included or optional. ³Includes coaching and mentoring. ⁴Includes mobile app to request support via one's mobile device.

Table 5.4. Social Media Networking: Products and Programs that Support Professional Development, Classified by Types of Social Media Networking Technologies

Professional Development Aim	Program or Product	Company, Publisher, or Developer(s)	Social Media Networking Technologies						
			Connections to Common Social Media Outlets			Alternative Social Media Site	Blogs	Photo or Video Sharing	Forum
			Facebook	LinkedIn	Twitter				
Curriculum	1. Second Step Early Learning Program	Committee for Children					x		x
Integrated Curriculum and Assessment	2. Galileo Pre-K Online Professional Development ^{1,2}	Assessment Technology Incorporated							x
	3. PreK-3 Blended Learning Program Professional Development and Digital Learning Community ¹	AWE Digital Learning Solutions					x	x	x
Instructional tool	4. Promethean Planet - The World's Largest Interactive Whiteboard Community ¹	Promethean					x		x
	5. SMART Exchange, EDCompass Blog, and CoursePark Discussion Board	SMART Technologies					x	x	x
In-service Programs for Various Pedagogical Strategies and Subject Areas	6. eCIRCLE Online Professional Development	Children's Learning Institute							x
	7. Learner Services	MyCourseRoom	x	x	x				x
TOTAL	7	7	1	1	1	0	4	2	7

¹Includes technical support or customer service. ²Continuing education credits/clock hours or college credits included or optional.

Table 5.5. Other: Products and Programs that Support Professional Development, Classified by Other Types of Technologies

Professional Development Aim	Program or Product	Company, Publisher, or Developer(s)	Other Professional Development Technologies									
			Audio Self-reflection	Online Documents Library and User Guides	Online Reliability Exercises or Tests	User Resource Exchange	Streaming or Pre-Recorded Audio	Telephone Conference	Webinars		Online Peer-to-Peer Interaction	
									Archived	Live		
Curriculum	1. KidSmart Early Learning Program Resources	KidSmart		x								
	2. Pre-Kindergarten Learning System Videos and Webinar Series	InvestiGator Club							x			
	3. Second Step Early Learning Program	Committee for Children		x								
	4. Splash into Pre-K Curriculum Support¹	Houghton Mifflin Harcourt		x								
Assessment	5. Children's Progress Academic Assessment¹	Northwest Evaluation Association		x				x	x	x		
	6. COR Advantage Webinars¹	HighScope							x	x		
	7. myIGDIs Training¹	Early Learning Labs							x			
	8. The Early Learning Accomplishment Profile (E-LAP)^{1,2}	Chapel Hill Training-Outreach Project, Inc.							x			
	9. The Ounce Scale Training¹	Pearson		x					x	x		
	10. Work Sampling Online Training¹	Pearson		x					x	x		
Screener	11. Ages and Stages Questionnaire Training and Resources¹	Paul H. Brookes Publishing Co.		x					x			
	12. Devereux Early Childhood Assessment (DECA) Infant And Toddler Program Informational Webinars¹	Devereux Foundation							x	x		

Professional Development Aim	Program or Product	Company, Publisher, or Developer(s)	Other Professional Development Technologies									
			Audio Self-reflection	Online Documents Library and User Guides	Online Reliability Exercises or Tests	User Resource Exchange	Streaming or Pre-Recorded Audio	Telephone Conference	Webinars		Online Peer-to-Peer Interaction	
									Archived	Live		
Integrated Curriculum and Assessment	12. Comprehensive Customer Support¹	Istation								x	x	
	13. Core Knowledge Preschool Sequence and Preschool Assessment Tool Implementation Analysis Tools	Core Knowledge Foundation		x						x		
	14. Curiosity Corner Professional Development³	Success For All		x				x			x	
	15. Galileo Pre-K Online Professional Development^{1,2}	Assessment Technology Incorporated		x	x							
	16. Literacy Instruction and Assessments Archived Webinars¹	Imagine Learning								x	x	
	17. Online Sessions for The Creative Curriculum System for Preschool and Teaching Strategies Gold²	Teaching Strategies			x							
	18. PreK-3 Blended Learning Program Professional Development and Digital Learning Community¹	AWE Digital Learning Solutions		x						x	x	x
	19. Preschool Curriculum and Child Observation Record Assessment^{1,2}	HighScope			x					x		
	20. Professional Development	Hatch Early Learning		x						x	x	
	21. Texas Opening the World of Learning (OWL) Pre-K Curriculum and Assessment Professional Development	Pearson		x								
	22. The DLM Early Childhood Express Resources	McGrawHill		x								

Professional Development Aim	Program or Product	Company, Publisher, or Developer(s)	Other Professional Development Technologies									
			Audio Self-reflection	Online Documents Library and User Guides	Online Reliability Exercises or Tests	User Resource Exchange	Streaming or Pre-Recorded Audio	Telephone Conference	Webinars		Online Peer-to-Peer Interaction	
									Archived	Live		
Instructional Tool	23. ActivTable ¹	Promethean		x								
	24. Boardmaker Support ^{1,2}	Mayer-Johnson		x					x	x		
	25. Interactive Whiteboard System and ActivInspire Software ¹	Promethean		x								
	26. LeapPad 2 Learning Tablet Parent Guides and Support ¹	LeapFrog		x								
	27. Promethean Planet - The World's Largest Interactive Whiteboard Community ¹	Promethean		x		x			x	x	x	
	28. SMART Board Interactive Whiteboards and SMART Notebook Software ^{1,4}	SMART Technologies		x					x	x		
	29. SMART Exchange, EDCompass Blog, and CoursePark Discussion Board	SMART Technologies				x						
	30. SMART Table 442i Collaborative Learning Center ^{1,4}	SMART Technologies		x					x	x		
Practitioner Assessment	31. MyTeachingPartner ³	Teachstone		x	x				x			

Professional Development Aim	Program or Product	Company, Publisher, or Developer(s)	Other Professional Development Technologies									
			Audio Self-reflection	Online Documents Library and User Guides	Online Reliability Exercises or Tests	User Resource Exchange	Streaming or Pre-Recorded Audio	Telephone Conference	Webinars		Online Peer-to-Peer Interaction	
									Archived	Live		
In-service Programs for Various Pedagogical Strategies and Subject Areas	32. Early Childhood Learning and Knowledge Center (ECLKC)	Office of Head Start		x						x	x	
	33. Literacy Environment Enrichment Program (LEEP)²	David Dickinson and Linda Caswell	x									
	34. Professional Development Products and Resources	Technical Assistance Center on Social Emotional Intervention for Young Children		x			x			x	x	
	35. Professional Development Products and Resources²	STARNET Illinois					x			x	x	
TOTAL	36	36	1	24	4	2	2	2	23	17	2	

¹Includes technical support or customer service. ²Continuing education credits/clock hours or college credits included or optional. ³Includes coaching and mentoring. ⁴Includes mobile app to request support via one's mobile device.

Exemplars for Professional Development

To better understand how technology is currently being used to support practitioners' professional development, we present in-depth descriptions of three technology-first professional development exemplars that have an empirical evidence base in the literature: Classroom Links to Early Literacy, MyTeachingPartner (MTP), and eCIRCLE. Each of these programs is an example of a professional development program, that may involve coaching, coursework (e.g., online classes), or in-service trainings (e.g., on instructional techniques; on using a particular instructional tool, such as an interactive white board). As is common in the Professional Development and Informal Learning Topic Area, each program employs video as a key mechanism to educate practitioners.

When examining the evaluative literature, on the whole, across all evaluations of the professional development exemplars described below, positive effects were found for both practitioner and child outcomes. Especially noteworthy were the statistically significant effect sizes on measures of children's language and literacy development, particularly vocabulary and phonological awareness. On several measures, practitioners and children participating in Classroom Links, MTP, and eCIRCLE outperformed their counterparts in control and comparison groups. Of note, a number of the evaluations were designed to isolate the effect of a single technology or a combination of technologies on practitioner and child outcomes. In general, the use of video technology was found to be an effective technology to support coaching.

***Classroom Links to Early Literacy.*²⁸**

Classroom Links to Early Literacy is a 15-week remote coaching intervention for practitioners in either rural or urban Head Start classrooms whose students were four-years of age and likely to enter Kindergarten the following academic year. The first goal of Classroom Links is to improve practitioners' literacy instruction, namely through training them to implement specific, evidence-based instructional strategies that encourage children's use of language (e.g., directing questions of a particular type to children during large group reading to encourage conversation). The program's second goal is to improve children's literacy proficiency as measured by oral language skills (i.e., vocabulary knowledge, listening comprehension, and syntactic knowledge), phonological awareness, and letter knowledge. The intervention begins with two, 8-hour in-person workshops, during which literacy coaches introduce and guide practitioners through the intervention's instructional strategies. Following the workshops, each practitioner receives biweekly, individualized video-based feedback from coaches.

Four technologies are integral to Classroom Links' remote coaching: video cameras; asynchronous videotape feedback; Apple iBook computers (which practitioners were assigned for the duration of the project); and a "case-based hypermedia" resource. Practitioners use video cameras to record 15 minutes of targeted instruction and mailed the videotapes to remote coaches. Coaches select segments of these videos, for which they prepare feedback that includes assessments of practitioners' implementation of target instructional strategies and suggestions to improve implementation. Coaches transfer the selected segments and their feedback to DVDs, which they mail back to their practitioners. Practitioners use software on the iBook to view the DVDs in a split-screen format: on the left side of the screen, a coach-selected segment; on the right, the coach's feedback. To supplement coaches' feedback, practitioners can access a case-based hypermedia

²⁸ Classroom Links to Early Literacy was developed and evaluated by Drs. Karen Diamond and Douglas Powell at Purdue University.

resource preloaded on their iBook. The hypermedia resource includes 16 cases organized into five modules: Reading, Writing, Conversations with Children, Phonological Awareness, and Individualization. A total of 97, 2- to 3-minute video exemplars are available, in which Head Start practitioners who are not involved in the study expertly model the evidence-based instructional strategies. Each video exemplar also includes text that outlines the essential aspects of the practice in the video. Adding to the video exemplars are 33 published articles written for the early childhood practitioner audience, links within each case to related cases, and references to additional related readings.

The evidence base for Classroom Links consisted of two evaluative articles that examined the impact of the program as a whole on practitioner outcomes (Powell, Diamond, & Burchinal, 2012; Powell, Diamond, Burchinal, & Koehler, 2010). Both articles specifically tested the impact of video technology on three types of outcomes: practitioner-focused outcomes (e.g., promoting word use among children, eliciting children’s speaking through book reading and free play, defining words, labeling objects, number of utterances), child-focused outcomes (e.g., vocabulary, alphabet knowledge, concepts about print, name writing, blending sounds, number of utterances), and classroom-focused outcomes (i.e., “General Classroom Environment” and “Language, Literacy, and Curriculum” subscale scores from the Early Language and Literacy Classroom Observation [ELLCO] Tool). The results of these studies suggest that Classroom Links – which utilizes video cameras, asynchronous videotape feedback, Apple iBook computers, and a case-based hypermedia resource—can produce large effects on practitioners’ vocabulary instruction, large effects on the classroom-level language and literacy environment, and small to moderate impacts on children’s emergent literacy outcomes.

My Teaching Partner (MTP).^{29,30,31}

MTP is a professional development support system designed to improve children’s language, literacy, and social and emotional development. It does so through practitioners’ implementation of evidence-based instructional strategies that promote effective practitioner-child interactions. Practitioners participate in the MTP program for at least 10 weeks, during which they (a) participate in remote coaching sessions where they receive direct, individualized feedback on their teaching, and (b) engage in other forms of professional development to build their skill in the initiation and maintenance of effective practitioner-child interactions. It is worth noting that MTP is curriculum neutral.

MTP relies primarily on three technologies: video recordings of practitioner-child interactions; a form of case-based hypermedia; and real-time, web-mediated videoconferencing during coaching sessions. Coaches and practitioners use these technologies during MTP’s *five-step cycle*, which repeats every two to three weeks. First, the practitioner uses either a video camera or a mobile device (i.e., a tablet or smartphone) to record a 30-minute lesson. The practitioner then sends the video to the coach (i.e., by sending the videotape or SD card through the mail or uploading the digital video to a secure website). Second, the coach reviews, edits, and adds feedback to the video. To assess practitioner-child interactions, the coach uses Teachstone’s Classroom Assessment Scoring System

²⁹ <http://curry.virginia.edu/research/centers/castl/mtp>

³⁰ <http://teachstone.com/services/training/other-trainings/myteachingpartner-coaching/>

³¹ MTP was developed by Drs. Robert Pianta and Bridget Hamre at the University of Virginia Curry School of Education’s Center for Advanced Study of Teaching and Learning.

(CLASS),³² a validated observational tool that scores these interactions within three domains: Emotional Support, Classroom Organization, and Instructional Support. The coach then makes the edited video and feedback available securely on the MTP website for the practitioner to review. In addition, the coach includes an MTP prompt for the practitioner to reflect on. Third, the practitioner reviews the coach-selected video segments and feedback and responds to the prompt. Fourth, the practitioner and coach participate in a real-time, one-on-one videoconference, during which they watch the edited video together and discuss the practitioner's implementation of the activities as well as the practitioner's response to the prompt. Finally, the coach creates a written action plan for the practitioner to execute prior to the start of the next MTP cycle. Typically, in the action plan, the coach recommends case-based hypermedia resources for the practitioner to consult, all of which are available online and include: sample weekly lesson plans; video exemplars on particular activities and strategies; and professional development materials (e.g., readings on dimensions of Quality Teaching, the instructional and social interactions that practitioners can use to improve children's academic and social development).

The evidence base for MTP consisted of six evaluative articles, all of which examined the impact of ongoing, one-on-one web-mediated video consultancy (i.e., coaching) on practitioner- and child-focused outcomes (Downer, Kraft-Sayre, & Pianta, 2009; Downer et al., 2011; Lee, Kinzie, & Whittaker, 2012; Mashburn, Downer, Hamre, Justice, & Pianta, 2010; Pianta, Mashburn, Downer, Hamre, & Justice, 2008; Whitaker, Kinzie, Kraft-Sayre, Mashburn, & Pianta, 2006). Practitioner-focused outcomes included classroom behavior management and program use (e.g., the number of minutes spent on MTP-related tasks, the frequency of use of MTP resources, and the number of website log-ins). Child-focused outcomes included vocabulary, phonological and print processing, blending sounds, lexical diversity, syntactic complexity and emergent literacy in general. The articles showed that practitioners who participated in MTP coaching were significantly more engaged in their professional development (as measured by practitioner-focused outcomes such as time spent on the website and frequency of visits to the website) than their comparison group counterparts. In turn, children whose practitioners used MTP made greater gains in child-focused outcomes, such as language and emergent literacy, than did children in the comparison groups. Overall, the results from the evaluative literature suggest that MTP, with its technology mediated coaching and professional development resources, can positively impact both practitioner and ultimately child outcomes.

eCIRCLE.^{33,34}

eCIRCLE is the professional development arm of the *Texas School Ready!* (TSR) project,³⁵ a comprehensive program that both trains early childhood practitioners to implement a state-adopted curriculum and delivers ongoing professional development, coaching, and child progress monitoring. eCIRCLE provides practitioners with formal training on the following topics: phonological awareness, letter knowledge, effective book reading, building vocabulary, building language and conversational skills, math, science, working with special needs children, social-emotional development, management and routines, and classroom set-up. eCIRCLE is delivered

³² <http://teachstone.com/the-class-system/>

³³ <http://www.childrenslearninginstitute.org/our-programs/program-overview/tx-school-ready/development/ecircle.html>

³⁴ eCIRCLE was developed under the direction of Dr. Susan Landry at the Children's Learning Institute at the University of Texas Health Science Center at Houston (UTHealth).

³⁵ <http://www.childrenslearninginstitute.org/our-programs/program-overview/TX-school-ready/>

either remotely via the web or in a blended learning format. In the blended learning format, practitioners meet with their professional learning groups and their community's TSR mentor, typically in their local high school computer lab. The mentor facilitates conversations on the materials in the eCIRCLE program.

eCIRCLE requires Internet access and a computer with audio and video capabilities. Practitioners work through 17 courses, each lasting between 4 and 8 hours. According to an expert interview with Dr. Landry, the average practitioner typically takes two years to complete all eCIRCLE coursework. Each course centers on a specific topic. The three major components of every course are videos, activities, and assessments. The videos in each course are narrated by an expert commentator. They show one or more of the same expert practitioners in typical school or instructional settings (e.g., their classrooms, in small and large groups, on the playground, during lunchtime) executing activities or instructional techniques relevant to the course topic (e.g., phonological awareness activities or instructional techniques). In addition to viewing videos, practitioners complete activities and post their work to an online forum accessible to their professional learning group. Finally, practitioners complete learning assessments, which earns them professional development credit hours or college credit. In its ultimate form, eCIRCLE will be completely web-based, will include remote coaching, and will replace in-person meetings with virtual meetings. This new web-based version of eCIRCLE is currently under development.

The evidence base for eCIRCLE consisted of two evaluative articles (Landry, Anthony, Swank, & Monseque-Bailey, 2009; Landry, Swank, Anthony, & Assel, 2010). Neither of the articles tested the impact of the use of specific eCIRCLE technologies on practitioner or child outcomes. However, the articles did examine the impact of the eCIRCLE program as a whole on practitioner-focused outcomes (e.g., teaching quantity, teaching quality, and practitioner instructional behaviors) or child-focused outcomes (e.g., vocabulary, print awareness, phonological awareness, and print knowledge). Overall, the articles showed that practitioners who participated in eCIRCLE professional development and also implemented the technology-enhanced version of the associated C-PALLS assessment displayed higher quality instruction than control group practitioners. In addition, their children achieved significantly greater gains on language and emergent literacy outcomes than their control group counterparts. Thus, the results from evaluations of eCIRCLE suggest that this technology-enhanced professional development program can have a positive impact on both practitioner and child outcomes.

3.2 Technologies that Support Informal Learning

Our web search identified 15 technologies that early childhood practitioners use to support informal learning. As with professional development, the informal learning technologies were classified into four main categories: video-enabled informal learning, online coursework, social media networking, and other. Each of these four categories and their associated technologies and sample uses within the Topic Area are listed in Table 5.6. Detailed definitions for each of the technologies are available in the Appendix C: Glossary.

