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SPECIAL EDITION: EDUCATIONAL OUTCOMES & RESEARCH FROM 1:1 COMPUTING SETTINGS

The Journal of Technology, Learning, and Assessment

Volume 9, Number 1 · January 2010

Educational Outcomes and Research from 1:1 Computing Settings

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www.jtla.org

A publication of the Technology and Assessment Study Collaborative
Caroline A. & Peter S. Lynch School of Education, Boston College

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Volume 9 Number 1

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Educational Outcomes and Research from 1:1 Computing Settings

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This special issue of the Journal of Technology, Learning, and Assessment focuses on the educational impacts and outcomes of 1:1 computing initiatives and technology-rich K–12 environments. Despite growing interest in and around 1:1 computing, little published research has focused on teaching and learning in these intensive computing environments. This special issue provides a forum for researchers to present empirical evidence on the effectiveness of 1:1 computing models for improving teacher and student outcomes, and to discuss the methodological challenges and solutions for assessing the effectiveness of these emerging technology-rich educational settings.

EDUCATIONAL OUTCOMES & RESEARCH FROM 1 TO 1 COMPUTING SETTINGS

Complete listing of papers published within the JTLA 1:1 Special Edition

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JTLA is a free on-line journal, published by the Technology and Assessment Study Collaborative, Caroline A. & Peter S. Lynch School of Education, Boston College.

Preferred citation:

Bebell, D. & O'Dwyer, L.M. (2010). Educational Outcomes and Research from 1:1 Computing Settings. *Journal of Technology, Learning, and Assessment, 9*(1). Retrieved [date] from http://www.jtla.org.

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Abstract:

Despite the growing interest in 1:1 computing initiatives, relatively little empirical research has focused on the outcomes of these investments. The current special edition of the Journal of Technology and Assessment presents four empirical studies of K–12 1:1 computing programs and one review of key themes in the conversation about 1:1 computing among advocates and critics. In this introduction to our 1:1 special edition, we synthesize across the studies and discuss the emergent themes. Looking specifically across these studies, we summarize evidence that participation in the 1:1 programs was associated with increased student and teacher technology use, increased student engagement and interest level, and modest increases in student achievement.

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Educational Outcomes and Research from 1:1 Computing Settings

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In recent years, we have seen increased interest in implementing 1:1 computing initiatives in schools. However, for educators and policy makers that wish to invest in these initiatives as a means for improving educational outcomes, there is little empirical evidence upon which to base decisions. Specifically, this special edition presents four empirical studies of K–12 1:1 computing programs and one review of key themes in the conversation about 1:1 computing among advocates and critics. In our introduction to this special edition, we synthesize across the studies and discuss the emergent themes.

Over the past decade the belief that increased access and use of computers (and digital technology tools) would lead to improved teaching and learning, greater efficiency, and the development of critical skills in students motivated educational leaders and policy makers to make substantial investments in educational technologies. Recently, 1:1 computing has emerged as a technology-rich educational reform where access to technology is not shared—but where all teachers and students have ubiquitous access to laptop computers. The articles collected here begin to serve this increased need for outcome evidence with rich descriptions and results from existing 1:1 laptop programs across the country:

- Damian Bebell and Rachel Kay from Boston College's Technology and Assessment Study Collaborative offer a summary of results from Massachusetts' 1:1 middle school pilot program in *One to One Computing: A Summary of the Quantitative Results from the Berkshire Wireless Learning Initiative*.

