THE FEASIBILITY OF UBIQUITOUS COMPUTING IN SCHOOL

Longitudinal Study in 1:1 Classes Suggests — Time Matters

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Abstract: Despite the growing interest in and excitement about ubiquitous computing in school and 1:1 models, there is a lack of research that focuses on teaching and learning in these intensive computing learning environments. This is a particularly salient issue in light of the high cost of implementing and maintaining 1:1 settings. This study evaluates an innovative educational program, taking place in three elementary schools and one middle school. 1,257 students and their teachers were provided with personal laptop computers for class and home use. This paper presents a portion of the results concluding four years of study and focuses on the way science teachers perceive the impact of teaching and learning in ubiquitous computing environment. Results suggest that "time matters". The statistical analysis as well as interviews with teachers revealed that as time passes, and the 1:1 settings become a routine in school, it is easier to detect the advantages of teaching and learning with personal laptops. Students feel more motivated, experience higher self-efficacy and develop increased technology proficiency for learning. These findings add unique and positive evidence to the growing body of research regarding one-to-one models.

1 INTRODUCTION

During the last decades, educators and policy-makers called to move education beyond the traditional learning environment. Reforms in education have taken place in many countries. These reforms formulated new standards and reflect the overall goal of preparing students for the requirements of the twenty-first century knowledge society. Educators are required to redefine educational goals and integrate technology into the school curriculum. The integration of technology within schools has varied: from desktop computers, to laptop computers (1:1); from computer use in a specific lesson, to computer use anytime anywhere (24/7); etc. A one-to-one learning environment is more than a ratio of one laptop per student; it is the anytime, anywhere accessibility of resources and tools; it is a profound involvement and engagement in the educational process (La Mar, 2005). This study describes an innovative educational project that started in 2006 in Israel, taking place in four schools (three elementary schools and one middle school) of two small urban communities (grades five – nine). All students and all teachers were provided with personal laptop computers for class and home use. The teaching and learning routinely took place in an information and communication technology (ICT) saturated environment and Virtual Learning Campus (VLC).

However, providing computers are the bare minimum, since in this age of information, knowledge is the main resource (Van Weert, 2006). It is also not enough to simply acquire retrieval skills in order to gain an advantage over others. The key to success is using higher-order thinking and learning skills that will enable implementation of knowledge at the right time, and recognizing such opportunities (Salomon & Perkins, 1998).

Society must learn to utilize technology for its own needs, while placing the citizen at the focal point (Postman, 1998). It has to take responsibility for the individual's general intellectual development, as well as the abilities and skills to process information, to calculate, to design, to solve complex problems, to invent, and to improve one's own ability to think (Salomon, 2000, Weston & Bain, 2010).

2 BACKGROUND

Nowadays, there is a dramatic surge surrounding the

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world of initiatives that provide laptop computers for students and teachers, aimed at reaching the pervasiveness of computers in schools. Early research and evaluation studies suggest several positive outcomes from one-to-one (1:1) laptop initiatives, including: increased student engagement (Cromwell, 1999; MEPRI, 2003; Rockman, 1998), decreased disciplinary problems (Baldwin, 1999; MEPRI, 2003), increased use of computers for writing, analysis and research (Baldwin, 1999; Cromwell, 1999; Guignon, 1998; Russell, Bebell, & Higgins, 2004), and a movement towards student-centered classrooms (Rockman, 1998).

Baldwin (1999) also documented effects on student behavior at home—more time spent on homework. Gulek and Demirtas (2005) compared test scores among students participating and not participating in a voluntary one-to-one laptop program in middle school. A significant difference in test scores was found, in favor of students participating in the laptop program.

Despite the growing interest in and excitement about 1:1 computing, there is a lack of sufficient, sustained, large-scale research and evaluation that focuses on teaching and learning in these intensive computing environments (Bebell, & Kay, 2010). Specifically, there is a lack of evidence that connects the use of technology in these 1:1 settings with measuring student achievement. This is a particularly salient issue in light of the high cost of implementing and maintaining 1:1 laptop initiatives and the current climate of educational policy (Bebell, & Kay, 2010).