Video-enabled informal learning technologies included: video conferences, video exemplars, and product training and implementation videos. Online-coursework included both online courses and online learning modules. Social media networking technologies included: alternative social media networking sites, blogs, forums and photo/video sharing technologies. Practitioners used other technologies for informal learning including: online document libraries and user guides, user

resource exchanges, audio recordings, teleconferences, online peer-to-peer interaction, and webinars (live and/or archived).

Table 5.6. Technologies that Support Informal Learning

Technology	Technology Category	Definition	Example(s) of Practitioner Use	Example(s) of Coach/Trainer Use
Product Training and Implementation Videos	Video-enabled Informal Learning	How-to videos associated with specific products/programs.	<ul style="list-style-type: none"> Learn how to access or use a feature of a product or program 	N/A
Video Conferences	Video-enabled Informal Learning	Real-time video enabled meetings among practitioners that occur over the Internet. Video conferences require computers or mobile devices, an internet connection, and access to video and audio capabilities.	<ul style="list-style-type: none"> Engage in real-time meetings with practitioners or coaches 	N/A
Video Exemplars	Video-enabled Informal Learning	Recordings that depict model practitioner actions (e.g., execution of a particular instructional strategy with high level fidelity of implementation).	<ul style="list-style-type: none"> View by oneself as part of an online-course 	<ul style="list-style-type: none"> Coach shows video exemplars as part of a coaching session
Online Courses	Online Coursework	Formal courses available through the Internet. Online courses typically follow an academic calendar (i.e., one quarter, one semester or longer) and are led by an instructor.	<ul style="list-style-type: none"> Complete online courses individually or as part of a larger professional development program 	N/A
Online Modules	Online Coursework	A small/defined instructional unit available through the Internet. Modules are by definition shorter in duration than online courses (e.g., the materials may be viewed in one sitting), designed to be completed independently, typically completed asynchronous within an academic calendar, and usually not led by an instructor.	<ul style="list-style-type: none"> Complete online modules individually or as part of a larger professional development program 	N/A

Technology	Technology Category	Definition	Example(s) of Practitioner Use	Example(s) of Coach/Trainer Use
Alternative Social Networking Sites	Social Media Networking	Similar in function and features to common social networking sites (e.g., Facebook, LinkedIn and Twitter), but tailored for specific audiences, topics, or purposes.	<ul style="list-style-type: none"> Communicate and collaborate with other practitioners through virtual professional working groups (PWG) or professional learning communities (PLC) 	N/A
Blog	Social Media Networking	A personal, public website or webpage where an individual can regularly post text, web-links and a variety of media for others to read and view. Practitioners maintain blogs to share thought and ideas, and engage in discussions with peers (e.g., via comments on posts). Companies might also maintain blogs on which practitioners write posts and engage in asynchronous conversations with peers.	<ul style="list-style-type: none"> Share thoughts and ideas and engage in asynchronous discussions with peers 	N/A
Forums	Social Media Networking	Online discussion boards, typically geared toward a particular audience and designed to engage other members of the online community on a particular issue or topic.	<ul style="list-style-type: none"> Engage other practitioners of an online community on a particular issue or topic 	N/A
Photo or Video Sharing	Social Media Networking	Enabled by social networking sites or other sites designed specifically for sharing multimedia (e.g., Vimeo, Flickr).	<ul style="list-style-type: none"> Share with peers photos of their classrooms, videos that they made, or videos they found elsewhere). 	N/A
Audio	Other	Pre-recorded voice recordings or live streamed voice available via the Internet.	<ul style="list-style-type: none"> Listen to pre-recorded voice recordings or live streamed voice available over the internet 	N/A
Online Documents and User Guides	Other	Web-based repositories of user manuals or help files for practitioners to consult if they have questions about how to use a product/program.	<ul style="list-style-type: none"> Learn to use the features of a technology Troubleshoot technical problems with a technology 	N/A
Online Peer-to-Peer Interactions	Other	Practitioners interact with one another directly through a website.	<ul style="list-style-type: none"> Interact with other practitioners in real-time or asynchronously over the Internet 	N/A

Technology	Technology Category	Definition	Example(s) of Practitioner Use	Example(s) of Coach/Trainer Use
Telephone Conference	Other	Conferences consist of two or more participants held over a dedicated telephone line. One-to-one teleconferences (i.e., a consultation) with a coach may occur as part of ongoing support and be included with a subscription to a particular informal learning product /program.	<ul style="list-style-type: none"> • Listen to a group presentation or participate in a group discussion 	N/A
User Resource Exchanges	Other	Web-based, member-accessible central repositories where practitioners can freely share resources with one another.	<ul style="list-style-type: none"> • Share instructional resources with other practitioners 	N/A
Webinars	Other	A seminar, lecture, presentation, workshop, or other learning session held over the Internet. Organizations and companies offer live and/or archived webinars.	<ul style="list-style-type: none"> • Learn about a product or program • Learn how to use or access features of a product or ask specific questions about the product • View a live presentation on a particular topic • Participate in a discussion with other practitioners 	N/A

In addition to identifying technologies, a broad, but not exhaustive, web-search identified eight unique products/programs that support informal learning and use one or more of the technologies. The most common technologies used for informal learning were: online peer-to-peer networks (4), alternative social media sites (3), blogs (3), forums (3), and photo or video sharing tools (3).

Below we present our findings for technologies that support informal learning in four separate tables organized by the following four technology categories: video-enabled informal learning (Table 5.7); online coursework (Table 5.8); social media networking (Table 5.9); and other forms of technology (Table 5.10). The tables also include information about the primary aim of the product/program. Aims for informal learning products/programs may be to support independent learning or to foster peer collaboration. We do not present an exemplar for informal learning due to the limited sample of products/programs and lack of any evaluative literature in this area.

Table 5.7. Video: Products and Programs that Support Informal Learning, Classified by Types of Video Technologies

Informal Learning Aim	Program or Product	Company, Publisher, or Developer(s)	Video Technologies								
			Video Exemplars	Videotape Feedback from a Coach or Trainer	Case-based Hypermedia Resource	Web-mediated Coaching	Videotape Feedback Sent to Practitioners via E-mail by Coach or Trainer	Video Self-reflection	Product Training and Implementation Videos	Video Conference	
Independent Learning	1. Kidvision Virtual PreKindergarten Teacher Development	PBS Learning Media								x	
	2. Professional Development	Los Angeles County Office of Education									x
	3. Professional Development Videos and Resources	Eastern Connecticut State Center for Early Childhood Education	x								
TOTAL	3	3	1	0	0	0	0	0	0	1	1

Table 5.8. Online Coursework: Products and Programs that Support Informal Learning, Classified by Types of Online Coursework Technologies

Informal Learning Aim	Program or Product	Company, Publisher, or Developer(s)	Online Coursework Technologies			
			Online Courses	Online Modules		
				Text	Embedded Video	Details Not Available
Independent Learning	1. Birth to 3 Professional Development and On-Line Learning	University of Wisconsin-Madison Waisman Center	x		x	
	2. Professional Development	Los Angeles County Office of Education	x		x	
TOTAL	2	2	2	0	2	0

Table 5.9. Social Media Networking: Products and Programs that Support Informal Learning, Classified by Types of Social Media Networking Technologies

Informal Learning Aim	Program or Product	Company, Publisher, or Developer(s)	Social Media Networking Technologies						
			Connections to Common Social Media Outlets			Alternative Social Media Site	Blogs	Photo or Video Sharing	Forum
			Facebook	LinkedIn	Twitter				
Independent Learning	1. Early Childhood Professional Development Resources and Social Media	Engagement Strategies, LLC					x		
Peer Collaboration	2. Early Childhood Exchange	Ning				x	x	x	x
	3. Think Early Childhood: Maryland's Online Community for Early Childhood Educators	Ning				x	x	x	x
	4. Video Sharing	TeacherTube				x		x	x
TOTAL	4	4	0	0	0	3	3	3	3

Table 5.10. Other: Products and Programs that Support Informal Learning, Classified by Other Types of Technologies

Informal Learning Aim	Program or Product	Company, Publisher, or Developer(s)	Other Informal Learning Technologies									
			Audio Self-Reflection	Online Documents Library and User Guides	Online Reliability Exercises or Tests	User Resource Exchange	Streaming or Pre-Recorded Audio	Telephone Conference	Webinars		Online Peer-to-Peer Interaction	
									Archived	Live		
Independent Learning	1. Birth to 3 Professional Development and On-Line Learning	University of Wisconsin-Madison Waisman Center		x				x	x			
	2. Early Childhood Professional Development Resources and Social Media	Engagement Strategies, LLC								x	x	x
	3. Professional Development	Los Angeles County Office of Education								x	x	
Peer Collaboration	4. Early Childhood Exchange	Ning				x						x
	5. Think Early Childhood: Maryland's Online Community for Early Childhood Educators	Ning										x
	6. Video Sharing	TeacherTube										x
TOTAL	6	6	0	1	0	1	1	1	1	2	2	4

Topic Area 4 – Facilitators and Barriers to Technology Use

Topic Area 4 examined the facilitators and barriers to practitioners' effective use of technology to support early childhood practice. Topic Area 4 is different from the preceding topic areas in that: 1) the primary data source was the expert interviews rather than web searches or academic searches; and 2) the scope of the topic area encompassed all three prior Topic Areas 1 through 3. The goal of Topic Area 4 was to obtain from experts in the fields of early childhood Instruction and Assessment, PFCE, and Professional Development and Informal Learning, first-hand reports of activities and variables that they have found promote and hinder early childhood practitioner's successful use of technology. The section of the expert interview protocol dedicated to Topic Area 4 contained two specific inquiries:

- 4.1 How have early childhood programs (Head Start in particular) that have successfully implemented technology into their programs overcome barriers to implementation?
- 4.2 Is staff development a factor limiting the fidelity of implementation of technology in early childhood settings?

Based on our findings from the expert interviews, early childhood programs face many similar obstacles to effective uses of technologies, as well as solutions to overcome them. The three most frequently noted barriers include: insufficient technological literacy among practitioners; inadequate access to technology resources; and lack of support from administrators. The three most frequently recommended solutions to overcome these barriers were to: give practitioners access to contemporary, functional technology resources; provide practitioners with quality professional development to use the technology; and explain to practitioners how the technology will directly benefit their practice.

An important finding was the critical role early childhood administrators play in either encouraging or hindering practitioners' use of technology. The experts interviewed often described how administrators support practitioners' use of technology by providing adequate funding, technological infrastructure, training and professional development, technical support, and explicit encouragement; therefore, administrators appear to be best able to affect positive practitioner outcomes in regard to technology use. On the other hand, if administrators are indifferent or hostile towards their practitioners' use of technology, even the most self-motivated practitioners will find it difficult to use technology with fidelity.

4.1 Overcoming Barriers to Technology Use

Barriers to Technology Use. Prior to discussing successful efforts to overcome obstacles to the use of technology, we first summarize common barriers to technology identified by our experts. Table 6.1 lists the frequencies of ten obstacles that experts stated hindered early childhood practitioners' use of technology. As listed in the table, the three most frequently noted barriers include: insufficient technological literacy among practitioners (12 experts); inadequate access to technology resources (9); and lack of support from administrators (6).

Table 6.1. Frequencies of Expert-Nominated Barriers to Technology Use

Barriers	Total	Description
Technological literacy	12	Practitioners with limited knowledge about the technology, familiarity with the technology, understanding of how to use the technology (both conceptual and procedural), and comfort using the technology, have difficulty using technology to support practice.
Access to technology resources	9	Inadequate access to reliable (i.e., working) technology, quality software, up to date technology (both hardware and software), and broadband Internet access can severely hinder technology use.
Administrators' support	6	When administrators do not support or are ambivalent towards use of technology, practitioners are either not inclined to use the technology or are unable to do so successfully.
Funding	5	Technology is costly. Many early childhood programs lack sufficient funding to make such significant investments in technology.
Time	4	Practitioners have difficulty finding time to learn to use a new technology and then use the technology during an already busy work day.
Research on technology efficacy	4	The relatively sparse evidence base for currently available technologies leaves decision makers at a loss for determining which technologies are wise investments.
Training	3	Practitioners do not receive training on how to use the technology, nor why the technology is helpful to their practice.
Negative attitudes toward technology	2	Some practitioners believe that technology is inappropriate in early childhood settings and resist its implementation.
Staff turnover	1	The loss of a well-trained technology user may diminish or eliminate a program's internal capacity to continue its use.
Difficult to use	1	When a technology is not easy to use, practitioners will stop using it.
Total	47	

The most common barrier mentioned was practitioners' lack of knowledge about the technology, familiarity with the technology, understanding of how to use the technology (both conceptual and procedural), and comfort using the technology (i.e., technological literacy). Experts consistently noted that practitioners who had low levels of technological literacy, not only for the specific technology in question, but for technology in general, had difficulty using technology to support practice.

The second most frequently nominated barrier was practitioners' inadequate access to technology resources. Experts noted the absence of access to reliable technology, quality software, up-to-date technology (both hardware and software), and broadband Internet. Access to broadband Internet was a particularly notable barrier because it eliminates many current technology-enhanced options for practitioners' use (e.g., SaaS, remote coaching). Many experts stated that while Internet access in general has significantly improved, many early childhood programs fail to have consistent or high quality connections.

Experts nominated the lack of support from administrators for technology use as the third most frequent barrier to technology use. Experts noted that when administrators do not support or are ambivalent towards their staff's use of technology, practitioners are either not inclined to use the technology or are unable to do so successfully. Administrators that do not support or are ambivalent towards technology use do not typically provide practitioners with resources to support its use (i.e., funds to purchase or maintain the technology, training or professional development to use the technology, adequate technology infrastructure to properly implement the technology, or access to tech support to solve problems).

In addition to the more frequently named barriers, our experts referenced several other common barriers to technology use, including the cost associated with implementing some technologies, a lack of time to learn to implement and then use a new technology, and the need for clarity as to which technologies were useful to practitioners and effective in producing positive impacts on children.

Facilitators to Overcome Barriers to Technology Use. Each of the 16 experts were also asked to describe what they considered the top three facilitators that lead to early childhood practitioners' successful use of technology to support instruction and assessment, PFCE and professional development and informal learning. Table 6.2 lists the frequencies with which experts nominated each of twelve facilitators for early childhood practitioners' use of technology.

Table 6.2. Frequencies of Expert-Nominated Facilitators for Technology Use

Facilitators	Total	Description
Access to technology	6	When practitioners have access to contemporary, reliable technology, they are more likely to be familiar with it and feel comfortable using it.
Professional Development/training	6	Quality professional development allows practitioners to be more knowledgeable and feel more comfortable using technology.
Understanding benefits to practice	6	Observing a peer use a technology, or obtaining guidance from a coach can help practitioners understand how and why a technology can benefit their practice.
Technical support	5	Availability of a resource that can assist practitioners when they inevitably run into an obstacle using the technology facilitates continued technology use.
Administrators' support	5	Support in the form of adequate funding for the purchase, maintenance and updating of requisite technologies; encouragement to attend trainings and professional development sessions; modeling positive attitudes toward technology use; and recognizing staff who use technology well leads to high levels of practitioner fidelity of technological implementation.
Dedication to self-improvement	4	Tapping in to practitioners' innate motivation to improve and excel at their practice can facilitate adoption and effective implementation of new technologies
New/better technology	4	New technologies are increasingly more user-friendly. Practitioners who feel comfortable with the technology are more likely to use the technology.
Ease of use	3	Practitioners prefer to use technology that is intuitive to operate, does not take too much time to use, and does not take too much training to use or technical support to implement with fidelity.

Facilitators	Total	Description
Positive attitudes towards tech	3	Practitioners with positive attitudes towards technology are more open to learning about a new technology and how it can help them improve their practice.
Data to improve program outcomes	2	Technologies that provide objective data on their use (particularly as they relate to student and practitioner outcomes) can be an effective way to obtain support from administrators.
Coaching	2	Coaches tailor learning for an individual practitioner and model effective use of a technology.
Feeling connected to peers	1	Connect practitioners with one another and allow them to engage with the wider early childhood community can further support technology use.
Total	47	

Experts nominated with equal frequency three common facilitators to overcome barriers to technology use among early childhood practitioners. The first facilitator had to do with practitioners' access to and experience with technology. When practitioners had regular and repeated access to technology both at their workplace and in their personal lives, they were more likely to be familiar with the technology, know how to use it, and feel comfortable doing so. An excellent example is practitioners' familiarity with mobile device technology. Most practitioners are familiar with mobile devices from their use of this technology in their personal lives (e.g., smartphones and tablet computers). As such, products/programs that utilize mobile devices are more familiar, easier to learn, and more likely to be used with fidelity than a technology with which the practitioner has no previous experience.

A second commonly nominated facilitator for technology use was adequate professional development and training on how to use technology (procedural training) and why it is helpful to the practitioner (conceptual professional development). When practitioners are provided quality professional development and given adequate time to complete it, they are more knowledgeable and feel more comfortable using the technology with fidelity.

Related to this facilitator is helping practitioners understand and observe explicitly how the technology can help improve their practice. While professional development and training are two methods for imparting this understanding, observation of a peer using a technology, or guidance from a coach can help practitioners understand how and why a technology can benefit them. Once practitioners understand how technology will support their practice, they are more likely to use it.

In addition to these three frequently nominated facilitators, experts also recommended access to quality technical support. Technical support can be provided in person by an on-site expert or remotely by an off-site expert via phone, email, or Internet forum. Technical support can also be built directly into the technology itself (i.e., self-help options). Regardless of how technical support is delivered, availability of a resource that can assist the practitioner when they inevitably run into an obstacle using the technology is critical. Without readily accessible technical support, a practitioner may choose to stop using the technology regardless of their own motivation or best intentions.

Experts noted that while technical support can provide practitioners with the practical assistance they need to solve a technological problem, support from administrators for technology use is an important condition for continuous practitioner use. Experts recommended a number of steps that administrators could take to support technology use among their practitioners. Administrators

should provide adequate funding for the purchase, maintenance and updating of requisite technologies. They should ensure that the practitioners have access to requisite infrastructure (e.g., reliable Internet access) and ongoing technical support. They should also encourage practitioners to attend trainings and professional development sessions that will assist them in using the technology effectively. In addition, administrators can lead by example, modeling positive attitudes toward technology use (e.g., attending trainings with their staff and using the technology themselves when possible) and recognizing staff who use technology particularly successfully. Finally, experts noted that administrators who create a supportive atmosphere in regard to technology use typically produce high levels of practitioner fidelity of technological implementation.

