Rosen, Y. (2011). *Intertwining digital content and one-to-one laptop environment in teaching and learning: Lessons from Time To Know program*. Paper presented at International Society for Technology in Education Annual Conference, Philadelphia, USA.

Intertwining digital content and one-to-one laptop environment in teaching and learning: Lessons from Time To Know program[1]

Yigal Rosen, Ph.D.

Time To Know and University of Haifa

yigal.rosen@timetoknow.com

Abstract

This study explores the effects of a social-constructivist technology-rich learning environment on elementary schools students' achievement in Mathematics and English Language Arts (ELA). The subjects were 59 4th grade students, who joined a Time To Know program in Dallas and 68 4th grade students who learned in traditional settings. Findings indicated that learning with Time To Know program significantly enhanced students Mathematics and ELA achievements and contributed to development of Mathematics reasoning skills. In addition, the study showed that Time To Know program narrowed the gap between the low and high achievement students, as well as significantly promoted the academic outcomes of at-risk students, compared to the traditional settings.

Keywords: one-to-one laptop, academic outcomes, bridging the gap, Time To Know.

[1] The empirical results are based on data from Rockman et al., 2010 evaluation study.

Background and Rationale

One of the main challenges for education systems is to leverage the learning sciences and modern technologies to develop engaging, authentic and personalized learning experiences (Bransford, Brown, & Cocking, 1999; Collins, & Halverson, 2009; Fullan, 2007; Marzano, & Kendall, 2007; U.S. Department of Education, 2010). Technology-rich learning environments are becoming more prevalent in the classroom and have been used as intellectual partners for active participation in construction of knowledge (Jonassen, & Reeves, 1996; Lajoie, 2000; Salomon, & Perkins, 2005; Weston, & Bain, 2010; White, & Frederiksen, 2005). However, despite high-profile efforts, and significant investments of resources, educational technology programs have revealed mixed effects (Bernard, Abrami, et al, 2009; Cuban, 2001; Donovan, Green, & Hartley, 2010; Greaves, & Hayes, 2006). Not surprisingly, findings from series empirical studies have shown consistently a peripheral use of technology by teachers and students (Bebell, 2007; Becker, 2001; Cuban, 2001; Kerr et al., 2003; Zucker, & Hug, 2007). In most cases, the technology is implemented for traditional practices, while paradigmatic change in teaching, learning, and assessment in technology-rich environments is rare. To achieve this change, a school system must go through major processes. It requires setting new educational objectives, preparing new curricula, developing digital instructional material aligned with learning standards, designing new teaching and learning environment, training teachers, creating a school climate that is conducive to educational technology, and so on. Innovative approaches in learning science, technology, assessment combined with professional development for teachers can provide a foundation for new and better ways to enhance students' knowledge and skills.

Qualitatively different learning environments offer different kinds of learning experiences and thus serve different educational goals (Rosen, & Salomon, 2007). Past research has showed that technology-rich learning environment can promote more effectively social-constructivist educational goals, such as: higher-order thinking skills, learning motivation, teamwork; in comparison to traditional settings (Rosen, & Salomon, 2007). *It is possible that educational technology can play a social role in bridging the achievement gap between students, as well as promoting higher-order thinking skills* (e.g., Jackson, & von Eye et al, 2006; Rosen, 2009; Rosen, & Rimor, 2009; Warschauer, 2003; Warschauer, & Matuchniak, 2010). One of possible ways to achieve these effects is by implementing one-to-one computing social-constructivist learning environments among young students.

Over past decade, there has been a growing interest in one-to-one laptop technology initiatives, whereby the teachers and the students have full access to a technology-rich learning environment (Bebell, 2007; Berry, & Wintle, 2009; Dawson, Cavanaugh, & Ritzhaupt, 2008; Gulek, & Demirtas, 2005; Jaillet, 2004; Lei, & Zhao, 2008; O'Dwyer et al., 2008; Penuel, 2006; Shapley et al., 2009; Silvernail, & Gritter, 2005; Weston, & Bain, 2010; Zucker, & Light, 2009). However, most of these initiatives use a techno-centric approach (the technology is perceived as a major goal), while innovative technology-rich learning environment should be conceptually designed and practically implemented as a method for paradigmatic change of learning and teaching (Cuban, 2003, 2006; Salomon, & Perkins, 2005).