Lei & Zhao (2008) contend that when it comes to the question of what really happens when every child has a laptop and how the laptops are being used in classrooms, current studies provide only general information on "what" is used, "how much" is used, and the changes in "what" and "how much," but not much information on "how" the laptops are being used in teaching and learning practices (Lei & Zhao, 2008). Due to the expansion of such initiatives in many countries, it is required to question the effectiveness of such learning environments (Kozma, 2003; Penuel, 2006), to characterize the one-to-one learning environments and to analyze the impact of such environments on student achievements and other variables (Beresford-Hill, 2000; Inan**,** & Lowther, 2010).

3 RATIONALE

This study evaluates an innovative educational project that started in Israel in 2006, taking place in four schools: three elementary schools and one middle school, in two small urban communities (i.e., covering the fifth to ninth grades). All students and teachers were provided with personal laptop computers for class and home use. The teaching and learning has been routinely taking place in an ICT saturated environment and a Virtual Learning Campus (VLC). This paper presents a portion of the results concluding four years of study and focuses on the way science teachers perceive the impact of teaching and learning in 1:1 classes. The following research questions were addressed:

1. What variables can indicate a positive and significant change in the way students learn in a ubiquitous computing learning environment?
2. What perceptions and concerns do teachers hold regarding ubiquitous computing?

4 METHODOLOGY

4.1. Research Sample

This paper presents a longitudinal study. Data was collected over four years. As mentioned above, the study took place in four schools: three elementary schools (one of which includes both elementary and middle schools) and one middle school, in two small urban communities. Participants included 1,257 students in the fifth to ninth grades, and 30 teachers of whom 10 were interviewed intensively.

4.2. Research tools

Research data was collected by means of mixed methods. Qualitative methods included: classroom observations, interviews, analysis of the virtual learning environments, and student outcomes. Quantitative methods included pre- and post-questionnaires. This paper presents some of the findings following this longitudinal study.

5 RESULTS

5.1. Variables Indicating Change in the Way Students Learn

Data was gathered during four years of research. However, evidence of improved learning achievements was hard to identify. Therefore, the objective was to discover what variables could

indicate a positive and significant change in the way students learn in a 1:1 learning environment. The issues of whether variables of time and age have any impact were examined. Figure 1 represents data gathered from all participants in the study (N=1,257), before and after the first year of learning with personal laptops. Findings show significant change in habits of computer usability for learning at school and at home and most importantly, students' feelings of higher self-efficacy regarding the use of technology for learning. These findings were consistent for all grade levels in all years—during the individual's first year of personal laptop use (Figure 1).

One of the most universal findings in the current study was that both the implementation and outcomes of the program were somewhat varied across the four schools and over the three years of the student laptop implementation. However, there was supporting evidence that students' information literacy and learning abilities were enhanced and improved (Figure 2). 63% of the students believed that the laptops enabled them to be more organized in their studies. 80% of students believed they gained an improved ability to locate necessary information and to differentiate between reliable and unreliable information. 72% of students indicated they wrote more drafts when preparing their assignments (Figure 2).

Findings indicated engagement with and persistence on assignments—even at home. During interviews, students listed the advantages of the laptop: Equal access to information: *"It's much more pleasant to learn with laptops because they give a sense of fairness—for example, personal opinions can be expressed…everybody has the same sources of information…the same access to information…the same resources. It's more fun to learn this way—much faster".*

Added interest in lessons: *"When I studied with a book—the book was full of facts. I wrote what was written in the book and answered according to what the teacher said. Now that I have my laptop, I'm exposed to all kinds of reports and scientific investigations—which might be different from what's written in the book. It's much more interesting and more up-to-date!"*

Improvement in achievements: *"Yes, it is a fact. I get better grades—higher achievements—because I have more time to think*" (T., student with a learning disability).

Classroom observations revealed that the laptops also served as a tool for writing and personal expression. Students used the laptops to work on their assignments, compose essays, write stories and prepare presentations. For many students, writing on computers was easier than using pencil and paper because they found they could easily rewrite and edit their work, incorporate images into the text, insert hyperlinks to make their work interactive, and improve the design of their final products.