4.2 Staff Development as a Limiting Factor

It is clear from the expert interviews that staff development was one of the most common barriers to successful use of technology among early childhood practitioners. According to our expert interviews, many practitioners have low-levels of technological literacy, which impedes their ability to use new technologies and leads to feelings of discomfort and unease. Experts noted that this is a common obstacle, but one that is rapidly becoming less prevalent as new and more familiar technologies are being harnessed for used in early childhood instruction and assessment, PFCE and professional development and informal learning. Two common examples offered by experts are the increasing use of mobile devices and social media in early childhood products/programs and services. The majority of early childhood practitioners are familiar with these technologies from their own personal uses (e.g., smartphones, iPads/tablets, and Facebook/LinkedIn). By incorporating technologies familiar to practitioners and designing them to be user friendly, early childhood product/program developers can best ensure that their technologies will be used with fidelity.

4. Conclusions

The purpose of this report was to review the knowledge base on the use of technology to support the practice of early childhood professionals who work directly with children and families. The results were intended to fill a knowledge gap regarding what technologies are currently available to early childhood programs; how practitioners are using these technologies on a regular basis; the barriers to and facilitators for practitioner use. As such, the search was guided by eight research inquiries among four primary Topic Areas of interest to ACF/OPRE: 1) instruction and assessment, 2) parent, family and community engagement (PFCE), 3) professional development and informal learning, and 4) facilitators and barriers to technology use. Below we provide brief summaries of the findings for each research inquiry organized by Topic Area.

Topic Area 1 – Instruction and Assessment

Topic Area 1 explored the potential of current and emerging technologies to support practitioners' instruction and assessment of young children. The results of our review of instruction and assessment technologies are organized by the following three research inquiries:

- 1.1 What technologies are currently used in early childhood settings with children to support instruction and assessment?
- 1.2 How do practitioners use technology with children for instruction and assessment?
- 1.3 How is technology used to track progress and individualize instruction/services to children?

1.1 What technologies are currently used in early childhood settings with children to support instruction and assessment?

Our broad but not exhaustive web-search identified 12 technologies that early childhood practitioners are currently using to support instruction and assessment. Hardware includes: computers, interactive books, interactive whiteboards, mobile devices, movement sensors, multi-touch tables, and proprietary computers. Software includes: apps for mobile devices, eBooks, software as a service (SaaS), and traditional software. Practitioners also use video technology to support instruction.

Because the instruction and assessment Topic Area is so expansive, we outline the use of these technologies within three more focused categories: 1) curricula and instructional tools; 2) assessments; and 3) integrated curricula and assessments. Curricula frequently use computers and traditional software to deliver content to children, though more cutting edge curricula also feature web-based software as a service (SaaS). *ABCmouse.com* serves as an exemplar for a contemporary web-based SaaS curriculum that practitioners can use with children in their classroom and share with parents to use with their children at home. The software is optimized for both computers and apps for mobile devices, and it can also be used on interactive white boards.

Instructional tools are intended to assist practitioners with direct instruction, often with multiple children at once. In the case of instructional tools, the tool and the technology are generally one in the same. Two instructional tool exemplars are the *Inspire-NG multi-touch table* and interactive whiteboards. The Inspire-NG multi-touch table consists of a 40-inch HD touchscreen mounted on a pivoting, height-adjustable, hydraulic platform on wheels. It can recognize as many as 50 individual touches simultaneously, allowing for multiple children and the practitioner to interact with the tool

simultaneously. The table comes pre-loaded with proprietary software that allow children to engage in open-ended activities that teach literacy and language. Interactive whiteboards such as the SMART Board and the Promethean ActivTouch have similar technical features in that they allow children to use touch to manipulate digital displays projected on the board. In addition, however, interactive whiteboard software allows practitioners to download or develop their own lessons and instructional materials.

Assessments use computers and SaaS, typically to enter data and report results. During the review, we learned that most standalone assessments do not require the use of technology. The assessments are administered with paper and pencil and can be hand scored on the paper record form. They do, however, have a traditional software component or SaaS that will store data, score data, and report results. The current version of *myIGDIs* served as an exemplar to illustrate such an assessment. Newer technology is allowing practitioners to collect assessment data directly on mobile devices and upload the data directly to the SaaS via the Internet. *mCLASS:CIRCLE* served as a technology-first exemplar for this type of assessment. Of note, *myIGDIs* is also actively adapting its assessment to be a completely web-based SaaS as well.

Integrated curricula and assessments also commonly use computers and software (particularly SaaS). The software for these products/programs requires immediate access to assessment data so it can make accurate instructional suggestions. Given this interdependence, integrated curricula and assessments often require the use of technology (i.e., it is not optional). This is particularly true among products/programs that were originally designed to be interdependent. *Building Blocks: Real Math PreK* and *Making Online Decisions (MOD)* are exemplars for such products/programs. Advances in technology have made the integration of assessments and curricula via technology a goal of many products/programs that were originally paper-based. *The Creative Curriculum System for Preschool* and *Teaching Strategies Gold (TS GOLD)* represents a curriculum and assessment system that has completed further integration in the form of a SaaS, and are currently developing a technology-first version (*PLUS*). As with standalone assessments, integrated curricula and assessments are actively adapting their products/programs for use on mobile devices.

1.2 How do practitioners use technology with children for instruction and assessment?

In order to learn how practitioners use technology to support instruction and assessment, we searched for products/programs that use the 12 technologies. The 53 resulting products/programs are concrete examples of how practitioners use technology to instruct and assess children. Of the 53 products/programs, 20 used technology with a curriculum or as an instructional tool, 11 with an assessment, and 22 with an integrated curriculum and assessment. The 22 integrated curricula and assessments enable practitioners to simultaneously track progress and individualize instruction and are therefore discussed in more detail under Inquiry 1.3.

Technology was an integral component of two-thirds of the products/programs (i.e., technology-first), meaning that the product/program could not function properly without the use of technology. All of the products/programs were designed to be used “out of the box,” and only a small proportion also included features that allowed for practitioner customization. The large majority of products/programs covered more than one content area (e.g., language and literacy, mathematics, science, social-emotional development).

Curricula and instructional tools support practitioners’ instruction. In regard to curricula, practitioners frequently use computers and traditional software to deliver content to children. More

cutting edge curricula feature web-based content, often as SaaS. The advantage of a web-based curriculum is that it can be made available to both practitioners and families (e.g., *ABCmouse.com*). It can also be updated more frequently than paper-based curricula. Whereas practitioners use curricular technologies to convey information to children, they use instructional tool technologies to facilitate instruction. For example, practitioners can use interactive whiteboards to involve children in interactive lessons provided by curriculum developers. However, they can also use whiteboard software to develop their own lessons. The touch-activated nature of interactive whiteboards and multi-touch tables are particularly engaging for young children.

With respect to assessments, practitioners typically use computers and SaaS to entering data and obtain outcome reports. In the absence of technology, practitioners must conduct an assessment with paper and pencil, and then score the results on the paper record form. Some assessments may have a paper report template that the practitioner must also complete. With technology, practitioners enter data into the assessment's software package. Then software scores the data and produces a report. Autoscoring and reporting reduces potential for error. Newer technology is allowing practitioners to collect assessment data directly on mobile devices, eliminating the need to transfer data from a paper form. Some cutting edge assessments are eliminating data entry altogether by having children respond to assessment items directly, typically on a mobile device's touchscreen (e.g., *mCLASS:CIRCLE*).

1.3 How is technology used to track progress and individualize instruction/services to children?

Integrated curriculum and assessment packages are designed specifically to track student progress and individualize instruction to children. Integrated curricula and assessments are typically powered by traditional software or SaaS, and operate on non-proprietary hardware (e.g., a computer, a mobile device). Practitioners collect assessment data on a mobile device (e.g., tablet computer) or desktop computer, which is then saved to a web-based SaaS. The software automatically scores the assessment and offers the practitioners instructional suggestions based on assessment results.

Advances in technology have allowed these packages to provide practitioners with timely and accurate information that supports effective data-based decision making. These packages often have the ability to track progress and provide instructional suggestions for a single child or for multiple children. Aggregating data across multiple children allows the program to suggest small groups based on objective data. The algorithms that make these suggestions, either for groups of children or for a single child, are typically based on scientific research. Overall, the intentional integration of an assessment and curriculum via technology allows the practitioner to not only instantaneously assess, score, and obtain reports on child outcomes, but also receive immediate, evidence-based instructional suggestions. Fully-integrated technology-first curricula and assessments are becoming widely available to early childhood practitioners. Given that these potential advantages afforded by this cutting-edge technology, many developers, researchers and companies are currently working to create new or integrate existing curricula and assessments.

Topic Area 2 – PFCE

Topic Area 2 focused on technologies practitioners use to support parent, family, community engagement (PFCE). The review of PFCE technologies was guided by the following research inquiry:

2.1 What technologies are commonly used to support parent, family and community engagement (PFCE) for children?

The web search identified eight technologies that early childhood practitioners use to support PFCE. Hardware included: computers, mobile devices, and the LENA system. Software included: traditional software, SaaS, and apps. An additional technology used to support PFCE was video. Of the 13 PFCE products/programs identified through the web search, the majority required technology for proper use (i.e., 70% technology-first). The most frequently utilized technologies included video and traditional software, which were designed to operate on existing hardware (i.e., computer or mobile device, not proprietary hardware). The prevalence of these two technologies is in keeping with the two primary objectives for PFCE technology use – to build and maintain positive social relationships through more regular communication, and to share facts, ideas, and exemplars or build skills with parents or families. Almost 40% of the PFCE products/programs used video technology to 1) model ideal parent behaviors (pre-recorded video), and/or 2) serve as an objective measure for self-critiquing a parent’s behavior or a source for coaching. Another 40% used software to enhance PFCE activities, particularly to present parent educational materials (e.g., power point presentations).

While the goals and therefore outcomes of the two PFCE exemplars (i.e., *Play and Learning Strategies* and *Thirty Million Words Initiative*) differed, they both shared the same theory of change – home visitors educated parents in an effort to change parent behavior so as to improve child outcomes. The empirical evidence from their evaluative studies suggests that high quality PFCE interventions, particularly those that use video exemplars and video feedback, have a positive impact on a variety of both parent outcomes (e.g., parental responsiveness, emotional well-being) and child outcomes (e.g., language, cognitive function, attachment).

Topic Area 3 – Professional Development and Informal Learning

Topic Area 3 focused on technologies practitioners use to support their own professional development and informal learning. This Topic Area encompasses not only formal professional development programs (e.g., in-service programs for pedagogical strategies and subject areas; training on product-specific implementation and enrichment), but also informal approaches such as independent learning and peer collaboration. The results of our review of professional development and informal learning technologies are organized by the following two research inquiries:

- 3.1 In what ways has technology been used effectively to provide professional development and training to early childhood practitioners (e.g., product-specific training, prescribed coaching and mentoring)?
- 3.2 How do early childhood practitioners use technology to support informal learning (e.g., independent learning, peer collaboration)?

3.1 In what ways has technology been used effectively to provide professional development and training to early childhood practitioners (e.g., product-specific training, prescribed coaching and mentoring)?

The web-search uncovered 21 technologies that early childhood practitioners use to support professional development. These technologies were classified into four main categories: video-enabled professional development, online coursework, social media networking, and other. Video-centered professional development technologies included: video exemplars, multi-media or email feedback from a coach or trainer based on video review, case-based hypermedia resources, web-

mediated coaching, video self-reflection, product training and implementation videos. Practitioners used video-enabled professional development technologies for learning and communication. Social media networking technologies included common commercial social networking sites, community specific social networking sites, blogs, forums and photo/video sharing technologies. Practitioners used social media networking technologies to connect with other early childhood professionals. Practitioners used other technologies for professional development, including: audio self-reflection, online document libraries and user guides, online reliability exercises/tests, user resource exchanges, audio recordings, teleconferences, online peer-to-peer interaction, and webinars (live and/or archived).

In addition to identifying technologies, a broad but not exhaustive web-search identified 50 unique products/programs that use one or more of the technologies to support professional development. The most common technologies among professional development products/programs were: webinars, online document libraries and user guides, online courses, product training and implementation videos, and video exemplars. To understand which technologies have been used *effectively* to provide professional development, we examined the evaluative literature for all 50 products/program. Despite the predominance of webinars for professional development, we found no evaluative literature describing the effects of webinars on practitioner or child outcomes. Instead, the vast majority of literature examined video-enabled professional development technologies; specifically video exemplars and video feedback provided by a coach or trainer.

As such, we described three technology-first professional development exemplars that have an empirical evidence base in the literature: *Classroom Links to Early Literacy*, *MyTeachingPartner (MTP)*, and *eCIRCLE*. Each of these programs may involve coaching, coursework (e.g., online classes), or in-service trainings (e.g., on instructional techniques; on using a particular instructional tool, such as an interactive white board). As is common in the Professional Development and Informal Learning Topic Area, each program employs video as a key mechanism to educate practitioners. The results of the evaluative studies across all three exemplars suggest that video-centered professional development can have a positive impact on both practitioner and child outcomes. Especially noteworthy were the statistically significant effect sizes on measures of children's language and literacy development, particularly vocabulary and phonological awareness.

3.2 How do early childhood practitioners use technology to support informal learning (e.g., independent learning, peer collaboration)?

The web search identified 15 technologies that early childhood practitioners use to support informal learning. Video-enabled informal learning technologies included: video conferences, video exemplars, and product training and implementation videos. Online-coursework included both online courses and online learning modules. Social media networking technologies included: alternative social media networking sites, blogs, forums and photo/video sharing technologies. Practitioners used other technologies for informal learning including: online document libraries and user guides, user resource exchanges, audio recordings, teleconferences, online peer-to-peer interaction, and webinars (live and/or archived).

To better understand how practitioners use these technologies to support informal learning, we conducted an additional search to identify products/program that use these technologies. We found only eight sample products/programs. Among the eight, the most common technologies used for informal learning were: online peer-to-peer networks, alternative social media sites, blogs, forums,

and photo or video sharing tools. We also conducted an academic search that failed to find any evaluative articles for early childhood practitioner's use of technology to support peer collaboration.

Due to the small sample of products/programs and the absence of any evaluative literature, we did not provide an exemplar for informal learning. We know that peer collaboration technologies (e.g., social networks such as Facebook, Pinterest and Twitter) are in widespread use among the general population. Unclear is the extent to which early childhood practitioners harness these technologies for informal learning.

Topic Area 4 – Facilitators and Barriers to Technology Use

Topic Area 4 examined the facilitators and barriers to practitioners' effective use of technology to support early childhood practice. It differed from the other Topic Areas in that 1) the primary data source was the 15 expert interviews rather than web searches or academic searches, and 2) the scope of the inquiry area encompassed all three other topic areas. The results for Topic Area 4 are organized by the following two research inquiries:

- 4.1. How have early childhood programs (Head Start in particular) that have successfully implemented technology into their programs overcome barriers to implementation?
- 4.2. Is staff development a factor limiting the fidelity of implementation of technology in early childhood settings?

4.1 How have early childhood programs (Head Start in particular) that have successfully implemented technology into their programs overcome barriers to implementation?

To answer inquiry 4.1, it was first necessary to identify the barriers that programs needed to overcome when trying to implement technology with early childhood practitioners. Based on our findings from the expert interviews, early childhood programs face many common obstacles to effective uses of technologies to support instruction and assessment, PFCE or professional development and informal learning. The most common barrier to successful implementation was staff technological literacy. Providing adequate professional development/training and technology support services were two of the most commonly mentioned facilitators for successful implementation and thus solutions to this challenge. An expanded discussion of this barrier is provided in 4.2 below.

Other common barriers included lack of access to technology resources, lack of support from administrators for the use of technology, and lack of time to learn and use the technology. Experts continually highlighted the critical role early childhood administrators play in either encouraging or hindering practitioners' use of technology. When administrators support practitioners' use of technology by providing adequate funding, technological infrastructure, hardware, software, training and professional development, technical support, and explicit encouragement, they are best able to affect positive practitioner outcomes in regard to technology use. If, however administrators are indifferent or hostile towards their practitioners' use of technology, even the most self-motivated practitioners find it difficult to use technology with fidelity. Among the most effective strategies that proactive administrators can engage in to encourage successful practitioner use of technology for instruction and assessment, PFCE, and professional development and informal learning, are: building upon early childhood practitioners' intrinsic desires for self-improvement and to produce the best outcomes for their children, leading by example, providing adequate resources, and recognizing high performing staff

4.2 Is staff development a factor limiting the fidelity of implementation of technology in early childhood settings?

As noted in 4.1 above, the experts consistently stated that staff development is one of the most common barriers to successful use of technology among early childhood practitioners. They noted that many practitioners often have low-levels of technological literacy. Lack of knowledge and experience leads to feelings of discomfort and unease, and hinders adoption and use of new technologies. Providing adequate professional development/training and technology support services were two of the most commonly mentioned solutions to this challenge. Experts also noted, however, that this obstacle is rapidly becoming less prevalent as new and more familiar technologies are being harnessed for use in early childhood instruction and assessment, PFCE and professional development and informal learning. Two common examples are the increasing use of mobile devices and social media in early childhood products/programs and services. The majority of early childhood practitioners are familiar with these technologies from their own personal uses (e.g., smartphones, iPads/tablets, and Facebook/LinkedIn). By incorporating technologies that practitioners are familiar with, that are designed to be intuitive to use and that are user friendly, early childhood product/program developers can best ensure that their technologies will be used with fidelity.

Recommendations for Research, Policy and Practice

This review has provided a comprehensive sampling of both common and cutting-edge uses of technology that support early childhood practice, outlining both the opportunities and obstacles associated with increasing the use of technology among early childhood programs, with a particular focus on Head Start and Early Head Start programs. Through this process, we also identified literature that evaluated the impact of these technologies and/or technology-enhanced products/programs on child, family, or practitioner outcomes. Based on our findings we provide several recommendations for future research and policy exploration on these topics.

Further examination of opportunities and obstacles to the use of technology

Given the ubiquity and integration of technology in modern society's every-day activities (e.g., internet, social media, and personal mobile devices), the proliferation of technology in practice at all levels of the education system will likely only accelerate. As such, the need for better access to technological advances is becoming increasingly important to the success of the Head Start program.

As noted by experts, a common site-level barrier among individual early childhood programs is an absence of agency/site-level leadership embracing and modeling the importance and necessity of technology to support practice. Faced with a limited research literature on the impact of technology-enhanced programs to support early child development practice, a lack of technological literacy among site staff, and dearth of financial resources to acquire and support technology, site and program directors are both conceptually and fiscally challenged to actively work to incorporate technology into their daily practice. In order to overcome this barrier, the site's leadership must choose to transform itself into a high-performance system driven by the Digital-Age learning needs of all students and staff. Administrators must prepare themselves to model the use of technology effectively and work with colleagues to guide their site towards more effective uses of technology in teaching, learning and management (Partnership For 21st Century Skills, n.d.).

