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A Dual-Generation Strategy: Using Technology to Support Learning for Children and for Families.

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American children face very different chances of getting ahead in life depending on the circumstances of their birth. According to a detailed review of the evidence conducted by scholars at The Brookings Institution, 42 percent of children who grew up in households in the bottom quintile of the income distribution ended up in the bottom quintile themselves as adults. Only six percent of such children reached the top quintile of the income distribution as adults (Isaacs, Sawhill, & Haskins, 2008). Fortunately, there is now strong evidence that early childhood interventions can improve the life chances of low income children (Heckman, 2006). Many such interventions target children directly. However, dual-generation strategies that strengthen maternal educational skills at the same time they improve learning opportunities for children may be even more effective.

Improving Parents' Literacy Skills in a Dual-Generation Strategy

Dual-generation intervention strategies designed to increase maternal educational skills and attainment are especially compelling given the mounting evidence that increasing mothers' education improves children's outcomes in health and education (Bjorklund & Salvanes, 2011). A recent study showed that maternal literacy skills are the single most important factor in closing the achievement gap between children in affluent and low-income neighborhoods in Los Angeles (Sastry & Pebley, 2010). The mechanism driving the linkages between maternal education and child outcomes appears to be the quality of the home environment (Carneiro, Meghir, & Parey, 2007; Magnuson, 2007). A rich and supportive home learning environment helps children succeed in school. Unfortunately, the home learning environment of low-income children falls short of that experienced by their more advantaged peers.

Narrowing Income-based Disparities in Children's Achievement

The income achievement gap is now much larger than the black-white achievement gap, a reversal from the pattern 50 years ago (Reardon, 2011). Parents with higher levels of education spend more time with their children overall (Guryan, Hurst, & Kearney, 2008) and more time in developmentally-relevant activities (Kalil, Ryan, & Corey, 2012). Parents with more education and income, compared to their poorer and less-educated peers, talk more to their children, use more varied vocabulary in their speech, provide more contingent replies to children's questions, ask children more questions, and use less speech that directs children's behavior (Hart & Risley 1995; Hoff-Ginsberg 1991; Hoff 2003, 2006).

Because of these differences, it is not surprising that many gains from early childhood intervention fade out over time due to poor subsequent home and schooling environments. For example, adults with little education spend far more time watching television and far less time reading for pleasure compared to their higher-educated counterparts (U.S. Department of Labor, 2011). Similar socioeconomic differences in time spent in educationally enriching activities have been documented for children (Phillips, 2011).

How Parents' Literacy Shapes the Home Literacy Environment

An important barrier to improving children's literacy is the very low levels of literacy among parents with limited education. The U.S. Department of Education (2007) reported that 50 percent of the U.S. adult population who did not graduate from high school has "below basic"

prose literacy skills, meaning they can perform no more than the most simple and concrete literacy skills. In contrast, only 13 percent of high school graduates and only three percent of college graduates meet this definition. Quantitative literacy is even more compromised in the U.S. population: 64 percent of the U.S. adult population who did not graduate from high school has “below basic” quantitative literacy skills, whereas 24 percent of high school graduates and four percent of college graduates, respectively, meet this definition.

Parents’ literacy is highly related to the literacy environment that children experience: 19 percent of parents with “below basic” prose literacy did not try to teach their PreKindergarten age children the letters of the alphabet during the previous month; 41 percent of this group did not read to their children (under age 8) during the previous week; 11 percent never talked to their school-age children about things they studied in school, and 25 percent never worked with their school-age children on homework. Nineteen percent of this group reported having no reading materials in the home and 15 percent were not involved in any way at their children’s school (U.S. Department of Education, 2007). These figures are substantially higher than those for parents deemed proficient in prose literacy skills.

Given these challenges, it is perhaps not surprising to find limited evidence for the efficacy of dual-generation interventions that aim to improve parents’ educational and literacy skills and the home environment while their children participate in early education programs. For example, the U.S. Department of Education’s Even Start program, which began in 1989, has shown consistently weak results. Even Start provided participating families with an integrated program of early childhood education, adult literacy or basic skills training, parenting education, and joint parent-child literacy activities. The underlying philosophy of this program is that families need to receive all types of services to bring about lasting improvement in children’s school success (St. Pierre et al. 2003). The program, however, which cost approximately \$10,366 (in 2005 dollars) per family during the 2000–2001 program year produced no meaningful effects on a range of child cognitive and behavioral outcomes, nor on parental behavior or literacy, based on a randomized trial of 463 families in 18 programs sites (Ricciuti et al., 2004). As in other such interventions, Even Start parents had high levels of non-participation and drop-out rates in the program.

