Examining the effectiveness of technology use in classrooms: A tertiary meta-analysis

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ABSTRACT

Identifying effective literacy instruction programs has been a focal point for governments, educators and parents over the last few decades (Ontario Ministry of Education, 2004, 2006; Council of Ontario Directors of Education, 2011). Given the increasing use of computer technologies in the classroom and in the home, a variety of information communication technology (ICT) interventions for learning have been introduced. Meta-analyses comparing the impact of these programs on learning, however, have yielded inconsistent findings (Andrews, Freeman, Hou, McGuinn, Robinson, & Zhu, 2007; Slavin, Cheung, Groff, & Lake, 2008; Slavin, Lake, Chambers, Cheung, & Davis, 2009; Torgerson & Zhu, 2003). The present tertiary meta-analytic review re-assesses outcomes presented in three previous meta-analyses. Four moderator variables assessed the impact of the systematic review from which they were retrieved, training and support, implementation fidelity and who delivered the intervention (teacher versus researcher). Significant results were found when training and support was entered as a moderator variable with the small overall effectiveness of the ICTs ($ES = 0.18$), similar to those found in previous research, increasing significantly ($ES = 0.57$). These findings indicate the importance of including implementation factors such as training and support, when considering the relative effectiveness of ICT interventions.

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1. Introduction

Identifying effective literacy instruction programs has been a focal point for governments, educators and parents over the last few decades (Ontario Ministry of Education, 2004, 2006; Council of Ontario Directors of Education, 2011). Given the increasing use of computer technologies in the classroom and in the home, a variety of information communication technology (ICT) and computer-assisted instruction (CAI) interventions for learning have been introduced. The variation across studies in factors such as sample size, types of ICT/CAI employed, and design of the study, however, make it difficult to reach clear conclusions about the overall effectiveness of these literacy based ICT/CAIs. Indeed, meta-analyses have generally been unable find a consistent positive effect for the use of ICTs in the classroom (Andrews et al., 2007; Kulik, 2003; Slavin et al., 2008; Slavin et al., 2009; Torgerson & Zhu, 2003). The lack of a clear, consistent definition of ICT/CAI makes the task of investigating the effects of these technology-based interventions even more challenging (Andrews et al., 2007). For example, the type of tool or "technology" used, the purpose of implementation, and the method of implementation may vary across studies. Ross, Morrison, and Lowther (2010) identified three roles for technology in education (i.e., technology as a tutor, technology as a teaching aid, and technology as a learning tool) that can be used to understand implementation differences in educational contexts. Specifically, technology as a tutor refers to computer-assisted technology that provides lessons and practice often dynamically by adjusting to the needs of the individual. Technology as a "teaching aid" refers to use of multiple media (e.g., including video segments, interactive exercises and multimedia presentations) to enhance teacher-led instruction. Technology as a learning tool refers to student use of technology to enhance their learning. Consistent with Ross et al. (2010), studies included in the current meta-analysis could be defined by one of these three roles. Despite

variability in defining ICTs and CAIs across studies, many educators and researchers advocate for the potential for these tools to improve learning (e.g., Chambers et al., 2008; Savage et al., 2013), Further research, however, is needed to explore other factors that may be contributing to the inability to assess the effectiveness of these technology-based interventions in education.

1.1. Previous meta-analyses

Slavin et al. (2008) assessed the use of computer-assisted instruction (CAI) on reading in middle and high school students. Eight studies met the inclusion criteria. Slavin et al. (2008) reported a mean effect size of +0.10 and concluded "Also consistent with previous research is the finding in the present study that forms of CAI generally produced small effects." (p. 309). Slavin et al. (2009) found similar results concluding "the evidence summarized here clearly indicates that the types of supplementary CAI programs that have dominated the use of technology in education for 30 years are not producing significant effects in upper elementary reading." (p. 1434).

Torgerson and Zhu (2003) conducted a meta-analysis on the use of ICT in English literacy learning. Of the 20 included studies they found only four studies to be statistically significant, with 1 of these having a negative effect size. Torgerson and Zhu (2003) stated "These data would suggest that there is little evidence to support widespread use of ICT in literacy learning in English." (p. 52).