It is important for administrators to recognize that technology is a tool – a means to more efficiently and effectively achieve the ultimate goal of improving child outcomes. As such, the success of any

technological implementation will require prior thoughtful consideration of appropriate educational and/or engagement goals and approaches. These decisions will impact the choice of assessment, curriculum, instructional approaches, engagement strategies and finally technologies. Adopting technologies without thoughtful consideration of its relationship to educational goals will not likely produce hoped for outcomes.

Once a site's leadership has made the commitment to incorporate technology at a site, the next barrier to overcome is the lack of preparation to use technology with young children among individual practitioners. As noted above, a common individual barrier to practitioners becoming proficient users of the wide variety of technologies available today is their own knowledge and competency to use technology (i.e., technological literacy). Technological literacy among today's diverse community of early childhood practitioners varies greatly, often hindering the adoption and use of even the most effective technology. Some argue that young adults are best positioned to incorporate technology because they are "digital natives" and have the intuitive skills to use technology. However, that argument assumes that knowing how technology works is sufficient to make informed decisions about choosing and then applying technology to positively influence practice. Effective practice is the result of much trial and error. If one is not considered a "digital native," then learning how to use the technology is a required first step in its implementation, followed by multiple iterations of trial and error. Whether an individual is a digital native or not, effective practice comes about because she is willing to try a new approach and learn what works and what does not.

As mentioned previously, practitioners not only need to learn to use technology, but they often lack the time, resources and expertise to identify effective technologies in the first place. Finding and sharing such resources can be a time consuming task for an individual practitioner working in their own classroom or conducting home-visits. Professional development is one mechanism through which practitioners can take the first step in learning how to use technology to improve their practice. Typical education technology professional development has been delivered in face-to-face classes where the technology skill is presented, but often without the context of how it fits into teaching and learning. As the results of our professional development inquiry demonstrated, current effective trends utilize blended-learning approaches, which combine some online content such as videos or webinars for at home review. Online videos have the advantages of being accessible at any time of day and available for later reference. They typically showcase model examples of technology in actual classroom use; something that is difficult to replicate in typical professional development settings. The Results Matter Video Library is an excellent example of just such an existing video collection.³⁶ Blended-learning approaches have the added benefit of providing practitioners with experience using technology and building valuable technology skills.

Given the cost (i.e., time, money, effort) associated with adopting a new technology, support from administrators for the implementation of technology oftentimes requires strong empirical evidence demonstrating effectiveness. However, as is clear from the results of this review, the existing literature on the use of technology is sparse. Below, we briefly review the results and highlight promising areas for future research and evaluation.

³⁶ http://www.cde.state.co.us/resultsmatter/RMVideoSeries_UsingTechnology.htm#top

In the Instruction and Assessment Topic Area, very little literature examines the effectiveness of instructional tools, and very few studies were designed to explicitly isolate the impact of using a technology. As such, it is unclear whether and to what extent technology helps practitioners instruct and assess children. Yet, a number of technologies and technology-enhanced products/programs are currently in widespread use and/or growing in popularity.

For example, among Curricula and Instructional Tools, numerous free and downloadable apps are available for mobile devices and are widely utilized due to their convenience and ease of use. Many of these are based on software for traditional desktop computers. However, there is little or no evaluative literature on the effectiveness of either product in improving student or practitioner outcomes. Similarly, in the area of Integrated Curricula and Assessments, apps for mobile devices are being developed based on existing products, many of which have limited evaluative research.

In addition, among Curricula and Instructional Tools, multi-touch tables and whiteboards are growing in popularity. Multi-touch tables in particular are new and innovative technologies. However, no evaluative literature assesses their effectiveness as an instructional tool. A potential evaluation might examine whether the addition of a multi-touch table in a classroom leads to better outcomes for students compared to a traditional classroom setting.

In the area of Assessments, little evaluative literature exists to determine whether use of any of the Software as a Service (SaaS)-enhanced assessment products can affect practitioner or student outcomes. Ten of the eleven assessments highlighted in the report offer SaaS features, in which assessment software is delivered via the Internet and a service provider hosts, maintains, and provides technical support remotely.³⁷ Practitioners can use the SaaS features of these assessments to input assessment results into an online database for storage and scoring, and then often receive individual or aggregate reports of students' outcomes. Among these products, those that are available as both a paper-based assessment as well as a technology-enhanced SaaS would be suitable for an evaluative study isolating the effects of SaaS on practitioner and student outcomes. Such an evaluation would provide evidence of whether SaaS supported or dependent assessments increase practitioner assessment efficiency, quality and reliability, as well as instructional quality and effectiveness.

In order to rigorously assess the impact of stand-alone curricula, instructional tools, and assessments, as well as integrated curricula and assessments, on student and/or practitioner outcomes, future research should first examine implementation and effectiveness of these curricula, instructional tools or assessments *independent* of the technology. Once established, an evaluation of the technology-enhanced product/program can be conducted to isolate the effect of the technology. Among the latest integrated curricula and assessment products/programs, it is often impossible to separate the technology from the product/program. The integrated nature of the technology may therefore preclude experimental manipulation of the technology to isolate its impact. In such instances, it may be necessary to identify comparable products/programs that have similar content in order to estimate the differential impact of the products/programs (e.g., two products that have an integrated emergent literacy curriculum and assessment; one with technology and one without).

³⁷ Because SaaS providers store student data, it is important for SaaS subscribers to know and understand providers' data use policies (e.g., for marketing, research) and data security protections (e.g., encryption, compliance with state or federal regulations).

Within the Professional Development and Informal Learning Topic Area, webinars were identified as the most common form of professional development among early childhood educators, yet we found no evidence base describing the effectiveness of webinars to support early childhood professional development. Likewise, despite the widespread use of social media in the general population, we found no evaluative literature on the use of peer collaboration technologies to support informal professional learning.

The rapid pace of technology development and evolution may be a key reason for the lack of literature. Many of these technologies are relatively new to the market, and especially to the field of early childhood education (e.g., multi-touch tables, tablet computers, SaaS, interactive whiteboards). The often protracted process of funding, developing, conducting, and publishing academic research studies typically takes a longer time than the products/technologies (in their current state) are in use. Considering the speed with which technology evolves, by the time a typical academic article is published the technology in question may be out of date and the findings of little value to users. A more rapid evaluation mechanism is likely needed to provide administrators, practitioners and policy makers with objective data to help them know which technology-enhanced products and programs are most effective.

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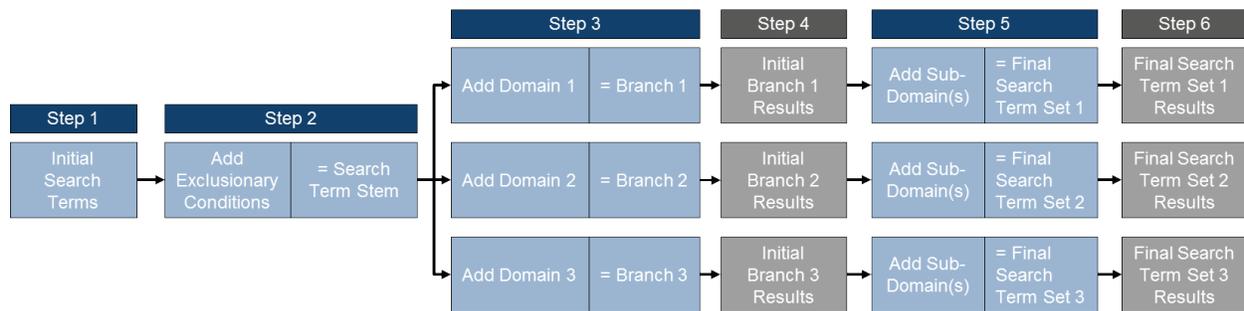
Appendix A: Detailed Description of Search Processes

Web Search Process

The first step in the search process was to conduct a web search to identify technology-mediated products/programs and practices that early childhood practitioners currently use to support instruction and assessment, PFCE, and professional development and informal learning. The goal of the web search was to generate a comprehensive, though not exhaustive, sampling of technology-mediated products/programs and practices. The results include both commonly used as well as innovative and-cutting edge technologies. At this stage in the search process, empirical evidence of effectiveness was not required for inclusion in the web search results.

The review team used the Google search engine to conduct the web search to identify technology-mediated products/programs and practices intended to support early childhood practitioners. For each of the first three Topic Areas (i.e., instruction and assessment, PFCE, and professional development and informal learning), roughly the same six step web search sequence³⁸ was conducted (Figure A.1).³⁹

Figure A.1. Web-search Process



In the first step of the web search process, the review team used each Topic Area and its specific research inquiry(ies) to inform the selection of *initial search terms* to enter into the Google search. These initial search terms served to sufficiently narrow the search (a) to topic-relevant results and (b) to one of many distinct *sub-topics* within the broader Topic Area, if sub-topics existed within the research inquiry.⁴⁰ *Initial search terms* were the string of words and conjunctions first entered into Google to conduct the web search for technologies and technology-mediated products/programs and practices relevant to a Topic Area or sub-topic. Sub-topics are mutually exclusive and together comprise a Topic Area. Together, the sub-topics and sets of initial search terms allowed enough specificity to perform a fruitful first-run web search.

To illustrate the first step of the web search, consider Topic Area 1 – instruction and assessment. Three research inquiries comprise Topic Area 1:

³⁸ Although the review team uses the word “sequence,” the search process within a Topic Area was iterative. The review team may have advanced to a subsequent step or retreated to a prior one. For illustrative purposes, the review team describes the steps as if it followed them in sequence.

³⁹ In some instances, the review team skipped a step because it was unnecessary.

⁴⁰ Sub-topics existed only within research inquiries 1.1, 1.2, 3.1 and 3.2.

- 1.1 What technologies are commonly used in early childhood settings with children to support instruction and assessment?
- 1.2 How do practitioners use technology with children for instruction and assessment?
- 1.3. How is technology used to track progress and individualize instruction/services to children?

The scope of Topic Area 1 encompasses two sub-topics: curricula (including interventions) and assessments. To ensure the web searches for Topic Area 1 were sufficiently narrow, the Topic Area was divided into six sets of initial search terms (Table A.1). The first set of initial search terms focused on *curricula* only: ("Head Start" OR "early childhood education") AND technology AND (curriculum OR curricula) AND (practitioner OR teacher) AND (child OR children). Similarly, the second set of initial search terms focused on *assessments* only: ("Head Start" OR "early childhood education") AND technology AND assessment AND (practitioner OR teacher) AND (child OR children). The remaining sets of initial search terms were similarly constructed.

Table A.1. Initial Search Term Sets for Topic Area 1 Research Inquiries

Inquiries within Topic Area 1	Initial Search Terms Sets
1.1 What technologies are commonly used in early childhood settings with children to support instruction and assessment?	("Head Start" OR "early childhood education") AND technology AND (curriculum OR curricula) AND (practitioner OR teacher) AND (child OR children)
1.2 How do practitioners use technology with children for instruction and assessment?	("Head Start" OR "early childhood education") AND technology AND assessment AND (practitioner OR teacher) AND (child OR children)
1.3. How is technology used to track progress and individualize instruction/services to children?	("Head Start" OR early childhood education) AND technology AND "individualized instruction"
	("Head Start" OR early childhood education) AND technology AND instruction AND (data-driven OR "data systems")
	("Head Start" OR early childhood education) AND "measure" AND "online assessment"
	("Head Start" OR early childhood education) AND "progress monitoring" AND "data-driven"

In the second step of the web search, the review team further narrowed the search results by adding at least one of two types of exclusionary conditions to each set of initial search terms: 1) exclusionary keywords and 2) a date range. This second step was necessary because each set of initial search terms in step one typically produced too many results to be analyzed comprehensively.⁴¹ Based on a quick review of these results, the review team produced a set of common terms to be used as exclusionary keywords (i.e., keywords that summarized search results that were outside the scope of the review). Two examples of common exclusionary keywords were “bachelor” and “special education.” Products/programs, practices and technologies associated with undergraduate degree-granting programs or used exclusively with children with special needs fell outside the scope of the review. As such, the review team added the terms “bachelor” and “special education” one by one to the initial search terms as exclusionary keywords. The addition of exclusionary keywords

⁴¹ Typically in the range of tens of thousands or greater.

instructed Google to ignore resources that included these terms, thus further narrowing the web search results.

The review team also added a date range to the initial search term sets as a second exclusionary condition. Because technology is constantly evolving and can quickly become outdated, the review team limited the search to the most recent five-year period at the time of the web search: 1/1/2009 through 12/31/2014. The review team excluded from the web search any resource older than 1/1/2009. The logic behind this constraint was that it was not immediately helpful to practitioners to report on the effectiveness of an outdated technology. One example is a Palm Pilot-based instructional tool: in large part, smartphones have replaced Palm Pilots. Another example is the ubiquitous iPad, which Apple first introduced in spring 2010. Despite this constraint, because the evaluation cycle typically does not keep up with the rapid evolution of technology, resources evaluated in 2009 often included technologies that are no longer available.

The review team refers to the combination of the initial search terms and the exclusionary keywords or a date range as the *search term stem*. Building upon the example of the step one web search for *curricula* from above, an example of a search term stem is: ("Head Start" OR "early childhood education") AND technology AND (curriculum OR curricula) AND (practitioner OR teacher) AND (child OR children) -"special education" -"exceptional education" -"bachelor" -"degree" -"facilities" -career -"course description" 1/1/2009 - 12/31/2014.⁴² The results obtained from the search term stem were significantly smaller than those obtained from the initial search terms.

In the third step of the web search process, the review team added a *domain* to each search term stem. The review team defines domains as non-mutually exclusive information subsets within a Topic Area that were of particular interest to the review team. Domains for Topic Area 1 serve as a good example. Within Topic Area 1, the review team classified the sub-topic *curricula* into five domains: math, social-emotional, science, literacy, and language. The review team conducted five separate searches, where each of the curriculum-specific domain terms was added the search term stem. Likewise, the review team classified the sub-topic early childhood *assessments* into three domains: formative, summative, and progress monitoring. The review team conducted three separate searches, in which the team added each of the assessment-specific domain terms to the search term stem. The review team refers to the resulting search term stem plus domain term as a search term *branch*. Building upon the example of the step two web search for *curricula* from above, an example of a search term branch is: ("Head Start" OR "early childhood education") AND technology AND (curriculum OR curricula) AND (practitioner OR teacher) AND (child OR children) AND **"social-emotional"** -"special education" -"exceptional education" -"bachelor" -"degree" -"facilities" -career -"course description" 1/1/2009 - 12/31/2014. The domain added to the search term stem is highlighted in bold. The results obtained from the branch search were specific, relevant and small enough to begin answering the research inquiry.

Thus, in the fourth step of the web search process, the review team began building a list of products/programs, practices and technologies from the branch search results. Sometimes by the fourth step of the web search for a particular branch, the results of the search numbered several thousand. In these instances, the review team limited its analysis to those resources appearing among the first 500 to 1,000 search results. The review team assumed that products/programs, practices

⁴² Rather than enter the date range in the search field, the review team entered it directly into Google's date range pull-down menu. The dates are shown as part of the search terms stem here for illustrative purposes only.

and technologies appearing early among the search results would be most relevant to the research inquiry. Alternatively, if the number of search results was reasonably small (i.e., in the hundreds), the review team analyzed all of the results for relevance to the research inquiry. It is important to recall that the objective of the review was to generate a comprehensive, but not exhaustive, sampling of products/programs, practices and technologies. As such, the review team limited the enumeration of products/programs, practices and technologies to those that were most relevant to the research inquiry. To assess relevance, the review team conducted an additional web search on each of the products/programs, practices and technologies. The goal of this additional search was to determine whether the product/program, practice, or technology fell within the project's scope. If it did not, the review team eliminated it from the result list. Examples of relevant early childhood curricula that used technology include the Creative Curriculum by Teaching Strategies and WePlaySmart by Hatch.

During step five of the web search, the review team added types of technologies or specific subjects, referred to as *sub-domains*, to the branch search combination, resulting in a *final search terms set*. Sub-domains either appeared frequently among the first 500 to 1,000 search results during the step four branch analysis, or the review team perceived them as worthy of further investigation. In the latter case, a promising sub-domain may have been a technology-relevant phrase (e.g., “information and communication technologies,” “innovative learning”) or a technology tool (e.g., iPad or netbook). An example of a final search term set comprised of a branch and a sub-domain of great frequency (in bold) is: ("Head Start" OR "early childhood education") AND technology AND (curriculum OR curricula) AND (practitioner OR teacher) AND (child OR children) AND “social-emotional” AND **“developmentally appropriate”** -"special education" -"exceptional education" -"bachelor" -"degree" -"facilities" -career -"course description" 1/1/2009 - 12/31/2014. An example of a final search terms set comprised of a branch and a promising sub-domain (in bold) is: ("Head Start" OR "early childhood education") AND technology AND (curriculum OR curricula) AND (practitioner OR teacher) AND (child OR children) AND “social-emotional” AND **“iPad”** -"special education" -"exceptional education" -"bachelor" -"degree" -"facilities" -career -"course description" 1/1/2009 - 12/31/2014. The results of the fifth step web search using the final search term set included a final sample of products/programs, practices and technologies, which oftentimes overlapped with the results from the third step web branch search.

The sixth and final step of the web search involved the same procedure described for step four above. That is, the first 500 to 1,000 search results were analyzed for relevance to the research inquiry. A web search was conducted for each unique product/program, practice and technology that had not previously been analyzed during step four. The review team included in the final list those that fell within the scope of the review; the team eliminated those that fell outside the scope. Thus, the six-step web search process culminated in a comprehensive sample of technology-enhanced products/programs and practices used by early childhood practitioners, organized by research Topic Areas, sub-topics and domains.

Academic Search Process

The objective of the academic search process was to obtain evaluative literature on the products/programs, practices and technologies resulting from the web search. To maximize the comprehensiveness of the academic search, the review team searched the following relevant databases for evaluative literature: Articles Plus, Google Scholar, EBSCO Host, and APA PsycNET. Within EBSCO Host, the review team searched all available databases, including: Academic Search Complete, Academic Search Premier, Child Development and Adolescent Studies, Education

Abstracts, Education Resources Information Center (ERIC), Professional Development Collection, SocINDEX, and Urban Studies Abstracts.