- Brian Drayton, Joni K. Falk, Rena Stroud, Kathryn Hobbs, and James Hammerman from TERC explore the use and impacts of technology tools in high school science classes equipped with 1:1 computer access in *After Installation: Ubiquitous Computing and High School Science in Three Experienced, High-technology Schools*.
- Kelly Shapley, Daniel Sheehan, Catherine Maloney, and Fanny Caranikas-Walker from Shapley Research Associates and the Texas Center for Educational Research summarize results across three years of research in 21 high need middle schools in *Evaluating the Implementation Fidelity of Technology Immersion and its Relationship with Student Achievement*.
- Kurt Suhr from the Newport Heights Elementary School, David Hernandez from Walden University, Douglas Grimes, and Mark Warschauer from University of California, Irvine examine the impacts of 1:1 instruction on upper elementary English Language Arts test scores in *Laptops and Fourth-Grade Literacy: Assisting the Jump over the Fourth-Grade Slump*.
- Mark Weston from the University of Colorado, Denver and Alan Bain from Charles Sturt University offer a theoretical perspective of 1:1 models and their potential with *The End of Techno-Critique: The Naked Truth about 1:1 Laptop Initiatives and Educational Change*.

These different studies of 1:1 programs begin to highlight the similarities and differences that exist across existing 1:1 environments. By definition, "1:1 computing" refers to the level at which access to technology is available to students and teachers; by definition, it says nothing about actual educational practices. Given that access to technology must predicate use and that technology use predicates any educational impacts (Norris, Sullivan, Poirot, & Soloway, 2008; O'Dwyer, Russell, & Bebell, 2004), having a robust access ratio of one computer to one student would seemingly provide an optimal setting for the study of how educational technology can impact teaching and learning. Although all of the studies presented here involve 1:1 technology access, each 1:1 setting had its own unique "1:1 program" that comprises a set of expectations, funding mechanisms, and individual implementation models including variation in hardware, software, networking, teacher training and professional development, as well as program support. Similarly, each research article has its own unique set of expectations, methodological approaches, and outcomes.

This collection of articles focuses on recently enacted 1:1 programs, their implementation, and subsequent results. Weston and Bain's article represents the most theoretical of the papers offering a perspective on 1:1

computing efforts to date and a vision for schools to better realize the potential for 1:1 computing. In addition, Shapley, et al. propose a valuable framework for theorizing the impacts of 1:1 computing which served to guide their own investigation of Texas' first 1:1 program. The theoretical expectations and possibilities for education reform summarized by Weston and Bain in 1:1 classrooms represent an interesting contrast to the expectations and outcomes defined in the empirical studies (Bebell & Kay, Suhr et al., Shapley et al., and Drayton et al.) Given that emphasis on educational accountability and measurement has greatly increased in American education, it is not surprising to find that three of the four empirical studies focus (at least partially) on quantitative measures of student achievement, typically state assessment scores. For example, Suhr et al. reported on a two-year study of upper elementary classrooms where 1:1 students outperformed non-laptop students on English Language Arts (ELA) assessments. Similarly, Shapley et al.'s study of Texas' 1:1 laptop pilot investigates the extent to which a sample of middle schools successfully implemented a 1:1 program as well as the relationship between the implementation strength at the school, teacher, and student levels and students' reading and mathematics achievement. Bebell and Kay's study also investigated the implementation of a state pilot 1:1 program using students ELA and math achievement as one of many outcome measures. So, although each of these articles has unique research aims, data sources, and outcome measures, the majority of papers examine specific teacher and student outcomes and it is therefore possible to discern some common trends across the various study results. Collectively, the studies presented here point to several common themes around 1:1 computing programs and their impact.

First, a number of the authors suggest the importance of examining the impacts of 1:1 computing in the context of use/practice. Although each of these studies goes beyond such simple examinations of technology use, effective use of technology is a prerequisite to any realization of positive educational outcomes resulting from 1:1 computing resources. Not surprisingly, across the empirical articles the authors generally reported that the increased resources provided in 1:1 settings indeed resulted in an increased frequency and variety of technology use by students and teachers. For example, Suhr et al. report in their study of upper elementary 1:1 classrooms that the "most common [student] uses of laptops at school were, in order, writing papers, browsing the Internet, creating presentations (KeyNote), maintaining a personal calendar (iCal), managing photos (iCal), working with movies (iMovie), and taking quizzes" (Suhr et al., p. 22, 2010). Similarly, Shapley et al. found that "students used laptops in their classrooms most often to conduct Internet research, create presentations, write with a word processor, and to complete a test or quiz"

(Shapley et al., p. 29, 2010). Bebell and Kay found that by the final year of the project "student and teacher practices incorporated substantial technology resources and tools in four of the five 1:1 pilot settings" (p. 16) and that technology was used somewhat less frequently for mathematics and science than for English language arts and social studies.