During the initial two years of the personal laptop computer program, qualitative and quantitative results showed diverse tendencies, or no change, regarding motivation for learning. However, during the third year of the program, when

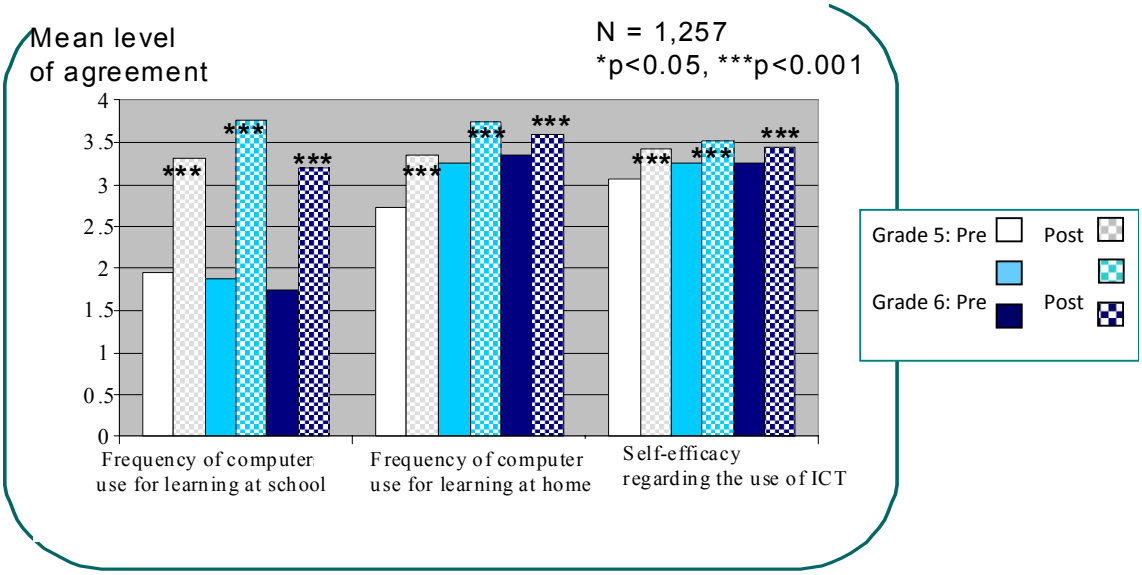

Figure 1: Students' mean level of agreement (on a scale of 1-6) regarding the use of laptops, according to age/grade levels, after first year of learning with laptops.

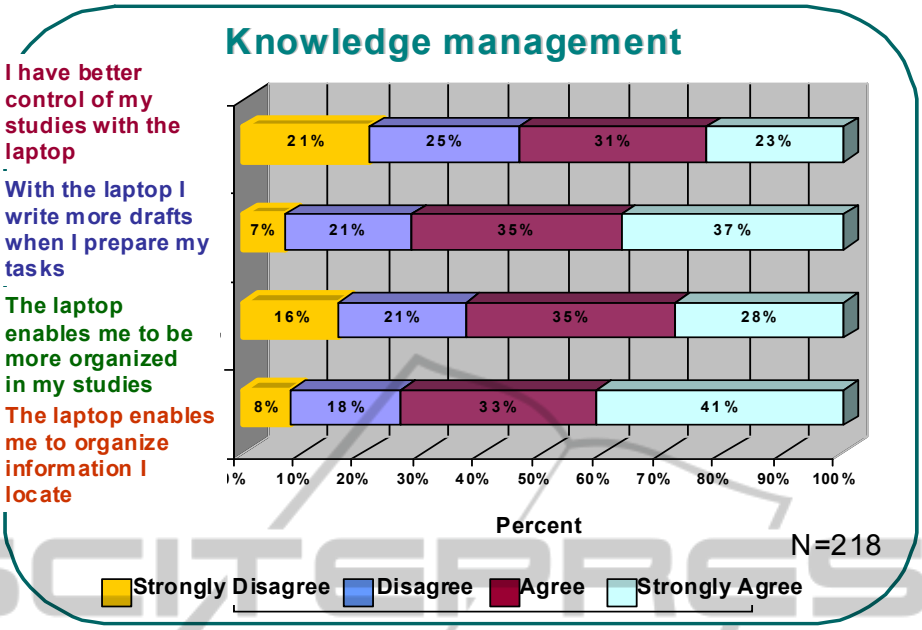

Figure 2: Students' level of agreement regarding the contribution of laptops to knowledge management after the first year of learning with laptops. Distribution of responses according to percentage.