Whereas the objective of the web search was to build, from the bottom-up, a comprehensive list of products/program, practices and technologies used by early childhood practitioners, the objective of the academic search was to obtain literature that evaluated effectiveness. As such, the academic search process was far more focused than the web search process. For the most part, the review team entered into the academic database search engines the products/programs, practices and technologies identified through the web-search. The results of the academic search took many forms, including conference papers and presentations, book chapters, government reports, and peer-reviewed journal articles.

Given the constrained nature of the academic search and the fact that evaluative literature on technology use in early childhood is comparatively limited, the number of academic database search results for a given product/program, practice or technology was several orders of magnitude smaller than the number of web search results (i.e., generally twenty or less instead of hundreds). This more reasonably sized pool of search results made feasible the individual assessment of all search results for relevance (i.e., was the study evaluative?).

On occasion, the review team added domains, sub-domains, or exclusionary conditions to the academic search parameters to reduce the number of search results. For example, if a program seemed relevant to both preschool and K-12 practitioners (e.g., a series of professional development courses offered through a private company), the review team added the terms “preschool” or “Head Start” to narrow the results to preschool practitioners only. Moreover, the review team constrained academic searches to more recent publication date ranges (i.e., the years 2000 through 2014). The default publication date range (i.e., 1980 through 2014) would have included older literature that would not have evaluated technologies of interest to the project.

The academic database search culminated in a corpus of evaluative literature examining the effectiveness of technology-enhanced products/programs and practices used by early childhood practitioners, organized by Topic Areas, sub-topics and domains. A complete bibliography listing the results of the academic search categorized by Topic Area is included in Appendix D.

Appendix B: Expert Interview Script

I. Introduction

My name is XXXXX, I am a XXXXXX at NORC at the University of Chicago, a researcher involved in a study examining the use of technology to support and improve the practice of early childhood practitioners working directly with children and families; particularly in Head Start and Early Head Start. The study is funded by the Administration for Children and Families' Office of Planning, Research and Evaluation.

To provide some background, the study focuses on the use of technology in three primary areas of interest: 1) instruction and assessment, 2) parent, family and community engagement, and 3) professional improvement. The first step of this review involved a literature review and examination of technologies commonly used in each of the three areas of interest, with particular emphasis placed on the use of technologies in evidence-based programs. The second step is to speak with experts who study the use of technology or employ technology as an integral part of their program (curriculum, intervention, assessment, PD, etc.). In the course of our review, we identified you as an expert who might be able speak about the use of technology to support practice. Today, we would like to talk with you about how you use technology to support practice in early childhood settings, and obtain your insights into the facilitators and barriers to the use of technology with early childhood practitioners.

We anticipate this call taking approximately one to two hours. If additional time is needed to complete the discussion, we are happy to schedule a follow up call. In addition, as a thank you for your time, we are pleased to be able to provide you with an honorarium in the amount of \$500, which we will send to you with 30 days.

Do you have any questions I can answer before we begin?

II. Questions

A. *Outline Use of Technology*

1. Please list and describe technologies that you have used, developed, or evaluated to support or improve practice in the following domains:
 - a. Instruction and assessment?
 - b. Parent, family, and community engagement (PFCE)?
 - c. Professional improvement?

B. *Instruction and Assessment*

1. We would like to learn more about how you use the [abovementioned] technology to support *practitioners' instruction of children*.
 - a. How do practitioners use technology in relation to your (instructional tool or curriculum)?
 - b. Is the technology an integral part of your (instructional tool or curriculum) or is it an optional feature?
 - c. Why did you choose to use this technology (e.g., cost, efficiency, effectiveness, etc.)? That is, what was the intended outcome or impact of utilizing this technology for instruction?

- d. How has the use of the technology impacted the delivery or implementation of the (instructional tool or curriculum)?
 - i. Has use of the technology had the intended impact?
 - ii. Has use of the technology had any unintended effects on the implementation of the (instructional tool or curriculum)?
 - e. What is your sense of staff members' comfort level using this technology to support instruction?
 - f. What is your sense of administrators' comfort level with the use of this technology to support instruction? (probe: by their staff; by themselves, if relevant)
 - g. What were practitioners' reactions to using the technology to support instruction?
 - h. Did practitioners' use the technology as intended? How or how not?
 - i. What benefits have practitioners realized as a result of using this technology with the (instructional tool or curriculum)?
 - j. What challenges have practitioners encountered as a result of using this technology with the (instructional tool or curriculum)?
 - k. How have practitioners (and/or your team) overcome these challenges?
 - i. What support(s) was necessary to ensure that the practitioners could use this technology to support instruction (e.g., hardware, software, connectivity, technical assistance, training)?
 - l. Have you returned to evaluate (formally or informally) programs where you introduced this instructional technology?
 - i. If so, did practitioners continue to use the technology?
 1. If yes, why do you think they continue to use the technology?
 2. If no, why do you think they discontinued use of the technology?
2. We would like to learn more about how you use the [abovementioned] technology to support *practitioners' assessment of children*?
- a. How do practitioners use technology in relation to your assessment?
 - b. Is the technology an integral part of your assessment or is it an optional feature?
 - c. Why did you choose to use this technology (e.g., cost, efficiency, effectiveness, etc.)? That is, what was the intended outcome or impact of utilizing this technology for assessment?
 - d. How has the use of the technology impacted the delivery or implementation of the assessment?
 - i. Has use of the technology had the intended impact?
 - ii. Has use of the technology had any unintended effects on the implementation of the assessment?
 - e. What is your sense of staff members' comfort level using this technology to support assessment?
 - f. What is your sense of administrators' comfort level with the use of this technology to support assessment? (probe: by their staff; by themselves, if relevant)
 - g. What were practitioners' reactions to using the technology to support assessment?
 - h. Did practitioners' use the technology as intended? How or how not?
 - i. What benefits have practitioners realized as a result of using this technology as part of the assessment?
 - j. What challenges have practitioners encountered as a result of using this technology as part of the assessment?
 - k. How have practitioners (and/or your team) overcome these challenges?

- b. Is the technology an integral part of your PD program or is it an optional feature?
 - c. Why did you choose to use this technology (e.g., cost, efficiency, effectiveness, etc.)? That is, what was the intended outcome or impact of utilizing this technology for PD?
 - d. How has the use of the technology impacted the delivery or implementation of PD?
 - i. Has use of the technology had the intended impact?
 - ii. Has use of the technology had any unintended effects on the implementation of PD?
 - e. What is your sense of staff members' comfort level using this technology to support their PD?
 - f. What is your sense of administrators' comfort level with the use of this technology to support their PD? (probe: by their staff; by themselves, if relevant)
 - g. What were practitioners' reactions to using the technology to support their PD?
 - h. Did practitioners' use the technology as intended? How or how not?

 - i. What benefits have practitioners realized as a result of using this technology to deliver PD?
 - j. What challenges have practitioners encountered as a result of using this technology to deliver PD?
 - k. How have practitioners (and/or your team) overcome these challenges?
 - i. What support(s) was necessary to ensure that the practitioners could use this technology to support PD (e.g., hardware, software, connectivity, technical assistance, training)?
 - l. Have you returned to evaluate (formally or informally) programs where you introduced this technology to support PD?
 - i. If so, did practitioners continue to use the technology?
 1. If yes, why do you think they continue to use the technology?
 2. If no, why do you think they discontinued use of the technology?
2. We would like to learn more about how you use the [abovementioned] technology to support *peer collaboration and professional improvement among practitioners* (e.g., Personal Learning Networks using social media tools)?
- a. How do practitioners use technology in relation to your peer collaboration and professional improvement program?
 - b. Is the technology an integral part of your peer collaboration and professional improvement program or is it an optional feature?
 - c. Why did you choose to use this technology (e.g., cost, efficiency, effectiveness, etc.)? That is, what was the intended outcome or impact of utilizing this technology for peer collaboration and professional improvement?
 - d. How has the use of the technology impacted peer collaboration and professional improvement?
 - i. Has use of the technology had the intended impact?
 - ii. Has use of the technology had any unintended effects on peer collaboration and professional improvement?
 - e. What is your sense of staff members' comfort level using this technology to support peer collaboration and professional improvement?
 - f. What is your sense of administrators' comfort level with the use of this technology to support peer collaboration and professional improvement? (probe: by their staff; by themselves, if relevant)

- g. What were practitioners' reactions to using the technology to support peer collaboration and professional improvement?
- h. Did practitioners' use the technology as intended? How or how not?
- i. What benefits have practitioners realized as a result of using this technology for peer collaboration and professional improvement?
- j. What challenges have practitioners encountered as a result of using this technology for peer collaboration and professional improvement?
- k. How have practitioners (and/or your team) overcome these challenges?
 - i. What support(s) was necessary to ensure that the practitioners could use this technology to support peer collaboration and professional improvement (e.g., hardware, software, connectivity, technical assistance, training)?
- l. Have you returned to evaluate (formally or informally) programs where you introduced this technology to support peer collaboration and professional improvement?
 - i. If so, did practitioners continue to use the technology?
 1. If yes, why do you think they continue to use the technology?
 2. If no, why do you think they discontinued use of the technology?

E. *Implementation*

Finally, we would like you to reflect upon all your experiences working with early childhood practitioners to implement the use of technology to support instruction, assessment, PFCE, and/or PD.

1. In your experience, what are the top three *barriers* to early childhood practitioners' successful use of technology?
 - a.
 - b.
 - c.
2. In your experience, what are the top three factors that *support* early childhood practitioners' successful use of technology?
 - a.
 - b.
 - c.
3. What technical skills are necessary for early childhood practitioners to successfully use technology to support practice?
4. Is staff development a factor limiting the fidelity of implementation of technology in early childhood settings? How?
5. How have early childhood programs that you have worked with (Head Start in particular) successfully integrated the use of technology into their programs?

III. Closing

Thank you for taking the time to speak with us today. We would appreciate it if you could share publications we have discussed during this call or any other materials that you believe may be helpful to the project. We will follow up with you via email within a few days.

Appendix C: Glossary

Alternative Social Networking Sites. Similar in function and features to common social networking sites (e.g., Facebook, LinkedIn and Twitter), but tailored for a specific audiences, topics, or purposes (e.g., early childhood education in Maryland, or early childhood educators who want to exchange instructional resources).

Apps. Self-contained software packages typically downloaded from the Internet, intended for use on a mobile device, and designed to serve a defined role. Apps allow practitioners to accomplish tasks on mobile devices that they would otherwise need to complete at a computer. Practitioners use apps within the contexts of instruction and assessment (e.g., to access pre-made lesson activities, to input assessment results in real-time) and PFCE (e.g., to communicate with caregivers via mobile device). Children use apps in the context of instruction and assessment in two ways: 1) to access online instructional materials (e.g., activities, games) associated with conventional curricula (i.e., curricula that are primarily paper-based and practitioner-driven) or 2) to access online instructional materials associated with curricula that can be described as software as a service. Apps might also allow practitioners or children to access the features of a software program that are primarily used on a standalone device.

Audio. Pre-recorded voice recordings or live streamed voice available via the Internet. During a webinar, presenters may live stream audio of their oral presentation via the internet or phone. Live audio is often recorded so others can listen again at another time. Some audio recordings are pre-recorded for the sole purpose of later being downloaded by learners. A podcast is an example of pre-recorded audio.

Audio Self-Reflection. A practitioner creates audio recording of her conversation with children, transcribes the dialogue, and then analyzes her conversations. The overarching goal is to reflect on her practice.

Blog. A personal, public website or webpage where an individual can regularly post text, web-links and a variety of media for others to read and view. Practitioners maintain blogs to share thought and ideas, and engage in discussions with peers (e.g., via comments on posts). Companies might also maintain blogs on which practitioners write posts and engage in asynchronous conversations with peers.

Build Your Own. A product or program with a build your own feature allows the user to customize the product or program's materials. An example product that includes "build your own" components is an interactive whiteboard that has templates or materials that allow the practitioner to construct her own lesson plans.

Case-based Hypermedia Resource. A resource typically dominated by links to video exemplars. It might also include links or digital copies of relevant articles written for an early childhood audience, as well as links to other resources (e.g., articles referenced within an included resource). This resource is designed specifically for practitioners, and might be available on a website or offline on a computer.

Clinical Decision Support System (CDSS). A computer-based program designed to help physicians make critical decisions regarding patient care. Physicians enter patient information into

medical CDSSs, which generate recommendations (e.g., diagnostic tests, dosage) based on that information. Physicians then select the appropriate course of treatment.

Coach. A professional who supports practitioner professional development through personalized instruction or training.

Comprehensive. See Content Area.

Common Social Networking Sites. Internet based software that allow anyone with an account to connect with any other individuals via private text, photo, audio and/or video messaging, as well as public spaces to post similar content and hold group discussions. Examples of common social networks include Facebook, LinkedIn and Twitter. Professional development and informal learning programs may utilize common social networks to enable practitioners to communicate and collaborate with one another through virtual professional working groups (PWG) or professional learning communities (PLC) from a distance.

Computers. In the context of instruction and assessment, computers are electronic hardware that practitioners use to support instruction and assessment, and often enable other technologies. For example, computers can connect to an interactive whiteboard display, download instructional materials (e.g., pre-made lesson plans, activities) from the Internet, enable entry of assessment results, or send e-mail messages to staff or children’s parents. Students might use computers to access lesson activities associated with an online curriculum. In the context of PFCE, computers are electronic hardware that deliver content to children’s caregivers (i.e., parents, guardians, family members), enable practitioners and caregivers to interact with one another at a distance (e.g., emails, video) via the internet, or facilitate use of other technologies (e.g., traditional software packages, software as a service).

Content Area. Academic topic areas including: Language, Literacy, Mathematics, Science, Social-Emotional Development, and Physical Development. Those curricula and assessments that covered more than one of these topic areas were defined as “Comprehensive”.

eBooks. A digital version of a print copy book. Practitioners use eBooks in place of hardcopies to read stories during shared reading or read-alouds. eBooks can be used on a variety of hardware devices including mobile devices and computers, as well as devices designed specifically for viewing eBooks.

Email Feedback from a Coach or Trainer based on Video Review. A practitioner takes video of herself instructing, and mail the video to their coach. After reviewing the video, he coach sends written feedback to the practitioner via e-mail. The e-mail message might follow a template (e.g., all messages begin with a positive statement, followed by three examples of targeted behavior that the coach looked for). Video is not included with the e-mail message.

Evaluative Literature. Any literature that describes a product/program or technology that underwent evaluation (with or without a comparison group). Evaluative literature took many forms, including conference papers and presentations, book chapters, government reports, and peer-reviewed journal articles. In accord with the US Department of Education, Institute of Education Sciences’ What Works Clearinghouse standards, examples of rigorous evaluation designs included randomized controlled trials (RCTs) and quasi-experimental designs (QEDs). Relevant but less

rigorous evaluations included single group pre-/post-test designs. In addition, studies that evaluated the reliability and validity of assessments were included as evaluative literature.

Forums. Online discussion boards, typically geared toward a particular audience and designed to engage other members of the online community on a particular issue or topic.

Informal learning. Unstructured, independent learning or learning through peer collaboration and networking.

Interactive Books. Are typically touch activated, include a writing implement, and are programmed to read text aloud (i.e., sound out words or letters) in response to touch. Both children and practitioners can simultaneously use interactive books (e.g., during shared book reading), or children can use them by themselves (i.e., the book will read text aloud to the child). An example of an interactive book is LeapFrog learning systems' preschool-focused *Ready, Set, Leap!*, which addresses language and literacy, math, music, visual arts, and social-emotional development.

Interactive Whiteboards. A wall-mounted board with an attached projector to display output from a computer. Whiteboards have interactive touch capabilities (i.e., the projections can be manipulated by hand or with specially designed writing implements). Practitioners use interactive whiteboards to present information (e.g., slides, pre-made lesson activities), and children use them as part of instructional activities (e.g., write, draw, or manipulate objects projected on the whiteboard).

Language ENvironment Analysis (LENA) System. The LENA system consists of a digital language processor (DLP) that captures up to 16 hours of audio surrounding whoever wears the device, as well as an analytical software package that automatically codes the recorded audio for language outcomes (i.e., adult word count, conversational turn count, child vocalizations) and electronic noise (e.g., TV time). LENA outcomes have been shared with caregivers to influence linguistic behaviors, and used as an evaluative tool.

Mobile Devices. Portable electronic hardware that typically has Wi-Fi or cellular internet access (e.g., cell phones, tablets).

Movement Sensors. Stationary devices that track children's movements, which in turn control a game or activity. An example of a movement sensor is the Kaplan Early Learning Company's Move-NG. The Move-NG is compatible with an interactive whiteboard and is made for use with Kaplan's interactive games.

Multi-media Feedback from a Coach or Trainer based on Video Review. Practitioners record video of themselves performing an instructional activity. A coach reviews the video recording and provides feedback to the practitioner. Sometimes a coach selects key clips from the video to provide feedback on the implementation of a particular instructional strategy. Other times they provide running commentaries throughout the entire video. In some programs, the practitioner might review the video and coach's feedback either prior to a live joint review with the coach, or in lieu of a live joint review. In any case, the goal is to provide practitioners with feedback on implementation and recommendations to improve practice. A trainer follows a similar procedure when working with a coach.

Multi-Touch Tables. Devices that lie flat or at an angle (like an easel) and feature a large, embedded touch screen display (e.g., 40 inches or greater). Similar in function to an interactive

whiteboard, children can simultaneously touch the screen as part of an activity (e.g., dragging puzzle pieces together). Some multi-touch tables can also serve as interactive whiteboards (e.g., the Kaplan Early Learning Company's Inspire-NG).

Online Courses. Formal courses available through the Internet. Online courses typically follow an academic calendar (i.e., one quarter, one semester or longer) and are led by an instructor.

Online Documents Library and User Guides. Web-based repositories of user manuals or help files for practitioners to consult if they have questions about how to use a product/program (e.g., how to operate an interactive white board).

Online Modules. A small/defined instructional unit available through the Internet. Modules are by definition shorter in duration than online courses (e.g., the materials may be viewed in one sitting), designed to be completed independently, typically completed asynchronous within an academic calendar, and usually not led by an instructor.

Online Peer-to-Peer Interactions. Practitioners interact with one another directly (e.g., via private messages), synchronously or asynchronously, through a website.

Online Reliability Exercises or Tests. Typically completed individually, these exercises or tests assess a practitioner's or a coach's knowledge of, or facility to use, a particular product (e.g., a classroom observation tool). Online reliability tests might be used to certify an individual as a trained user of the product.

Out of the Box. A product/program that is ready for immediate use and requires little, if any, preparation beyond the initial set-up. An example out of the box product is a multi-touch table that has built-in or ready-made activities available for immediate download from the Internet.