The Case for Technology to Support Parent and Child Literacy Skills

Given the rapid technological advances of the past decade, the potential exists for cost-effective technology-based interventions to improve family literacy and narrow the achievement gap between children from high and low-income families. These advances include:

- The proliferation of low-cost devices such as smart phones, portable game consoles, e-book readers, and interactive toys
- Advances in speech recognition and text-to-speech technology
- Intelligent tutoring systems that provide personalized instruction, model the interventions of an expert tutor, and improve over time
- Cloud computing, which can expand the computational resources that a low-cost device can access
- Digital libraries of engaging, age-appropriate material

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- Elements of game design that increase attentive time on task (White House Office of Science and Technology Policy, 2011).

These advances in technology could not only address barriers to effectiveness but could also open up new avenues for programs to make an impact. Given the ever-decreasing costs of hardware and the low marginal costs of software, using technology to improve upon existing approaches as well as develop new approaches is a promising strategy from a cost-benefit perspective.

A technology-based approach in which educational materials were pre-loaded on a digital device or downloadable from the Internet could reduce a program's dependence on home visits by a paraprofessional. Parents would not have to depend on face-to-face meetings to stay current with the program and, provided access to the Internet; they could make use of social media platforms to develop partnerships with other parents, thus replacing some of the time and expense of attending center-based activities.

Technology-based strategies also hold promise for increasing the impact and efficacy of educational skills interventions. Intelligent tutoring systems that provide personalized, effective instruction to parents and children can ease these burdens on home visitors and allow parents and children to move through the curriculum at their own pace, thereby modulating the curriculum in real time depending on the participant's performance. Such immediate feedback enables the participant to self-correct and results in more effective learning. The rapid response capability of a technology-based system versus an exclusively human-based delivery system will be more efficient and effective if it speeds learning, minimizes frustration, increases engagement, and reduces attrition.

Not only could a technology-based approach help to standardize instruction quality and access to instructional materials for parents, it can also more effectively engage parents in interactions with their children. Educational software can be developed that is as compelling as the best video game and that improves the more that one uses it. In *Even Start*, for example, staff reported that it was hard to get parents and children to play together and that many parents were uncomfortable or unsure of how to play with their children (St. Pierre & Swartz, 1995). Dynamic, engaging software can be developed that provides guidance for parents and increases their confidence in the role of teacher, thus improving parent-child interaction on skill-developing activities.

Research has shown that with guidance, low SES parents can learn how to effectively interact with their child in a learning setting (Whitehurst, Falco et al., 1994). Digital technology can provide this type of training within the game itself. The dynamic nature of a game interface also holds the possibility of increasing motivation and perseverance as well as improving participants' attention and executive function. Finally, participation in program activities is potentially more easily or consistently tracked in a technology-based approach, which creates new opportunities to incentivize and reward families' participation.

A Promising Program Model

One relevant program model -- Computers for Youth (CFY) – has adopted an approach along these lines with a focus on “family computing” that emphasizes dual-generation educational skill-building. The philosophy of the program includes three tenets:

- Students will take charge of their learning
- Teachers will make learning more engaging within the classroom and extend learning beyond the classroom and into the home
- Parents will become more powerful learning partners with their children to enhance their children’s home learning environment.

Geared toward low-income families with school-age children, CFY provides a computer-based home learning center, including a suite of highly engaging educational software. Participating students engaged in a number of family learning activities, including: learning English together with parents; using the Internet; teaching younger siblings with CFY’s software; working on projects with parents; doing specific Internet research for the family; and going on-line with parents to view the school’s website and assignments.

Students and their parents attend a workshop where a CFY Master Teacher provides instruction in setting up the computer and using the software. Evaluations of the program suggest that it boosts children’s academic engagement, confidence, interest and effort, and self-regulated learning (Tsikalas, Lee, & Newkirk, 2007) and that it helps support children’s writing abilities (Tsikalas, 2005). Information collected at CYF family workshops suggests that more than 90% of parents participating in the CFY program felt more confident that they could help their child learn. Importantly, the biggest increase was in math, with the lowest-educated parents experiencing almost twice the gains in confidence as higher-educated parents. Similarly, more than 95% of parents said the CFY program enabled them to see more potential in their child to learn, and more than 90% said they felt more connected to their child’s school as a result of the CFY program (<http://cfy.org/impact/impact-on-families/>). Evaluations of the program’s impact on parents’ educational skills and home instructional activities have not yet been conducted.

Conclusion

Recent advances in technology and innovation hold great promise for promoting dual-generational educational skills. Technological solutions can potentially solve problems identified in past interventions, including problems associated with cost-effectiveness, take-up and retention, program intensity, quality and content of instruction, and parent-child interaction. Most importantly, new technology-based approaches hold the potential to increase within-family synergies that reinforce educational motivation, persistence, and interest of both parents and children. Harnessing these opportunities offers the promise of improving the educational outcomes of America’s low-income children and their families.

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