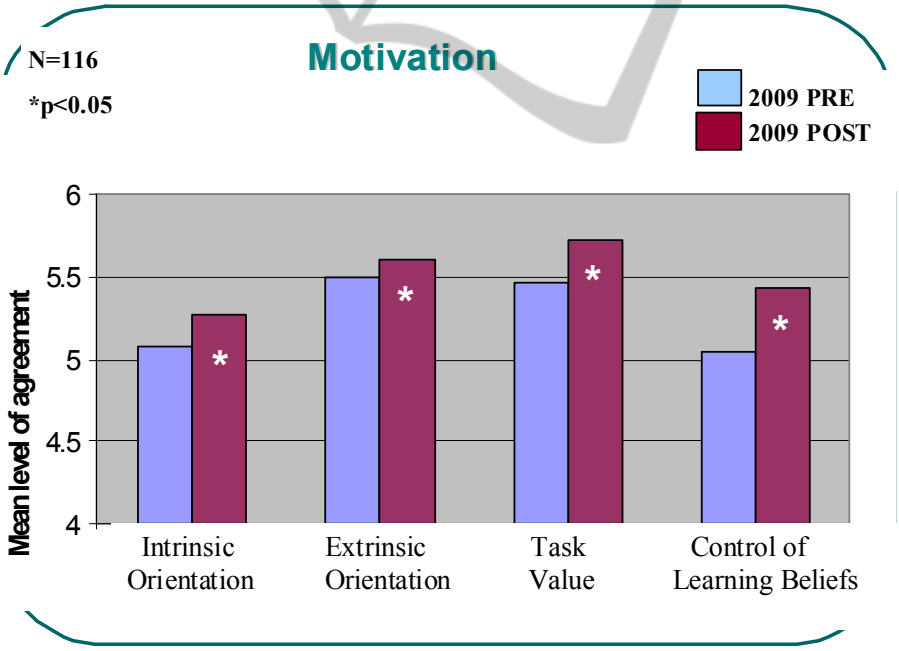

Figure 3: Students' mean level of agreement with items that expressed different aspects of motivation, before and after the first year of learning with laptops, during the third year of the program.

examining student motivation of fifth-graders who joined the program for their first year, a significant change could be detected for the first time—those students expressed a significantly higher level of motivation for learning, as presented in Figure 3. This is probably due to the fact that the fifth-grade students could see how elder students learned with laptops. They were already studying in an environment that encouraged and implemented powerful use of technology long before they even started to learn with personal laptops. Thus, when those students joined the program and studied with

their own laptops in 1:1 classes—they were better prepared and their motivation was enhanced with less frustration and disappointment.

5.2 Teachers' Perceptions and Concerns Regarding the Ubiquitous Computing Environment

Data from teachers was gathered mainly through interviews and observations. In the following section we present some quotes from the interviews.

An interview with one of the science teachers supports the above findings: *Although we learned about ionic compounds in the laboratory, students showed greater understanding when they viewed a computerized simulation. I asked them to prepare PowerPoint presentations or animations and to discuss their products during a class discussion. For many students, only after studying the different representations on the computer, did they understand this complex topic. What I explained in class was not useful in comparison with what they learned from the different visualizations...I felt a sense of satisfaction—there are other ways for them to attain an understanding. Students also gained a lot of pleasure and were proud of their products, had intelligent discussions and learned from the mistakes of other students. They even evaluated their computer skills and whether the use of the different computer programs was appropriate…*"

Teaching Methods and the Teacher's Role:

Teacher F: *"The teacher is transformed from an authority of knowledge to a facilitator and an instructor, and this is something I've always believed in."*

Teacher I: *"My job as a teacher has changed a lot. If at one time it was to transfer knowledge, today it's not like that; I've added the aspect of facilitator and I really feel like one. The whole format of instruction has changed."*