Photo or Video Sharing. Enabled by social networking sites or other sites designed specifically for sharing multimedia (e.g., Vimeo, Flickr). Practitioners might share with their peers photos of their classrooms, videos that they made (e.g., on how to create the materials for a lesson) or videos they found elsewhere (e.g., videos on PBS KIDS).

Practitioner. A teacher, home visitor, or other early childhood professional who works directly with 0-5 year old children or their families.

Practitioner-to-Parent Communication Integration. The product/program possesses an integrated mechanism for practitioners to communicate digitally with parents. For example, a product might have a feature that allows practitioners to send parents digital copies of their children's assessment results, perhaps by e-mail messages through the software program itself.

Product Training and Implementation videos. How-to videos associated with specific products/programs (e.g., how to access a particular feature of a product or a program).

Products/Programs. Devices or tools that use technology or are forms of technology; combinations of materials, services, or tools that use technology. Examples include The Creative Curriculum, The Attachment and Biobehavioral Catch-Up Intervention, The Incredible Years Teacher Training Program.

Professional development. Structured professional development specific to a product, program, or service. Involves training on implementation or utilizes materials (e.g., readings, training modules, videos) or services (e.g., ongoing coaching sessions) with a clearly defined goal in mind (e.g., to learn to execute a particular set of instructional strategies).

Proprietary Computers. Computers that run only pre-loaded, proprietary software. Proprietary computers are a type of standalone device. The IBM KidSmart Young Explorer computer is an example. It is housed in child-friendly furniture and runs educational software, specifically math, science, and language games.

Software as a Service (SaaS). An Internet-based method of software delivery where a service provider hosts, maintains, and provides technical support remotely. As an Internet-based service, SaaS requires continuous internet access in order to use the software and cannot be downloaded to hardware or used offline. SaaS is typically subscription-based: one pays for a license to gain access to the software via a web browser or a user-interface specially designed to access the product or program. Practitioners use SaaS to access instructional materials (e.g., activities to project on an interactive whiteboard) or accomplish tasks associated with a product (e.g., input assessment results into the online database). Children can use SaaS to access instructional materials associated with their curricula.

Standalone Devices. Self-contained bundles of hardware and software that are inseparable. The software loaded on a standalone device cannot be purchased separately and installed on any other device. It is available only on the device on which the software comes pre-installed. The category of standalone devices encompasses many different types of products beyond conventional computers. Three examples include multi-touch tables that run only the games designed for, or programmed into, the tables; interactive whiteboards; and any pre-loaded mobile device that runs only the software that was designed for the device (e.g., iStart Smart mobile).

Technology-Enabled. A product/program for which the use of technology is optional. An example is an assessment that can be delivered either with paper and pencil or via an app for a mobile device.

Technology-First. A product/program that requires the use of technology; technology is an integral feature. An example is a program that requires practitioners' video-tape their implementation of a lesson and review the video via a web interface with a remote coach.

Telephone conference. Conferences consist of two or more participants held over a dedicated telephone line. Practitioners might call in to a dedicated telephone conference line to listen to a group presentation and/or participate in a group discussion. One-to-one teleconferences (i.e., a consultation) with a coach may occur as part of ongoing support and be included with a subscription to a particular professional development or informal learning product /program.

Traditional Software. Computer programs that allow a user to complete a defined task. Traditional Software is typically stored on a CD, DVD, or other portable memory storage medium, and can be downloaded directly onto a hardware device. In the context of instruction and assessment, practitioners use traditional software to install applications (e.g., the program that lets one use an interactive whiteboard) or to access instructional materials (e.g., sample weekly lesson plans, lesson printouts to distribute to children) associated with a particular product or device. In the context of

PFCE, traditional Software can enable a variety of processes and cover a wide variety of content areas (e.g., word processing, PowerPoint presentations, spreadsheets, video, etc.). Practitioners primarily use traditional software to deliver content to caregivers (e.g., to display a Power Point presentation).

Trainer. A professional who supports a coach's professional development.

User Resource Exchanges. Web-based, member-accessible central repositories where practitioners can freely share resources (e.g., lesson plans, lesson plan materials) with one another.

Video Conferences. Real-time video enabled meetings among practitioners that occur over the Internet. Video conferences require computers or mobile devices, an internet connection, and access to video and audio capabilities.

Video Exemplars. Recordings that depict model practitioner actions (e.g., execution of a particular instructional strategy with high level fidelity of implementation). Video exemplars are used in a wide variety of ways, for example: shown or shared as part of a coaching session; viewed on one's own as part of an online-course; presented during a webinar.

Video Self-Reflection. During individual or small group meetings that are part of an ongoing in-service training, practitioners view video footage of classroom activities captured by themselves or their peers. The small groups might discuss the instructional concepts and strategies observed in the video and their relation to those they have studied as part of a course.

Videos. Videos are recordings that may be streamed digitally through the web or stored directly on a computer and viewed using a video viewing app or software (e.g., flash, QuickTime). Pre-recorded video may also be played directly from a cassette tape or DVD on a TV or computer. Practitioners use pre-recorded video exemplars to model target children's behaviors to children (i.e., the Incredible Years Teacher Classroom Management and Child Social and Emotion Curriculum). New video may also be collected using a dedicated video camcorder, or camera equipped mobile device or computer.

Webinars. A seminar, lecture, presentation, workshop, or other learning session held over the Internet. Practitioners participate in webinars for many reasons, including: to learn about a product or program (e.g., how a company's interactive white board differs from others), to learn how to use or access features of a product or ask specific questions about the product (e.g., how to generate student reports based on assessment data; how to manipulate features of those reports, such as chart colors), to view a live presentation on a particular topic (e.g., leadership supporting quality teaching and learning), and to participate in a discussion with other practitioners. Organizations and companies offer live and/or archived webinars.

Web-Mediated Coaching. Coaching that occurs live (i.e., real-time) between practitioners and coaches via a videoconference over the Internet. Coaches might provide feedback to practitioners during the videoconference, and might recommend resources (e.g., readings, video exemplars in the case-based hypermedia resource) for practitioners to consult.

Appendix D: Topic Categorized Bibliography

Web Search Bibliography by Topic Area

Topic Area 1: Instruction and Assessment

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Landry, S. H., Smith, K. E., Swank, P. R., Zucker, T., Crawford, A. D., & Solari, E. F. (2012). The effects of a responsive parenting intervention on parent–child interactions during shared book reading. *Developmental Psychology*, 48(4), 969–986. doi:10.1037/a0026400

Smith, K. E., Landry, S. H., & Swank, P. R. (2005). The Influence of Decreased Parental Resources on the Efficacy of a Responsive Parenting Intervention. *Journal of Consulting and Clinical Psychology*, 73(4), 711–720. doi:10.1037/0022-006X.73.4.711

Families in Schools: Abriendo Puertas/Opening Doors

Bridges, M., Cohen, S. R., & Fuller, B. (2012). *Abriendo Puertas: Opening Doors to Opportunity—A National Evaluation of Second-Generation Trainers*. Institute of Human Development, University of California-Berkeley. Retrieved from <http://files.eric.ed.gov/fulltext/ED538864.pdf>

Safecare: Cell Phone-Enhanced Planned Activities Training

Carta, J. J., Lefever, J. B., Bigelow, K., Borkowski, J., & Warren, S. F. (2013). Randomized Trial of a Cellular Phone-Enhanced Home Visitation Parenting Intervention. *PEDIATRICS*, 132(Supplement), S167–S173. doi:10.1542/peds.2013-1021Q

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Kumpfer, K. L., Whiteside, H. O., Greene, J. A., & Allen, K. C. (2010). Effectiveness outcomes of four age versions of the Strengthening Families Program in statewide field sites. *Group Dynamics: Theory, Research, and Practice*, *14*(3), 211–229. doi:10.1037/a0020602

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Axberg, U., Hansson, K., & Broberg, A. G. (2007). Evaluation of the Incredible Years Series – An open study of its effects when first introduced in Sweden. *Nordic Journal of Psychiatry*, *61*(2), 143–151. doi:10.1080/08039480701226120

Hutchings, J., Gardner, F., Bywater, T., Daley, D., Whitaker, C., Jones, K., ... Edwards, R. T. (2007). Parenting intervention in Sure Start services for children at risk of developing conduct disorder: pragmatic randomised controlled trial. *BMJ*, *334*(7595), 678–678. doi:10.1136/bmj.39126.620799.55

Jones, K., Daley, D., Hutchings, J., Bywater, T., & Eames, C. (2007). Efficacy of the Incredible Years Basic parent training programme as an early intervention for children with conduct problems and ADHD. *Child: Care, Health and Development*, *33*(6), 749–756. doi:10.1111/j.1365-2214.2007.00747.x

McGilloway, S., Mhaille, G. N., Bywater, T., Furlong, M., Leckey, Y., Kelly, P., ... Donnelly, M. (2012). A parenting intervention for childhood behavioral problems: A randomized controlled trial in disadvantaged community-based settings. *Journal of Consulting and Clinical Psychology*, *80*(1), 116–127. doi:10.1037/a0026304

O’Neill, D., McGilloway, S., Donnelly, M., Bywater, T., & Kelly, P. (2011). A cost-effectiveness analysis of the Incredible Years parenting programme in reducing childhood health inequalities. *The European Journal of Health Economics*, *14*(1), 85–94. doi:10.1007/s10198-011-0342-y

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Webster-Stratton, C., Reid, M. J., & Hammond, M. (2001). Preventing conduct problems, promoting social competence: A parent and teacher training partnership in Head Start. *Journal of Clinical Child Psychology*, *30*(3), 283–302. Retrieved from http://www.tandfonline.com/doi/abs/10.1207/S15374424JCCP3003_2

Triple P Positive Parenting Program

Bodenmann, G., Cina, A., Ledermann, T., & Sanders, M. R. (2008). The efficacy of the Triple P-Positive Parenting Program in improving parenting and child behavior: A comparison with two other treatment conditions. *Behaviour Research and Therapy*, *46*(4), 411–427. doi:10.1016/j.brat.2008.01.001

Leung, C., Sanders, M. R., Leung, S., Mak, R., & Lau, J. (2003). An Outcome Evaluation of the Implementation of the Triple P-Positive Parenting Program in Hong Kong. *Family Process*, *42*(4), 531–544. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/14979223>

McConnell, D., Breikreuz, R., & Savage, A. (2012). Independent evaluation of the Triple P Positive Parenting Program in family support service settings: Triple P in family support service settings. *Child & Family Social Work, 17*(1), 43–54. doi:10.1111/j.1365-2206.2011.00771.x

Zubrick, S. R., Ward, K. A., Silburn, S. R., Lawrence, D., Williams, A. A., Blair, E., ... Sanders, M. R. (2005). Prevention of Child Behavior Problems Through Universal Implementation of a Group Behavioral Family Intervention. *Prevention Science, 6*(4), 287–304. doi:10.1007/s11121-005-0013-2

University of Chicago Medicine: Thirty Million Words Initiative

Suskind, D., Leffel, K. R., Hernandez, M. W., Sapolich, S. G., Suskind, E., Kirkham, E., & Meehan, P. (2013). An Exploratory Study of “Quantitative Linguistic Feedback”: Effect of LENA Feedback on Adult Language Production. *Communication Disorders Quarterly, 34*(4), 199–209. doi:10.1177/1525740112473146

University of Delaware Infant Caregiver Project: Attachment and Biobehavioral Catch-up (ABC) Intervention

Berlin, L. J., Shanahan, M., & Appleyard Carmody, K. (2014). Promoting Supportive Parenting in New Mothers with Substance-Use Problems: A Pilot Randomized Trial of Residential Treatment Plus an Attachment-Based Parenting Program. *Infant Mental Health Journal, 35*(1), 81–85. doi:10.1002/imhj.21427

Bernard, K., Dozier, M., Bick, J., Lewis-Morrarty, E., Lindhiem, O., & Carlson, E. (2012). Enhancing Attachment Organization Among Maltreated Children: Results of a Randomized Clinical Trial: Enhancing Attachment Organization. *Child Development, 83*(2), 623–636. doi:10.1111/j.1467-8624.2011.01712.x

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Dozier, M., Lindhiem, O., Lewis, E., Bick, J., Bernard, K., & Peloso, E. (2009). Effects of a Foster Parent Training Program on Young Children’s Attachment Behaviors: Preliminary Evidence from a Randomized Clinical Trial. *Child and Adolescent Social Work Journal, 26*(4), 321–332. doi:10.1007/s10560-009-0165-1

Dozier, M., Peloso, E., Lewis, E., Laurenceau, J.-P., & Levine, S. (2008). Effects of an attachment-based intervention on the cortisol production of infants and toddlers in foster care. *Development and Psychopathology, 20*(03). doi:10.1017/S0954579408000400

Dozier, M., Peloso, E., Lindhiem, O., Gordon, M. K., Manni, M., Sepulveda, S., ... Levine, S. (2006). Developing evidence-based interventions for foster children: an example of a randomized clinical trial with infants and toddlers. *Journal of Social Issues, 62*(4), 767–785. Retrieved from <http://onlinelibrary.wiley.com/doi/10.1111/j.1540-4560.2006.00486.x/full>

Lewis-Morrarty, E., Dozier, M., Bernard, K., Terracciano, S. M., & Moore, S. V. (2012). Cognitive Flexibility and Theory of Mind Outcomes Among Foster Children: Preschool Follow-Up Results of a Randomized Clinical Trial. *Journal of Adolescent Health, 51*(2), S17–S22. doi:10.1016/j.jadohealth.2012.05.005

Topic Area 3: Professional Development and Informal Learning

Sources for Professional Development Exemplars

Children's Learning Institute: eCIRCLE Online Professional Development

Landry, S. H., Anthony, J. L., Swank, P. R., & Monseque-Bailey, P. (2009). Effectiveness of comprehensive professional development for teachers of at-risk preschoolers. *Journal of Educational Psychology, 101*(2), 448–465. doi:10.1037/a0013842

Landry, S. H., Swank, P. R., Anthony, J. L., & Assel, M. A. (2010). An experimental study evaluating professional development activities within a state funded pre-kindergarten program. *Reading and Writing, 24*(8), 971–1010. doi:10.1007/s11145-010-9243-1

Karen Diamond and Douglas Powell: Classroom Links to Vocabulary and Phonological Sensitivity Skills (Classroom Links to Early Literacy)

Powell, D. R., Diamond, K. E., & Burchinal, M. R. (2012). Using coaching-based professional development to improve Head Start teachers' support of children's oral language skills. In C. Howes, B. K. Hamre, & R. C. Pianta (Eds.), *Effective professional development in early childhood education: Improving teacher practice and child outcomes* (pp. 13–29). Baltimore, MD: Brookes.

Powell, D. R., Diamond, K. E., Burchinal, M. R., & Koehler, M. J. (2010). Effects of an early literacy professional development intervention on head start teachers and children. *Journal of Educational Psychology, 102*(2), 299–312. doi:10.1037/a0017763

Teachstone: MyTeachingPartner

Downer, J., Pianta, R., Fan, X., Hamre, B., Mashburn, A., & Justice, L. (2011). Effects of Web-Mediated Teacher Professional Development on the Language and Literacy Skills of Children Enrolled in Pre-Kindergarten Programs. *NHSA Dialog, 14*(4), 189–212. doi:10.1080/15240754.2011.613129

Downer, J. T., Kraft-Sayre, M. E., & Pianta, R. C. (2009). Ongoing, Web-Mediated Professional Development Focused on Teacher–Child Interactions: Early Childhood Educators' Usage Rates and Self-Reported Satisfaction. *Early Education & Development, 20*(2), 321–345. doi:10.1080/10409280802595425

Lee, Y., Kinzie, M. B., & Whittaker, J. V. (2012). Impact of online support for teachers' open-ended questioning in pre-k science activities. *Teaching and Teacher Education, 28*(4), 568–577. doi:10.1016/j.tate.2012.01.002

Mashburn, A. J., Downer, J. T., Hamre, B. K., Justice, L. M., & Pianta, R. C. (2010). Consultation for Teachers and Children's Language and Literacy Development during Pre-Kindergarten. *Applied Developmental Science, 14*(4), 179–196. doi:10.1080/10888691.2010.516187

Pianta, R. C., Mashburn, A. J., Downer, J. T., Hamre, B. K., & Justice, L. (2008). Effects of web-mediated professional development resources on teacher–child interactions in pre-kindergarten classrooms. *Early Childhood Research Quarterly, 23*(4), 431–451. doi:10.1016/j.ecresq.2008.02.001

Whitaker, S., Kinzie, M., Kraft-Sayre, M. E., Mashburn, A., & Pianta, R. C. (2006). Use and Evaluation of Web-based Professional Development Services Across Participant Levels of Support. *Early Childhood Education Journal, 34*(6), 379–386. doi:10.1007/s10643-006-0142-7

Table C.1. Professional Development and Informal Learning Evaluative Articles by Technology

Article Citation	Video Technologies							Online Courses	Forums	Audio Self-reflection
	Video Exemplars (Video Modeling)	Videotape Feedback from a Coach or Trainer (Videotape Feedback)	Case-based hypermedia resource	Web-mediated Coaching	Video Self-reflection	Videotape Feedback sent to Practitioners via E-mail by Coach or Trainer	Videotape Feedback from Peers (Videotape Feedback)			
Artman-Meeker, K. M., & Hemmeter, M. L. (2012). Effects of Training and Feedback on Teachers' Use of Classroom Preventive Practices. <i>Topics in Early Childhood Special Education</i> , 33(2), 112–123. doi:10.1177/0271121412447115						x				
Buysse, V., Castro, D. C., & Peisner-Feinberg, E. (2010). Effects of a professional development program on classroom practices and outcomes for Latino dual language learners. <i>Early Childhood Research Quarterly</i> , 25(2), 194–206. doi:10.1016/j.ecresq.2009.10.001							x			
Cabell, S. Q., Justice, L. M., Piasta, S. B., Curenton, S. M., Wiggins, A., Turnbull, K. P., & Petscher, Y. (2011). The Impact of Teacher Responsivity Education on Preschoolers' Language and Literacy Skills. <i>American Journal of Speech-Language Pathology</i> , 20(4), 315–330. doi:10.1044/1058-0360(2011/10-0104)	x	x								
Cain, D. W., Rudd, L. C., & Saxon, T. F. (2007). Effects of professional development training on joint attention engagement in low-quality childcare centers. <i>Early Child Development and Care</i> , 177(2), 159–185. doi:10.1080/03004430500375927		x								
Campbell, P. H., & Sawyer, L. B. (2009). Changing Early Intervention Providers' Home Visiting Skills Through Participation in Professional Development. <i>Topics in Early Childhood Special Education</i> , 28(4), 219–234. doi:10.1177/0271121408328481	x	x					x			