Andrews et al. (2007) examined whether information and communication technologies were effective in teaching English. They found that the studies were too heterogeneous, in both the written composition and the ICTs used, to conduct a meta-analysis. They concluded that "we are thus unable to make confident comparisons between the effectiveness of different ICTs on learning in English for 5- to 16-year-olds." (p. 334).

Results from previous meta-analyses show very little evidence in support of ICT for literacy interventions. There is so much variation in the types of ICT interventions such as the technology used and the software programs used. Additionally, there is no clear definition or description of what constitutes an ICT intervention, it stands to reason that implementation of such studies needs to be further investigated to see if there are features of the implementation process that make them more or less effective.

1.2. Possible factors

Tamim, Bernard, Borokhovski, Abrami, and Schmid (2011) suggested that rather than the nature of the technology intervention, other factors such as pedagogy, teacher effectiveness, subject matter/domain and fidelity of implementation may have a greater impact on effect size. In their second-order meta-analysis they validated the approach of synthesizing effect sizes as an appropriate method to use when examining potential factors contributing to the effectiveness of technology in learning (Tamim et al., 2011). Results from their second-order meta-analyses yielded two important outcomes. First, their analyses support the potency of ICT interventions as a valuable instructional tool and second, they highlighted the importance of considering potential contributing factors when assessing ICT studies.

Following from Tamim et al. (2011) suggestion that contributing factors should be considered, Savage et al. (2013) identified two factors in particular that could be contributing to the effectiveness of ICT interventions and these served as the focus for the current meta-analysis; the training and support that the teacher receives in delivery of the intervention, and the fidelity of implementation. Studies vary in the training and support that teachers receive during and prior to implementation. In many cases training may involve only a single session leaving teachers feeling unprepared (Anderson, Wood, Piquette-Tomei, Savage, & Mueller, 2011). A recent study revealed not only the importance of proper training and support during initial implementation of an ICT intervention, but also the need for ongoing support throughout the intervention, especially when technology is involved (Anderson et al., 2011). In addition to training and support, implementation fidelity can also have an impact on the success of an intervention. Research shows that high fidelity of implementation can significantly increase the potential effectiveness of literacy programs (Davidson, Fields, & Yang, 2009). Also important to note is that training and support, and implementation fidelity are closely linked and that the more training and support that is offered the higher implementation fidelity is likely to be. One other closely related factor that should also be considered is whether the implementation is delivered by a teacher or by a researcher. It is essential to consider how these factors may have contributed to the outcomes obtained in previous systematic reviews of ICT based intervention studies.

1.3. Training and support

Because comfort with technology is an important predictor of the integration of technology it is essential to provide teachers with appropriate training and support prior to and during the use of technology in the classroom (Wood, Mueller, Willoughby, Specht, & Deyoung, 2005). While training may provide knowledge, it is vital to provide ongoing support until the teacher is comfortable with using the technology in the classroom.

ICT studies in the past have often provided very little if any information on training prior to implementation and when there is mention of training, it is often a one-day type training session (Campuzano, Dynarski, Agodini, & Rall, 2009; Jones, 1994; Ross, Nunnery, Avis, & Borek, 2005). Furthermore, in many cases no ongoing support is provided, increasing the likelihood that the teacher is not comfortable with implementing the intervention.

The need for training and ongoing support is especially prevalent in ICT interventions due to the additional variables introduced through often unfamiliar, constantly evolving technology. Anderson et al. (2011) found that when implementing a computer-based reading intervention in the classroom, over 84% of support requests revolved around computer hardware and software issues. When constant support was available for the duration of the implementation the support requests made decreased over time (Anderson et al., 2011). This illustrates the need for on-going support, especially during initial stages of implementation.

1.4. Implementation

Despite general agreement regarding its importance, the reporting of implementation fidelity in studies is quite low and can have a significant impact on the outcome (McIntyre, Gresham, DiGennaro, & Reed, 2007). Research has shown that technology integration in