Teacher A: *"In traditional learning, you teach a subject such as leadership and explain about a leader like David Ben Gurion with the help of a nice book. Here, when I could show a DVD of David Ben Gurion giving a speech, I felt the excitement in the classroom. An extraordinary hush…I felt as if they were right there at the occasion of the Declaration of Independence. Hearing Martin Luther King's speech and watching him will really leave a lasting impression on them."*

Workload:

Teacher F: *"I never realized how much hard work I would have, and I'm sure that the work is even harder for those who don't have technical skills, who have to deal with the technical skills as well as the pedagogical skills that we need to integrate computers. You need to be sensible about the proportions and what to use it for."*

Teacher A: *"For me personally, as a teacher, a day when the computer and regular teaching are integrated is a more varied day— the time passes more quickly."*

Teacher D: *"It's true— preparing good, challenging learning materials that make the most of the endless of possibilities that the laptop uncorks—demanded a lot of work hours from me."*

Meeting Student Diversity:

Teacher A: *"It's likely that during a certain lesson I'll take a group of weaker students and give them a particular e-learning task, and then give a different e-learning task to the stronger ones. It doesn't have to be the same task. Some of them could work with me on acquisition, without the computer—using workbooks—while others are busy working on courseware. It really depends…it's an open lesson."*

Teacher I: *"In my opinion it's much more interesting for them, I see that I manage to engage some of the students who wouldn't normally do it."*

Contribution of the e-Learning Environment:

Teacher B: *"In my short experience this year, in the sixth grade, I could tell that when the lesson I prepared was prepared "right"; it was a challenge for students, and all of them—down to the very last one—were engaged in learning. In fact, they were so busy learning that incidents like "we didn't hear the bell" and "butts glued to the seat", caught us by surprise and made us giggle over and over again."*

6 CONCLUSIONS

Decades ago, policy-makers hoped that the introduction of computers would lead directly to better instruction and better achievements. Nowadays, it is clear that simply providing computers for schools is not enough (Zucker & Light, 2009). Schools must realize that successful 1:1 initiatives go beyond the technology itself; they must also address and include professional development, training, and support. Both teachers and students need the training and resources to gain the skills needed to effectively utilize laptops for learning (Holcomb, 2009).

Thus, the aim of this study was to examine the learning processes in a ubiquitous computing learning environment. In this environment, all students and teachers were provided with personal

laptop computers (1:1) and Virtual Learning Campus (24/7).

Results from this study suggest that employing one-to-one computers can significantly help increase student technology proficiency. Students gain opportunities to acquire technology knowledge and skills while using the laptops to work on various tasks for learning, communication, expression, and exploration. Our findings suggest that one-to-one computers and related technologies have enriched students' learning experiences, expanded their horizons, and opened more opportunities and possibilities.

The findings of this research add unique and positive evidence to the growing body of research regarding ICT integration in school studies, and especially one-to-one models. Personal laptop computers are very powerful in the classroom and enable the teachers and the students to construct and enrich their understanding. The one-to-one setting in ubiquitous computing learning environments may facilitate achieving the goal of making schools more engaging and relevant as opposed to the more common, narrower goal of using computers to engage students (Zucker, 2008). This study contributes to the understanding that positive effects on students and teachers can be achieved only as part of balanced, longitudinal, comprehensive initiatives that address changes in education goals, curricula, teacher training, and assessment.

The one-to-one laptops have provided great opportunities and resources for teaching and learning, but have also raised questions regarding the effectiveness of such learning environments and cost-effective issues. Results presented here suggest that "time matters". The statistical analysis as well as interviews with science teachers and students revealed that as time passes, and the 1:1 settings become a routine and a habit of learning in school, it is easier to detect the advantages of teaching and learning with personal laptops in learning environment of ubiquitous computing. Students feel more motivated, experience higher self-efficacy and develop better knowledge management skills and increased technology proficiency for learning.

To summarize, possessing the technology is only one key piece of the puzzle. Several key factors have been identified that need to be considered in regard to the expectations for a 1:1 learning initiative (Holcomb, 2009). The findings of this study add unique and positive evidence to the growing body of research regarding this puzzle - ICT integration in school, and especially one-to-one models.

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