Article Citation	Video Technologies							Online Courses	Forums	Audio Self-reflection
	Video Exemplars (Video Modeling)	Videotape Feedback from a Coach or Trainer (Videotape Feedback)	Case-based hypermedia resource	Web-mediated Coaching	Video Self-reflection	Videotape Feedback sent to Practitioners via E-mail by Coach or Trainer	Videotape Feedback from Peers (Videotape Feedback)			
Carlson, J. S., Tired, H. B., Bender, S. L., & Benson, L. (2011). The Influence of Group Training in the Incredible Years Teacher Classroom Management Program on Preschool Teachers' Classroom Management Strategies. <i>Journal of Applied School Psychology, 27</i> (2), 134–154. doi:10.1080/15377903.2011.565277	x									
Conroy, M. A., Sutherland, K. S., Vo, A. K., Carr, S., & Ogston, P. L. (2014). Early Childhood Teachers' Use of Effective Instructional Practices and the Collateral Effects on Young Children's Behavior. <i>Journal of Positive Behavior Interventions, 16</i> (2), 81–92. doi:10.1177/1098300713478666	x	x								
Coulter, L., & Gallagher, C. (2001). Evaluation of the Hanen early childhood educators programme. <i>International Journal of Language & Communication Disorders, 36</i> (s1), 264–269. Retrieved from http://informahealthcare.com/doi/abs/10.3109/13682820109177895	x	x								
DeLuccie, M. F. (2002). Beyond the child development associate credential: Educating head start teachers to work with children and families in the 21st century. <i>Journal of Early Childhood Teacher Education, 23</i> (3), 235–244. doi:10.1080/1090102020230307							x	x		
Dickinson, D. K., & Caswell, L. (2007). Building support for language and early literacy in preschool classrooms through in-service professional development: Effects of the Literacy Environment Enrichment Program (LEEP). <i>Early Childhood Research Quarterly, 22</i> (2), 243–260. doi:10.1016/j.ecresq.2007.03.001	x				x					x

Article Citation	Video Technologies							Online Courses	Forums	Audio Self-reflection
	Video Exemplars (Video Modeling)	Videotape Feedback from a Coach or Trainer (Videotape Feedback)	Case-based hypermedia resource	Web-mediated Coaching	Video Self-reflection	Videotape Feedback sent to Practitioners via E-mail by Coach or Trainer	Videotape Feedback from Peers (Videotape Feedback)			
Domitrovich, C. E., Gest, S. D., Gill, S., Bierman, K. L., Welsh, J. A., & Jones, D. (2009). Fostering high-quality teaching with an enriched curriculum and professional development support: The Head Start REDI program. <i>American Educational Research Journal</i> , 46(2), 567–597.	x									
Downer, J. T., Kraft-Sayre, M. E., & Pianta, R. C. (2009). Ongoing, Web-Mediated Professional Development Focused on Teacher–Child Interactions: Early Childhood Educators’ Usage Rates and Self-Reported Satisfaction. <i>Early Education & Development</i> , 20(2), 321–345. doi:10.1080/10409280802595425	x	x	x	x						
Downer, J., Pianta, R., Fan, X., Hamre, B., Mashburn, A., & Justice, L. (2011). Effects of Web-Mediated Teacher Professional Development on the Language and Literacy Skills of Children Enrolled in Pre-Kindergarten Programs. <i>NHSA Dialog</i> , 14(4), 189–212. doi:10.1080/15240754.2011.613129	x	x	x	x						
Fukkink, R. G., & Tavecchio, L. W. C. (2010). Effects of Video Interaction Guidance on early childhood teachers. <i>Teaching and Teacher Education</i> , 26(8), 1652–1659. doi:10.1016/j.tate.2010.06.016		x			x					
Hemmeter, M. L., Snyder, P., Kinder, K., & Artman, K. (2011). Impact of performance feedback delivered via electronic mail on preschool teachers’ use of descriptive praise. <i>Early Childhood Research Quarterly</i> , 26(1), 96–109. doi:10.1016/j.ecresq.2010.05.004	x									
Landry, S. H., Anthony, J. L., Swank, P. R., & Monseque-Bailey, P. (2009). Effectiveness of comprehensive professional development for teachers of at-risk preschoolers. <i>Journal of Educational Psychology</i> , 101(2), 448–465. doi:10.1037/a0013842	x			x				x	x	

Article Citation	Video Technologies							Online Courses	Forums	Audio Self-reflection
	Video Exemplars (Video Modeling)	Videotape Feedback from a Coach or Trainer (Videotape Feedback)	Case-based hypermedia resource	Web-mediated Coaching	Video Self-reflection	Videotape Feedback sent to Practitioners via E-mail by Coach or Trainer	Videotape Feedback from Peers (Videotape Feedback)			
Landry, S. H., Swank, P. R., Anthony, J. L., & Assel, M. A. (2010). An experimental study evaluating professional development activities within a state funded pre-kindergarten program. <i>Reading and Writing</i> , 24(8), 971–1010. doi:10.1007/s11145-010-9243-1	x			x				x	x	
Lee, Y., Kinzie, M. B., & Whittaker, J. V. (2012). Impact of online support for teachers' open-ended questioning in pre-k science activities. <i>Teaching and Teacher Education</i> , 28(4), 568–577. doi:10.1016/j.tate.2012.01.002	x									
Marturana, E. R., & Woods, J. J. (2012). Technology-Supported Performance-Based Feedback for Early Intervention Home Visiting. <i>Topics in Early Childhood Special Education</i> , 32(1), 14–23. doi:10.1177/0271121411434935		x				x				
Mashburn, A. J., Downer, J. T., Hamre, B. K., Justice, L. M., & Pianta, R. C. (2010). Consultation for Teachers and Children's Language and Literacy Development during Pre-Kindergarten. <i>Applied Developmental Science</i> , 14(4), 179–196. doi:10.1080/10888691.2010.516187	x	x	x	x						
Pianta, R. C., Mashburn, A. J., Downer, J. T., Hamre, B. K., & Justice, L. (2008). Effects of web-mediated professional development resources on teacher-child interactions in pre-kindergarten classrooms. <i>Early Childhood Research Quarterly</i> , 23(4), 431–451. doi:10.1016/j.ecresq.2008.02.001	x	x	x	x						
Piasta, S. B., Justice, L. M., Cabell, S. Q., Wiggins, A. K., Turnbull, K. P., & Curenton, S. M. (2012). Impact of professional development on preschool teachers' conversational responsivity and children's linguistic productivity and complexity. <i>Early Childhood Research Quarterly</i> , 27(3), 387–400. doi:10.1016/j.ecresq.2012.01.001	x	x				x				

Article Citation	Video Technologies							Online Courses	Forums	Audio Self-reflection
	Video Exemplars (Video Modeling)	Videotape Feedback from a Coach or Trainer (Videotape Feedback)	Case-based hypermedia resource	Web-mediated Coaching	Video Self-reflection	Videotape Feedback sent to Practitioners via E-mail by Coach or Trainer	Videotape Feedback from Peers (Videotape Feedback)			
Powell, D. R., Diamond, K. E., & Burchinal, M. R. (2012). Using coaching-based professional development to improve Head Start teachers' support of children's oral language skills. In C. Howes, B. K. Hamre, & R. C. Pianta (Eds.), <i>Effective professional development in early childhood education: Improving teacher practice and child outcomes</i> (pp. 13–29). Baltimore, MD: Brookes.	x	x	x							
Powell, D. R., Diamond, K. E., Burchinal, M. R., & Koehler, M. J. (2010). Effects of an early literacy professional development intervention on head start teachers and children. <i>Journal of Educational Psychology</i> , 102(2), 299–312. doi:10.1037/a0017763	x	x	x							
Raver, C. C., Jones, S. M., Li-Grining, C. P., Metzger, M., Champion, K. M., & Sardin, L. (2008). Improving preschool classroom processes: Preliminary findings from a randomized trial implemented in Head Start settings. <i>Early Childhood Research Quarterly</i> , 23(1), 10–26. doi:10.1016/j.ecresq.2007.09.001	x									
Sutherland, K. S., McLeod, B. D., Conroy, M. A., Abrams, L. M., & Smith, M. M. (2013). Preliminary Psychometric Properties of the BEST in CLASS Adherence and Competence Scale. <i>Journal of Emotional and Behavioral Disorders</i> . doi:10.1177/1063426613497258	x	x								
Vo, A. K., Sutherland, K. S., & Conroy, M. A. (2012). BEST in CLASS: A classroom-based model for ameliorating problem behavior in early childhood settings. <i>Psychology in the Schools</i> , 49(5), 402–415. doi:10.1002/pits.21609	x	x								
Wasik, B. A., & Hindman, A. H. (2011). Improving vocabulary and pre-literacy skills of at-risk preschoolers through teacher professional development. <i>Journal of Educational Psychology</i> , 103(2), 455–469. doi:10.1037/a0023067	x	x								

Article Citation	Video Technologies								Online Courses	Forums	Audio Self-reflection
	Video Exemplars (Video Modeling)	Videotape Feedback from a Coach or Trainer (Videotape Feedback)	Case-based hypermedia resource	Web-mediated Coaching	Video Self-reflection	Videotape Feedback sent to Practitioners via E-mail by Coach or Trainer	Videotape Feedback from Peers (Videotape Feedback)	Video Conference			
Webster-Stratton, C., Reid, M. J., & Hammond, M. (2001). Preventing conduct problems, promoting social competence: A parent and teacher training partnership in Head Start. <i>Journal of Clinical Child Psychology</i> , 30(3), 283–302. Retrieved from http://www.tandfonline.com/doi/abs/10.1207/S15374424JCCP3003_2	x										
Whitaker, S., Kinzie, M., Kraft-Sayre, M. E., Mashburn, A., & Pianta, R. C. (2006). Use and Evaluation of Web-based Professional Development Services Across Participant Levels of Support. <i>Early Childhood Education Journal</i> , 34(6), 379–386. doi:10.1007/s10643-006-0142-7	x	x	x	x							
Wright, M. R., Ellis, D. N., & Baxter, A. (2012). The Effect of Immediate or Delayed Video-Based Teacher Self-Evaluation on Head Start Teachers' Use of Praise. <i>Journal of Research in Childhood Education</i> , 26(2), 187–198. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/02568543.2012.657745					x						
Zan, B., & Donegan-Ritter, M. (2013). Reflecting, Coaching and Mentoring to Enhance Teacher–Child Interactions in Head Start Classrooms. <i>Early Childhood Education Journal</i> , 42(2), 93–104. doi:10.1007/s10643-013-0592-7	x				x						
32	25	18	7	7	4	3	2	1	3	2	1

Topic Area 4: Facilitators and Barriers to Technology Use

- Clements, D. H., & Sarama, J. (2003). Strip mining for gold: Research and policy in educational technology—A response to “fool’s gold.” *AACE Journal*, 11(1), 7–69. Retrieved from <http://www.editlib.org/p/17793/>
- Daugherty, L., Dossani, R., Johnson, E.-E., & Oguz, M. (2014). Using Early Childhood Education to Bridge the Digital Divide. *RAND Corporation*, 1–29. Retrieved from <http://www.rand.org/pubs/perspectives/PE119.html>
- First 5 California. (2014). CARES PLUS, Round 1, Evaluation Findings Update (pp. 1–40).
- Fool’s Gold; A Critical Look at Computers in Childhood | Alliance for Childhood. (n.d.). Retrieved August 26, 2014, from http://drupal6.allianceforchildhood.org/fools_gold
- Guernsey, L. (2014). Digital Age Architecture. Retrieved from http://www.digitcoach.com/download/i/mark_dl/u/4012443450/4608245079/Early%20Childhood%20Digi%20Guidance.pdf
- Hart, B., & Risley, T. R. (1995). Meaningful differences in the everyday experience of young American children. Paul H Brookes Publishing.
- National Association for the Education of Young Children., & Fred Rogers Center for Early Learning and Children’s Media at Saint Vincent College. (2012). Technology and Interactive Media as Tools in Early Childhood Programs Serving Children from Birth through Age 8., 1–15. Retrieved from http://www.naeyc.org/files/naeyc/file/positions/PS_technology_WEB2.pdf
- Roseberry, S., Hirsh-Pasek, K., & Golinkoff, R. M. (2014). Skype Me! Socially Contingent Interactions Help Toddlers Learn Language. *Child Development*, 85(3), 956–970. doi:10.1111/cdev.12166

Appendix E: Key Findings from Evaluative Literature for Featured Exemplars by Topic Area

Appendix E contains expanded discussions of key findings from the evaluative literature for each of the exemplars featured in Chapter 3. The expanded discussions include short descriptions of study designs, comparison groups, outcomes, effect sizes, statistical significance, and relevant references. These discussions are intended to provide more detail in regard to a particular product/program or technology's evidence base. The Appendix organizes the discussions by exemplar within Topic Area. In the rare instance when we could not identify any evaluative literature for an exemplar (i.e., for Curricula and Instructional Tools), we list the exemplar and note the absence of literature below.

Topic Area 1: Instruction and Assessment

Curricula and Instructional Tools

ABCmouse.com

No evaluative literature has examined the effectiveness of ABCmouse.com.

Inspire-NG multi-touch table

No evaluative literature has examined the effectiveness of the Inspire-NG multi-touch table.

Interactive whiteboards.

No evaluative literature has examined the effectiveness of interactive whiteboards.

Assessments

myIGDIs

This literature consists of nine validation studies of myIGDIs as a comprehensive progress monitoring tool. These studies focus primarily on the sensitivity of myIGDIs to assess development of early literacy and numeracy skills (e.g., vocabulary, phonological awareness, number naming, one-to-one correspondence), predictive validity, and psychometric properties. The literature confirms that myIGDIs are a valid and reliable comprehensive progress monitoring tool (Bradfield et al., 2014; Floyd, Hojnoski, & Key, 2006; Hojnoski, 2009; McCormick & Haack, 2010; K. N. Missall & McConnell, 2004; K. Missall et al., 2007; Moyle, Heilmann, & Berman, 2013; Roseth, Missall, & McConnell, 2012; Wackerle-Hollman, Schmitt, Bradfield, Rodriguez, & McConnell, 2013). No studies evaluate the effectiveness of myIGDIs to improve student outcomes in comparison to a competing progress monitoring tool (e.g., DIBELS).

mCLASS:CIRCLE

The academic search produced two evaluative sources⁴³ establishing the evidence base for mCLASS:CIRCLE (Buisse, Peisner-Feinberg, & Burchinal, 2009; Mason-Arruda, 2012). Both sources present evaluations of the impact of mCLASS:CIRCLE on child outcomes. The evaluations estimate the effect of mCLASS:CIRCLE on 4-year-old children's emergent literacy outcomes (i.e., letter identification, vocabulary, and phonological awareness) in comparison to a business as usual

⁴³ One source is a poster presented at a conference. The other is a presentation given at a conference.

control (i.e., no assessment). One evaluation utilized a QED design (Buysse, Peisner-Feinberg, & Burchinal, 2009). The other study did not specify an evaluation design; however, students within classrooms who might benefit from mCLASS:CIRCLE were “targeted” for assessment (Mason-Arruda, 2012). One source reported effect sizes for three distinct analyses (Buysse, Peisner-Feinberg, & Burchinal, 2009). First, adjusting for classroom, state, and age, children who used mCLASS:CIRCLE posted statistically significant ($p < 0.01$) moderate effect sizes in letter identification ($d = 0.34$), vocabulary ($d = 0.40$), and phonological awareness ($d = 0.50$). Second, adjusting for classroom and age, children who used mCLASS:CIRCLE showed statistically significant ($p < 0.001$) moderate effect size growth in vocabulary ($d = 0.41$) only. Finally, in a restricted analysis of children whose pre-test scores were in the bottom half of all scores, those who used mCLASS:CIRCLE realized no statistically significant impact on the three outcomes. While the second evaluative source did not report effect sizes or statistical significance (Mason-Arruda, 2012), it did state that children whose practitioners used mCLASS:CIRCLE learned at a faster rate than children in the control group. Additional research is needed to confidently assess the impact of mCLASS:CIRCLE – a SaaS in which a computer, mobile device, and app are central features – on child emergent literacy outcomes.

Integrated Curricula and Assessments

Teaching Strategies: The Creative Curriculum System for Preschool, Teaching Strategies Gold (TS GOLD)

The academic search returned five evaluative articles for the Creative Curriculum. Participating children’s ages ranged from 3- to 5-years-old. Four evaluative pieces utilized a randomized controlled trial (RCT) design, and one implemented a quasi-experimental design (QED). One report contained three distinct evaluations of the Creative Curriculum. Two of the evaluative articles compared the Creative Curriculum to other technology-enhanced integrated curricula/assessments which also had been identified through the web search (i.e., the HighScope Preschool Curriculum and Opening the World of Learning). Across the five evaluative pieces, the children who received the Creative Curriculum were compared to children who received one of six other curricula: (1) High Reach Curriculum, a comprehensive curriculum that addresses mathematics, language and literacy, social-emotional development, science, and physical health and development; (2) Bright Beginnings, a comprehensive curriculum similar to High Scope and the Creative Curriculum, with additional emphasis on language and literacy skills; (3) Ladders to Literacy, a supplementary curriculum for literacy and language development with a focus on print awareness, metalinguistic awareness, and oral language; (4) Opening the World of Learning (OWL), a comprehensive curriculum with a focus on language and literacy, and OWL plus Enhance Milieu Teaching (OWL+EMT), targeting low-language children; (5) unspecified curricula; and (6) business as usual (i.e., a variety of currently in-use curricula).

Four of the five pieces focused on child behavior. Of these four, three reported statistically non-significant effect sizes (National Center for Education Research, 2008), when comparing the Creative Curriculum to Bright Beginnings, Ladders to Literacy, business as usual, and non-specified curricula. One article that did not report effect sizes for child behavior found statistically significant ($p < 0.05$) mean differences in positive social behaviors and positive attitudes toward school and learning for children receiving the Creative Curriculum in comparison to children receiving the High Reach Curriculum (Henry et al., 2004).