Despite similar levels of access across the studies presented here, there appeared to be substantial variation in technology use that occurred across the 1:1 initiatives. In their study of the Texas Technology Immersion Pilot program, Shapley et al. developed a technology immersion index to quantify the level of implementation across 22 1:1 middle schools. After four years of implementing the Texas Immersion program, the authors reported that: "results for the Implementation Index combined with evidence from standards-based scores suggest that about a quarter of middle schools (6), with Implementation Index scores ranging from 0.39 to 2.58 standard deviations above the mean, had a stronger presence of the components of Technology Immersion compared to other schools, and thus a higher level of implementation that more nearly approximated expected standards" (Shapley, et al, p. 33, 2010). In Bebell and Kay's study of five 1:1 middle schools, one school so struggled with implementation of the program that the frequency of student technology use in the third year of implementation was comparable to the non-1:1 control settings.

In their theoretical article, Weston and Bain suggest that students' and teachers' effective use of technology is stymied by many obstacles, even in 1:1 settings, and suggest a new vision for schools whereby "laptop computers are not technological tools; rather, they are cognitive tools that are holistically integrated (Senge et al., 2005) into the teaching and learning processes of their school (Bain, 2007)" (Weston & Bain, p. 10, 2010). Although few of the authors expressly designed their studies to investigate the factors that relate to a given program's success and effectiveness, the articles nevertheless provide telling insights into the observed variation of technology use across and between settings. These findings raise a question about *why* we see variation in technology use across and between schools that are implementing 1:1 computing models. Looking across the studies described in this issue we can discern common differences in implementation that were linked to variation in technology use. These were related to the roles of teachers and the administration, and to the professional development opportunities and other available systemic program supports.

Across the four empirical studies, it is evident that teachers play an essential role in the effective implementation of 1:1 initiatives and that the onus of responsibility for implementation often falls to the teacher. For example, Bebell and Kay (2010) concluded that it is "impossible to

overstate the power of individual teachers in the success or failure of 1:1 computing" (p. 47) and that "teachers nearly always control how and when students access and use technology during the school day" (p. 47). After examining three years of student and teacher technology use data, Bebell and Kay found that factors *within* each school setting played a larger role in the adoption and use of technology than teachers' subject area or grade level (Bebell and Kay, 2010). Similarly, Shapley et al. concluded that "teacher 'buy-in' for Technology Immersion is critically important because students' school experiences with technology are largely dictated by their teachers" (Shapley et al., p. 24, 2010). The Texas study authors conclude: "Respondents at higher implementing schools reported that committed leaders, thorough 'planning, teacher buy-in, preliminary professional development for teachers, and a commitment to the transformation of student learning were keys to their successful implementation of Technology Immersion" (Shapley et al., p. 46, 2010). Drayton et al. also report extensively on how teachers use technology and how their use is related to their judgment of the benefits of particular technologies for their teaching and for their students' learning and engagement. In summary, looking across the collection of 1:1 programs and studies presented in this special issue, it is evident that teachers are on the implementation front lines of any 1:1 initiative. As such, special attention needs to be paid to essential supports for teachers as schools and communities decide to undertake new 1:1 initiatives.

One of the essential supports that emerged across the studies related to the need for school level leadership support for 1:1 initiatives and programs. As Drayon et al. summarized after studying 14 upper elementary classrooms/schools equipped with 1:1 technologies, "[I]nformed and consistent administrative policy ... helped create the conditions necessary for the maturation of these experiments with ubiquitous computing" (Drayton et al, p. 44). Conversely, Bebell and Kay found that the lack of leadership support for the pilot 1:1 program led to weakened implementation in one of the five pilot schools. They noted that in the school "without any clear leadership concerning the management and oversight of the pilot program ... teacher and student technology use was regularly lowest in the student and teacher surveys" (Bebell & Kay, p. 50, 2010). According to Weston and Bain, sustaining and realizing the benefit of programs such as 1:1 initiatives requires that the school community (i.e., students, teachers, school leaders, and parents) have an "explicit set of simple rules" that defines their collective beliefs about teaching and learning (Weston & Bain, p. 11, 2010).