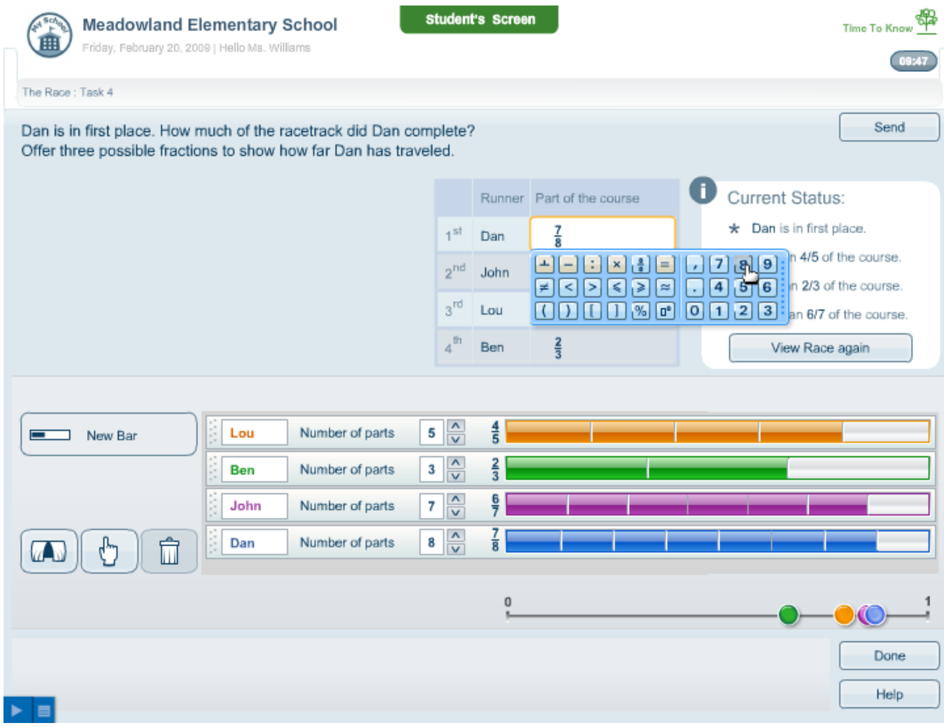
The current study explores the effects of teaching and learning in the Time To Know (http://www.timetoknow.com) program on Mathematics and English Language Arts (ELA) achievement of 4th grade students, compared to learning in more traditional setting. Time To Know's teaching and learning environment is designed with a social-constructivist approach to learning and teaching (Fosnot, 2005; Prawat, & Folden, 1994; Roschelle, Pea, Hoadley, Gordin, & Means, 2000; Von Glasersfeld, 1995) and it is aligned with the National Educational Technology Standards (NETS). The program consists of five main components (Walters, Dede, & Richards, 2009; Weiss, & Bordelon, 2010):

- Infrastructure: one-to-one laptop environment with a workstation for the teacher (see Figure 1).

Figure 1: Time To Know one-to-one laptop teaching and learning environment

- Interactive year-long core curriculum: Recommended sequences of interactive learning activities that are aligned with state standards (see Figure 2). Teachers can modify these sequences by uploading their own "best practice" materials directly into the lesson flow.

Figure 2: Mathematics learning activity by using fractions applet



- Digital Teaching Platform (DTP): A platform that enables the teacher to conduct or plan a lesson (see Figure 3), and to receive formative and summative assessment reports for data-driven instruction (see Figure 4).

- The platform also enables teachers to create their own content and adjust the recommended ready-made interactive learning activities to their teaching needs.

- Pedagogical support: Every teacher who joins the program takes part in comprehensive professional learning and ongoing guidance from an instructional coach.