All five evaluative pieces assessed the impact of the Creative Curriculum on children's language and literacy outcomes. Three out of the five evaluative pieces compared the Creative Curriculum to Bright Beginnings, Ladders to Literacy, and non-specified curricula. Statistically significant ($p < 0.01$) differences were reported for practitioner instruction in oral language ($d = 1.80$) and written expression ($d = 1.13, d = 1.73$).⁴⁴ These studies found no statistically significant effects for children's language and literacy outcomes (National Center for Education Research, 2008). The two evaluative pieces comparing the Creative Curriculum to the High Reach Curriculum, OWL, or OWL+EMT did not provide effect size estimates, but reported statistically significant mean differences ($p < .05$) in children's communication, vocabulary, grammatical sophistication, and print knowledge at the end of Kindergarten and vocabulary at the end of first grade (Henry et al., 2004; Kaiser et al., 2011). Four of the five evaluative pieces reported statistically non-significant effect sizes on child mathematics outcomes when comparing the Creative Curriculum to the High Reach Curriculum, Bright Beginnings, Ladders to Literacy, business as usual, and non-specified curricula (Henry et al., 2004; National Center for Education Research, 2008).

Three of the five evaluative pieces comparing the Creative Curriculum to Bright Beginnings, Ladders to Literacy, non-specified curricula, and business as usual examined the impact of the Curriculum's impact on practitioner-child interactions. Statistically significant ($p < 0.05$) differences were found in regard to decreased detachment ($d = -0.168$) and more positive interactions ($d = 1.65$) (National Center for Education Research (ED), 2008). The majority of outcomes, however, were statistically non-significant. Finally, three out of the five pieces reported on classroom quality. Of these three pieces, one reported significantly ($p < 0.05$) better classroom quality ($d = 1.66$) (Center for Education Research, 2008).

Overall, the evidence base for the differential effectiveness of the Creative Curriculum in comparison to other curricula was mixed. No statistically significant differences were reported for the large majority of *child outcomes* examined in these studies. Instead, the studies reported statistically significant differences in outcomes related to *practitioner outcomes*, specifically improvements in practitioner-child interactions, classroom quality, and practitioner oral language and writing instruction.

Building Blocks: Real Math PreK

The evidence base for Building Blocks consisted of three evaluative articles and one validation study. None of the articles specifically tested the impact of the use of a specific technology (i.e., SaaS computer based activities) on child outcomes, but they did examine the impact of the program as a whole. All three evaluative articles described the results of RCTs. Across these studies, 4- and 5-year-old children were randomly assigned to receive Building Blocks, or one of three alternative controls: business as usual, other curricula (i.e., the Creative Curriculum), or other instructional materials (e.g., Montessori math materials, practitioner-constructed materials). Child outcomes assessed included math (e.g., numbers, geometry, data analysis, measuring, counting), literacy (i.e., letter recognition) and oral language (e.g., complexity, sentence length). On math outcomes, the three articles reported statistically significant (i.e., $p < 0.05$) moderate to large effect sizes ranging from $d = 0.47$ to $d = 1.47$ (D. H. Clements & Sarama, 2008; Douglas H. Clements & Sarama, 2007; Sarama, Lange, Clements, & Wolfe, 2012). One article focused on language and literacy outcomes reported statistically significant ($p < 0.05$) small to moderate effect sizes ranging from $g = 0.08$ to g

⁴⁴ Two studies examined practitioner instruction in written expression, hence the two effect sizes reported on this outcome.

= 0.36 (Sarama, Lange, Clements, & Wolfe, 2012). These results suggest that the Building Blocks program, in which a computer and a SaaS are central features, can positively impact child math, language and literacy outcomes.

Making Online Decisions (MOD)

The academic search returned two evaluative articles on the MOD. The age of children in one article was noted as 16.8 months (SD = 9.2) and in the other article more generally as infants and toddlers. Both articles described evaluations that utilized a RCT design, where home visitors were randomly assigned to use the MOD or not use the MOD (i.e., control). That is, the home visitors in the control group administered, scored, and entered the Early Communication Indicators (ECI) results into an online database, but they did not have additional online support that linked the ECI data to the decision-making technology that provides child-specific intervention suggestions. In both articles, the outcome of interest was the ECI score. One article reported statistically significant ($p < 0.05$) moderate effect sizes ranging from $d = 0.24$ to $d = 0.71$ (Buzhardt et al., 2011). The other article did not report effect sizes, but showed that the mean rate of communication growth for children whose home visitors used the MOD was statistically significantly ($p < 0.05$) greater than that of children whose home visitors did not use the MOD (Buzhardt, Walker, Greenwood, & Carta, 2011). Together, these results suggest that the MOD, in which a SaaS is a central feature, can positively promote child language outcomes.

Topic Area 2: PFCE

Play and Learning Strategies (PALS)

The academic search returned five evaluative articles for PALS. None of the articles tested specifically the impact of the use of video on parent or child outcomes. However, the articles did examine the impact of the PALS program as a whole. Four articles described the results of studies that utilized a RCT design. In the four RCT studies, caregivers and their children in the control group received Developmental Assessment Screening (DAS). DAS included: (a) 10 weekly home visits, during which an infant's development is screened; (b) handouts on childcare (e.g., sleep, feeding); (c) and encouragement for mothers to speak with their healthcare providers if they had questions about infant development. The DAS control parents did not receive any technology-mediated training, nor did they learn or practice strategies that could facilitate child development. One article described the results from a QED study comparing caregivers' participation in either PALS versus an enhanced version of PALS, M-PALS. M-PALS is the same as PALS but also includes a facilitator plus a community mentor. Children in these studies ranged in age from 4 months to 4 years. Outcomes varied across the studies and focused on mothers (e.g., maternal behaviors, emotional well-being, perceived social support, parent competence) and infants or children (e.g., social skills, communication, responsiveness, affect). Three of the five articles reported statistically significant ($p < 0.05$) effect sizes ranging from $d = 0.27$ to $d = 1.16$ for maternal behaviors (Dieterich, Landry, Smith, Swank, & Hebert, 2006; Landry, Smith, & Swank, 2006) and from $d = 0.20$ to $d = 0.70$ for infant behaviors (Landry et al., 2012; Landry, Smith, & Swank, 2006). In one of the two articles that did not report effect sizes, mean differences between PALS and the control group, in terms of depressive symptoms, were statistically significant ($p < 0.05$). In the second article, that mothers receiving PALS were more likely than mothers not receiving PALS to display features associated with responsive parenting (i.e., less likely to be depressed and anxious, more mentally stable, hold more child-centered beliefs, and use social support adequately). These

results suggest that the PALS program, in which video modeling and feedback are central features, can positively impact parent outcomes.

The Thirty Million Words (TMW) Initiative

TMW is a new intervention and no studies have specifically tested the impact of any one of the three technologies (i.e., computer, video, LENA) on parent or child outcomes. However, one article did assess growth in parent and child language outcomes. A single-group, pre- and post-intervention pilot study (Suskind et al., 2013) found that parents who participated in the TMW intervention posted significant increases in adult word count (31.6%; $p < 0.01$) and conversational turn count (24.9%; $p < 0.01$) over baseline.

Topic Area 3: Professional Development and Informal Learning

Classroom Links to Early Literacy

The academic search returned two evaluative articles for Classroom Links that examined the impact of the program as a whole on practitioner outcomes. Both of the articles specifically tested the impact of video technology on practitioner and child outcomes. Each article described the results of a study that utilized a RCT design in which Head Start practitioners in the intervention group participated in Classroom Links remote coaching and those in the control group participated in on-site (i.e., in-person) coaching. In the remote coaching condition, practitioners had access to the case-based hypermedia resource and participated in videotape feedback. In the on-site coaching condition, a coach conducted a classroom observation on-site for 90 minutes and subsequently debriefed with the practitioner for 30 minutes. Children participating in these studies ranged in age from 3- to 4-years-old. Across both articles, three types of outcomes were assessed: practitioner-focused outcome (e.g., promoting word use among children, eliciting children's speaking through book reading and free play, defining words, labeling objects, number of utterances), child-focused outcomes (e.g., vocabulary, alphabet knowledge, concepts about print, name writing, blending sounds, number of utterances), and classroom-focused outcomes (i.e., "General Classroom Environment" and "Language, Literacy, and Curriculum" subscale scores from the Early Language and Literacy Classroom Observation [ELLCO] Tool).

Classroom Links significantly and positively impacted five of the eight child-focused outcomes assessed: concepts about print ($d = 0.22$; $p < .05$), alphabet knowledge ($d = 0.20$; $p < .001$), name writing ($d = 0.17$; $p < .05$), blending sounds ($d = 0.18$; $p < .05$), and child utterances ($d = 0.73$; $p < .05$) (Powell, Diamond, & Burchinal, 2012; Powell, Diamond, Burchinal, & Koehler, 2010). Only one of the nine practitioner-focused outcomes was impacted by Classroom Links: practitioner's vocabulary instruction ($d = 1.26$; $p < .05$) (Powell, Diamond, & Burchinal, 2012). Finally, one article reported statistically significant ($p < .001$) large effect sizes for the two classroom-level outcomes: General Classroom Environment ($d = 0.99$) and Language, Literacy, and Curriculum ($d = 0.92$) (Powell, Diamond, & Burchinal, 2012).

The results of these studies suggest that the Classroom Links to Early Literacy program—which utilizes video cameras, asynchronous videotape feedback, Apple iBook computers, and a "case-based hypermedia" resource—can produce large effects on practitioners' vocabulary instruction, large effects on the classroom-level language and literacy environment, and small to moderate impacts on children's emergent literacy outcomes.

My Teaching Partner (MTP)

The academic search returned six evaluative articles for MTP. All six evaluations isolated the impact of the ongoing, one-on-one web-mediated video consultancy (i.e., coaching), a core feature of the MTP program. Moreover, the evaluations isolated the impacts of one or more MTP components (e.g., lesson plans from the MyTeachingPartner—Language and Literacy [MTP-LL] supplemental curriculum, the MTP-LL curriculum plus access to video exemplars on the MTP website). Participating children in all six studies were between 4- and 5-years-old. Further, all six articles employed RCT designs. The treatment and control groups differed considerably, however, depending on the goal of the article/study. Each study used two or three out of the five comparison conditions listed in Table E.1. In the first condition, practitioners received instructional materials only (e.g., MTP Language and Literacy [MTP-LL] supplemental curriculum; MTP Math and Science Curriculum; Banking Time, techniques to create positive practitioner-child interactions; Preschool Promoting Alternative Thinking Strategies Curriculum [PATHS]). In the second condition, practitioners only had access to resources on the MTP website (e.g., descriptions of the ten dimensions of high quality practitioner-child interactions, video exemplars showing such interactions, tools to reflect on instructional techniques). In the third condition, practitioners received instructional materials and access to resources on the MTP website. In the fourth condition, practitioners received instructional materials, had access to resources on the MTP website, and participated in face-to-face workshops, during which they practiced asking quality questions through role-playing with their peers. Finally, in the fifth condition, practitioners received instructional materials, had access to the MTP website and participated in ongoing one-on-one video consultations once every two weeks.⁴⁵

Table E.1. Comparison conditions in evaluative articles on MTP.

Evaluative Article	Instructional Materials Only	MTP Website Only	Instructional Materials + MTP Website	Instructional Materials + MTP Website + Face-to-Face Workshops	Instructional Materials + MTP Website + Consultancy
J. T. Downer, Kraft-Sayre, & Pianta, 2009	x				x
J. Downer et al., 2011	x		x		x
Lee, Kinzie, & Whittaker, 2012	x			x	
Mashburn, Downer, Hamre, Justice, & Pianta, 2010		x			x
Pianta, Mashburn, Downer, Hamre, & Justice, 2008	x				x
Whitaker, Kinzie, Kraft-Sayre, Mashburn, & Pianta, 2006	x		x		x

⁴⁵ This condition represents the full MTP professional improvement package.

Outcomes were of two types: practitioner-focused (e.g., classroom behavior management; program use, such as number of minutes spent on MTP-related tasks, the frequency of use of MTP resources, and the number of website log-ins) and child-focused (e.g., vocabulary, phonological and print processing, blending sounds, lexical diversity, syntactic complexity and emergent literacy in general).

Three of the six articles examined practitioner-centered outcomes. Among these three articles, one reported a significantly ($p < 0.01$) greater ability to manage classroom behavior ($b=0.22$) among practitioners who engaged in more MTP activities (Pianta, Mashburn, Downer, Hamre, & Justice, 2008). The other two articles that reported practitioner-focused outcomes described statistically significant ($p < 0.05$) mean differences between practitioners who had 1) were given instructional materials, access to the MTP website, and web-mediated consultancy (i.e., the full MTP package), versus 2) practitioners who received access to instructional materials only and 3) practitioners who received instructional materials plus access to the MTP website resources (Downer, Kraft-Sayre, & Pianta, 2009; Whitaker, Kinzie, Kraft-Sayre, Mashburn, & Pianta, 2006). Practitioners who received the full MTP package logged on to the MTP website more frequently, spent more time on the MTP website, visited more pages on the MTP website that hosted exemplar videos, obtained more resources from the MTP website, found more helpful examples of high quality teaching, and implemented more Banking Time sessions.

The other three of six articles examined child-focused outcomes. All three reported statistically significant ($p < 0.05$) moderate to large effects on child outcomes. Children whose practitioners received the full MTP package posted significantly higher lexical diversity scores ($b = 0.77$; $p < .05$) and syntactic complexity scores ($b=0.97$; $p < .01$) than children whose practitioners implemented the district's existing curricula or had access to the MTP website only (Lee, Kinzie, & Whittaker, 2012). Children whose practitioners received the full MTP package made significantly greater gains ($ps < .05$) on the following outcomes than children whose practitioners received instructional materials only or instructional materials plus access to MTP website resources: phonological and print processing ($b = 0.11$), sound blending ($b = 0.40$), receptive vocabulary ($b = 0.50$), and general emergent literacy outcomes ($b = 1.84$) (Downer et al., 2011; Mashburn, Downer, Hamre, Justice, & Pianta, 2010).

In summary, children whose practitioners used MTP made greater gains in child-focused outcomes, such as language and emergent literacy, than did children in the comparison groups. Likewise, practitioners who participated in MTP coaching were significantly more engaged in their professional development (as measured by practitioner-focused outcomes such as time spent on the website and frequency of visits to the website) than their comparison group counterparts. Overall, the results from the evaluative literature suggest that MTP, with its technology mediated coaching and professional development resources, can positively impact both practitioner and ultimately child outcomes.

eCIRCLE

The academic search found two evaluative articles for eCIRCLE. Neither of the articles specifically tested the impact of the use of specific eCIRCLE technologies on practitioner or child outcomes. However, the articles did examine the impact of the eCIRCLE program as a whole. Children participating in the two studies ranged in age from 3- to 5-years-old. Each article described the results of a RCT study, where practitioners in the control groups did not receive eCIRCLE professional development. In one article, practitioners were randomly assigned to one of five comparison groups, a control condition with no eCIRCLE training, or one of four alternative

treatments that included eCIRCLE training and: 1) regularly scheduled in-classroom mentoring plus a PDA (Personal Digital Assistant)-based progress monitoring tool (i.e., C-PALLS)⁴⁶, 2) mentoring plus a paper and pencil version of C-PALLS, 3) the PDA version of C-PALLS only, and 4) the paper and pencil version of the C-PALLS only (Landry, Anthony, Swank, & Monseque-Bailey, 2009). Across both articles, studies examined practitioner-focused outcomes (e.g., teaching quantity, teaching quality, and practitioner instructional behaviors) or child-focused outcomes (e.g., vocabulary, print awareness, phonological awareness, and print knowledge). The impact of eCIRCLE on these outcomes is described below.

One article examined the impact of eCIRCLE on practitioner-focused outcomes (Landry, Anthony, Swank, & Monseque-Bailey, 2009). On all eight of these outcomes, the article reported statistically significant ($p < 0.05$) moderate to large effect sizes, ranging from $d = 0.76$ to $d = 1.40$ (Landry, Anthony, Swank, & Monseque-Bailey, 2009). Practitioners who both participated in mentoring and used the PDA C-PALLS taught more than practitioners in the control group ($d = 1.40$; $p < 0.001$), and displayed higher quality instruction compared to practitioners in the control group ($d = 1.11$; $p < 0.01$). Likewise, practitioners who used the PDA C-PALLS but who did not receive mentoring also taught more than practitioners in the control group ($d = 0.96$; $p < 0.05$) (Landry, Anthony, Swank, & Monseque-Bailey, 2009). Moreover, practitioners in the four alternative treatment groups displayed higher quality instruction than practitioners in the control group ($d = 0.76$; $p < 0.05$), and were rated higher on practitioner behaviors ($d = 0.84$; $p = .0001$) (Landry, Anthony, Swank, & Monseque-Bailey, 2009).

On the five child-focused outcomes, the articles reported statistically significant ($p < 0.05$) small to moderate effect sizes, ranging from $d = 0.11$ to $d = 0.26$ (Landry, Anthony, Swank, & Monseque-Bailey, 2009; Landry, Swank, Anthony, & Assel, 2010). Children whose teachers only used PDA C-PALLS displayed greater phonological awareness than children whose teachers were in the control group ($d = 0.16$; $p < 0.05$) (Landry, Anthony, Swank, & Monseque-Bailey, 2009). Children whose teachers received mentoring and used PDA C-PALLS attained higher vocabulary scores than children of teachers in the control group ($d = 0.19$, $p < 0.05$; or $d = 0.26$, $p < 0.05$) (Landry, Anthony, Swank, & Monseque-Bailey, 2009; Landry, Swank, Anthony, & Assel, 2010). Children whose teachers only used PDA C-PALLS attained higher print awareness scores than children whose teachers only used paper-and-pencil C-PALLS ($d = 0.16$, $p < 0.05$) (Landry, Anthony, Swank, & Monseque-Bailey, 2009). Finally, children whose teachers participated in eCIRCLE training displayed more advanced print knowledge than children in the control group ($d = 0.11$, $p < 0.05$) (Landry, Swank, Anthony, & Assel, 2010).

Overall, the articles showed that practitioners who participated in eCIRCLE professional development and also implemented the technology-enhanced version of the C-PALLS assessment displayed higher quality instruction than control group practitioners. In addition, their children achieved significantly greater gains on language and emergent literacy outcomes than their control group counterparts. Thus, the results from evaluations of eCIRCLE suggest that this technology-enhanced professional development program can have a positive impact on both practitioner and child outcomes.

⁴⁶ Specifically, the CIRCLE-Phonological Awareness, Language, and Literacy Screener (C-PALLS), which practitioners use to monitor children's school readiness skills relevant to language and literacy proficiency. The PDA version automatically computed, tracked, and monitored children's scores as well as selected appropriate activities from the CIRCLE activity manual.