Literacy Technologies and the Early Years of School

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November 2016

Introduction

Technology abounds in schools and homes. Literacy technologies such as CD-ROMs or DVDs have been available to educators and parents for at least the past 30 years. More recently web-based literacy technologies have emerged. Much of this material has been evaluated for impact on student learning outcomes. What have we learned from this work? What remains to be understood? These are the questions explored here.

Subject

Here we seek to review specific aspects of technology used in the early school years of education. Our focus is on web-based and traditional CD-ROM or similar 'packages' of literacy interventions. Other Encyclopedia entries consider the impact of specific technologies such as tablets or talking books, and the optimal methods for the inclusion of technologies within the classroom.[1,2]

Problems

The present article considers the following specific questions:

- Do children learn language and literacy skills from digital media? To do this we will summarize the whole literature.
- What are the characteristics of effective educational software-based teaching materials? We will analyze the features of the most effective tools.

Research Context

The focus of most evaluation research on technology has rightly been on implementation trials. Typically these

trials are quantitative quasi-experiments or randomized control trials (RCTs) that have as a bare minimum an intervention condition, a control condition and assess change in learning from pre to post-intervention on a respected language or literacy measure with known reliability and validity. Unfortunately, few really well-designed studies of this kind are published in education, and the work on literacy technology is no exception to this pattern. Nevertheless, such studies provide the only rigorous methods for knowing that the use of technology adds value in literacy development.[3] Only RCTs provide convincing evidence of causal links from the use of technology to raised reading attainments. Beyond this, the strongest evidence of the reliability and generalizability of such studies comes from carefully undertaken statistical meta-analyses of all such RCTs. Such studies are thus reviewed here.

Key Research Questions

So, do educational technologies 'work' to improve literacy? A tertiary analysis (that is, a review of a series of meta-analyses)[4] summarized all available individual meta-analyses and showed rather modest effects of intervention on literacy outcomes.[5-9] A more recent review of effective practices in elementary schools[10] also suggested that interventions using instructional technology generate only small effect sizes (d = +0.14) for reading outcomes.[a] More recently, a meta-analytic review[11] found similarly small positive effects (d = +.16). Finally, a meta-analysis of meta-analyses[12] also reported comparably modest effects.

Are such small positive effect sizes the best that technology can offer literacy? This is probably overly pessimistic on the basis of our own work and re-interpretation of the wider literature. We now have eleven published experimental (generally RCT) studies using our ABRACADABRA web-based intervention (http://abralite.concordia.ca). These have produced mostly small to medium effect sizes for impacts on a range of reading outcome measures in studies around the world.[13] In a recent meta-analysis[14] consistent medium effects were sometimes evident (e.g., g = +.38 for listening comprehension outcomes). Another recent meta-analytic review of the wider literature[15] also reported medium positive effect sizes for technology on outcomes such as children's concepts of print and phonological awareness.

Recent Research Results

One recent review[16] contrasted 'online' software with 'offline' closed systems (compact discs). Generally, online programs offered more comprehensive content, teaching more key literacy skills than offline software in Kindergarten and Grade 1 levels. Both the quality of instruction and the scaffolding of learning was also quite variable across on and offline technologies. Perhaps surprisingly, few programs, either online or offline, provided automatic progression across levels of task difficulty from short blends to longer ones based on mastery at the lower level (e.g., for blending sounds, from: 'i'-'t' to 's'-'i'-'t' to 's'-'p'-'i'-t' to 's'-'p'-'l'-'i'-'t'). This review provides information to support the principled selection and use of digital instructional materials by parents and educators. These findings also suggest that better software is needed before we can evaluate whether it is efficacious or not.

Research Gaps

Arguably three methodological issues remain to be resolved in future research:[17]

1. Study implementation. A tertiary meta-analysis[18] found effect sizes for technology on reading can be as high as d = +.60, but where training and support of teachers are poor, effects are close to zero.
2. The quality of the technology. Consistent with recent work,[17] another study[19] used a taxonomy of reading skills applied to thirty popular literacy software programs. Results showed that only 15% of the programs taught the key skill of synthetic phonics. Startlingly, activities to develop text comprehension skills were entirely absent. Tellingly, there were limited examples given for training each skill, inconsistent progression from simpler to more demanding items, and few opportunities to practice taught skills.
3. The theoretical and pedagogical coherence of technologies. Most interventions do not test theories of reading, or of technology (e.g., its multiple modalities, simultaneity, immediacy, its impartiality, privacy).

Conclusions

This article has sought to evaluate the impact of technologies for literacy. What do we know as a result of all this work? We know that technologies can work. While early reviews all found small or near-zero effects of intervention, more recent high quality work has consistently shown small-to-medium effects of intervention on language and literacy outcomes. It is notable that some recent reviews have found largest effects on outcomes that have proved traditionally 'hard to remediate' such as listening comprehension. Arguably research on literacy technologies suffers from extremism: 'naïve' modernist enthusiasm for technology as 'the answer' to literacy difficulties is countered by the backlash of cynicism against their use ('Oversold and Underused' as one critic has it[19]). The reality we argue is in the middle ground - technologies of high quality used by trained and well-supported expert staff in expert ways as one part of literacy instruction, connected to wider literacy goals appear to add consistent small to medium sized 'value added' for literacy in the early years.

Implications for Parents, Services and Policy

What are the implications for technology users? We think there are four:

Firstly, for parents and teachers the implication is caveat emptor ('let the purchaser beware'). Some commercially available technologies teach valuable content in a manner that conforms to best practices and are quite likely to aid early literacy. It is however important to critically evaluate technologies before purchasing and using them. Secondly, there are also very few technologies that teach all of the skills that wider research and expert opinion agree are core to effective reading acquisition, so literacy technologies can be used as an additional tool to aid some aspects of literacy, never as a replacement for expert teaching. In this respect 'on-line' technologies are as good if not superior to 'off-line' technologies.

Thirdly in formal educational contexts, the careful training of- and support for- staff in using technologies is likely to be an important feature of their effective use (though parents may benefit too!). Given that none of the most popular technologies provide automatic graduated transition for simpler to more complex items, the programming of effective learning lies with a capable adult who understands curricular progressions in early literacy. Expert teachers will therefore likely get the best from the best technologies. It is also highly unlikely that children left unsupervised with such technologies will learn effectively.

Fourthly, for policy makers we counsel that they should not throw the 'baby' of literacy technologies out with the

bathwater of poor results of earlier systematic reviews. Better technologies used in more sophisticated ways to test theory, implemented and supported well can, we think, add visible value to language and literacy learning. This goal awaits further better basic research testing contemporary theories of multimedia, literacy and technology.

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Note:

[a] 'Effect size' is an accepted way to measure the size or practical significance of improvements that follow any intervention. Mathematically this is based on the mean post-intervention score minus the mean pre-intervention score and usually divided by a measure of variability in scores at pre-intervention (e.g., pooled standard deviation), to give an effect size score, d. By common consent a 'small' effect size is d = + .2, a 'medium' effect size is d = +.5 and a 'large' effect size is d = + .8.