Of all the studies, Shapley et al. provides the most detailed quantitative summary of the role that various factors play in schools' implementation of 1:1 programs, including school level administration. Looking

across the 21 participating 1:1 middle schools, the study authors wrote: "Core-subject teachers' extent of Classroom Immersion was associated at a statistically significant level with their perceptions of the strength of the school's administrative leadership (r = .59), teachers' collective support for technology innovation (r = .67)" (Shapley et al., p. 33, 2010). Overall, the studies presented here point to the need for preparing school leaders and leadership teams for the implementation of 1:1 initiatives.

Given that nearly all of the studies reported that 1:1 programs depend largely on teachers for success, it was not surprising that teacher preparation through professional development was important for successful implementation. Shapley et al. found that teachers' level of implementation was statistically significantly related to the "quality of professional development (r = .47)" (Shapley et al., p. 33, 2010). Related to this point, Drayton et al. found that a lack of professional development was an obstacle for effective implementation. Their data showed that the teachers in each of the study schools reported that a "lack of time for professional development, especially in the form of teacher collaboration to develop best practices within the school, becomes a barrier to effective integration of computer and Web resources in the classroom" (Drayton et al., p. 41, 2010). Effective professional development is also a component of Weston and Bain's argument for realizing the benefits of 1:1 initiatives; through professional development, the "school community deliberately and systematically uses its rules to embed its big ideas, values, aspirations, and commitments in the day-to-day actions and processes of the school" (Weston & Bain, p. 11, 2010). As 1:1 programs become more popular, the quality and depth of preparation that teachers receive for implementation will become a central predictor of program success.

Examined collectively, it is apparent that the factors, which may influence the implementation of a 1:1 program, are quite complex. As with any educational reform, to have "traction" 1:1 initiatives must demonstrate efficacy in real world educational environments. This collection of studies found that student and teacher practices generally changed across the 1:1 environments, although not to the degree that Weston and Bain suggest may be attainable. However, the empirical studies demonstrate that a considerable number of teachers changed practices to accommodate the opportunities of increased technology access (Shapley el al.; Bebell & Kay; Drayton et al., Suhr et al.).

In terms of impacts on student outcomes, we also see common themes emerging across the four empirical studies. As improved student learning remains the primary measure of efficacy for today's generation of educational intervention, it is not surprising that three of the four empirical studies examined the impact of the 1:1 initiatives on student achieve-

ment. However, other student outcomes that are associated with success in school were examined. In particular, the degree of student engagement in these 1:1 programs was examined in several of the studies.

In their study, Bebell and Kay found that teaching and learning practices changed when students and teachers were provided with laptops, wireless learning environments, and additional technology resources. In the five 1:1 schools they examined, they found that while the implementation and outcomes of the program varied across schools and across the three implementation years, access to 1:1 computing led to measurable changes in teacher practices, student achievement, student engagement, and students' research skills compared to the control condition. Specifically, 7th grade students in their second year of the 1:1 program showed statistically significant gains on ELA state assessment scores compared to non-1:1 students, after controlling for prior ELA achievement. Similarly, Shapley et al. found that the "implementation strength of Student Access and Use (of technology) was a consistently positive predictor of students' *TAKS* reading and mathematics scores" and that students' use of their laptop for learning at home was the "strongest implementation predictor of students' *TAKS* reading and mathematics scores" (Shapley et al., p. 48, 2010). When Suhr et al. compared ELA test scores for a group of students who entered a 1:1 laptop program in the fourth-grade to a similar group of students in a traditional program in the same school district, they found that after two years, students in the 1:1 program outperformed the comparison group. Specifically, the 1:1 students had higher gains on the ELA test and on the subtests related to writing strategies and literary response and analysis than the non-1:1 students. Their findings suggest that "laptops may have a small effect on increasing such scores, with particular benefits in the areas of literary response and analysis and writing strategies" (Suhr et al., p. 38, 2010).

In terms of student engagement, the studies reported on the positive impacts of the 1:1 initiatives. Suhr et al. found a "high level of student engagement in the laptop classroom" and specifically teachers reported that "students enjoyed using multimedia, searching the Internet, and writing their papers on [the] computer" (Suhr et al., p. 24, 2010). Similarly, Bebell and Kay report on evidence from teacher and student surveys, teacher and principal interviews, and classroom observations that "student engagement increased dramatically in response to the enhanced educational access and opportunities afforded by 1:1 computing through the pilot program" (Bebell & Kay, p. 3, 2010).

Looking across these studies, we see evidence that 1:1 technology access is associated with changes in teacher practices and student outcomes. Despite variations between and across 1:1 settings, participation

in the 1:1 programs described was associated with increased student and teacher technology use, increased student engagement and interest level, and modest increases in student achievement. With regard to student achievement, positive increases were observed more frequently within the ELA domain than in mathematics; Bebell and Kay, Suhr et al. and Shapley et al. reported modest gains in ELA scores that may be attributed to technology use at the 1:1 level.

In addition to these common results emerging across the 1:1 studies, nearly all of the authors made note of the massive potential for 1:1 computing models for transforming education. Even Weston and Bain, who provide the most critical view of current 1:1 models, suggest that "quite possibly, 1:1 initiatives collectively represent heretofore-unattained scale and disturbance in the equilibrium of classrooms and schools (Dwyer, 2000) and disruption in the educational paradigm (Christensen et al., 2008)" (Weston & Bain, 2010, p. 9). Given that so many of the programs under study in these articles were newly established and typically just a few years old, it is noteworthy that the majority of the study authors posit far reaching expectations for ubiquitous computing. Both Shapley et al. and Weston and Bain present their 1:1 inquiries in the context of greater educational reform models and programs.

For these authors, the point of any far-reaching educational technology (pencil, text book, laptop) is not the mastery and success of the said technology, but the improvement of the process and environment in which teaching and learning occur. This collection of articles provides a snapshot of educational environments that have adopted 1:1 computing programs to serve a wide variety of educational needs. Technology for the sake of technology is rarely the goal of a school or state's decision to invest the requisite funds to provide and support computers for their students and staff. However, the context and expectations range widely for 1:1 models partially because the models, by definition, only describe the ratio of technology access, *not how it is being used*. So, as many schools are currently aspiring to 1:1 computing, those schools which find themselves with laptops for every teacher and student must focus on *how this hardware will be used* to support and further a wide range of educational activities.

Regardless of the reported effect sizes and individual study outcomes, it seems highly likely that some form of 1:1 computing will be the norm for the majority of American classrooms at some point in the future. How long this process takes or how the technology is adapted and implemented into curriculum and school culture will largely depend on policy makers and school leadership, as well as the costs and features of the respective technology. As is perhaps true for all educational reforms, initiatives and ideas, there is substantially more interest and opinion concerning the

idea, than actual research-based facts on the subject. It is our hope that the pioneering work undertaken by this first generation of 1:1 schools and researchers will serve to inform and instruct future models for 1:1 computing.

This collection of articles should by no means be considered a definitive exploration of 1:1 computing, given that the body of information is growing quickly. Although empirical research studies in *bona fide* 1:1 settings is still quite limited, it is our hope and expectation that our collective understanding about the implementation and outcomes of 1:1 programs will continue to develop through scholarly reflection and sharing. Furthermore, as educational technology continues to evolve, our notion of concepts like 1:1 computing will undoubtedly also evolve. It is our sincere hope that the collected efforts of researchers and evaluators will document as well as inform the next generation of educational policy and practice. Thus, we are pleased to present this special edition of the *Journal of Technology, Learning and Assessment*.

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