Figure 3: Planning and conducting a lesson

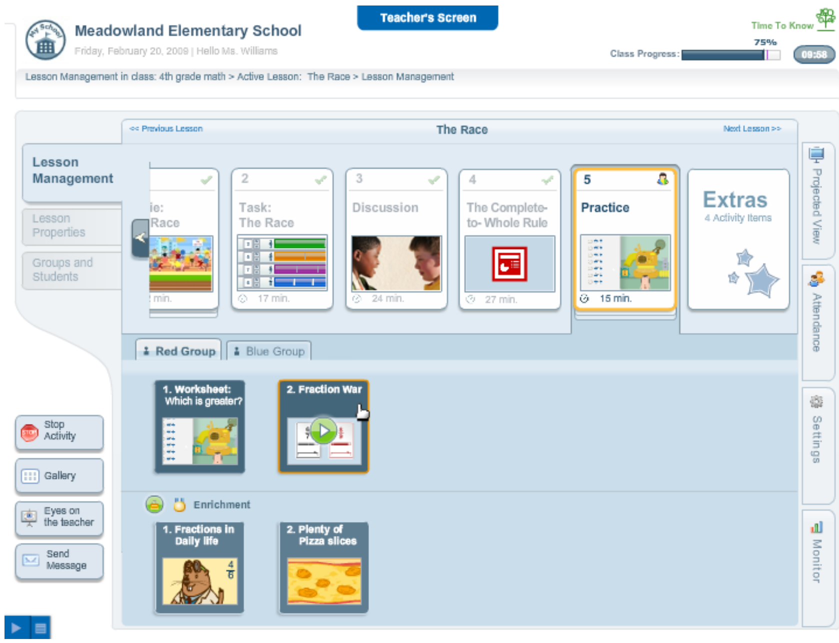


Figure 4: Assessment report

The Time To Know program contains a structured Mathematics and ELA curriculum of guided learning sequences for elementary schools that includes open-ended applets and discovery environments, multimedia presentations, practice exercises, and games. For example, in Mathematics the teacher opens the lesson with an animation, which is used as a trigger for a specific learning topic, such as fractions. Next, a class discussion on the topic increases the curiosity of the students who then explore the topic and perform guided experiments individually using the fraction applet. The students then submit their work to the class gallery where the teacher projects the work and engages the students in a discussion which leads students to concept generalization. The Time To Know DTP was designed to present differentiated materials to different groups simultaneously and support diverse learning levels for the same topic. The class may be divided into homogenous groups of students with similar mastery level on a given topic.

Past research on educational effects of the Time To Know teaching and learning environment in Israel showed highly promising results (Rosen, & Manny-Ikan, 2011). Findings indicated that learning with the Time To Know program significantly enhanced students' Mathematics, Hebrew and English as a Foreign Language (EFL) learning achievements. In addition, the findings showed that as a result of learning in the Time To Know environment, the knowledge and skills gap between the students was significantly narrowed.

Research Questions

The study addressed the following questions regarding the effects of the Time To Know program:

1. What is the impact of Time To Know program on reading, writing and Mathematics academic achievements, as measured by Texas Assessment of Knowledge Skills (TAKS) tests, compared to the traditional settings?

2. What is the impact of Time To Know program on academic achievements of at-risk students, compared to the traditional settings?
3. Do Time To Know students demonstrate greater Mathematics reasoning skills than control students?
4. Do lower performing Time To Know and control students (based on previous year TAKS scores) differ from higher performing students on Mathematics reasoning skills?

Design and Procedure

The study was based on the quantitative methodology using a quasi-experimental design (participation or non-participation in the Time To Know program). Pretest data were collected before the onset (April, 2009) of a Time To Know program, while post-test data were collected near the completion of the year-long school program (April, 2010).

Research Population

The study participants were 4th grade male and female students from four elementary schools from the Dallas-area district. Gender distribution was close to even. Two experimental schools were selected on the basis of two criteria: their participation in the Time To Know program and the same demographic background. Two control schools were purposively sampled to "match" the two Time To Know schools on the basis of known demographics (e.g., neighborhood characteristics, teacher characteristics, student characteristics). In all, there were 127 students who participated in the pre- and post-test data collection (59 experimental and 68 control students).

Measures

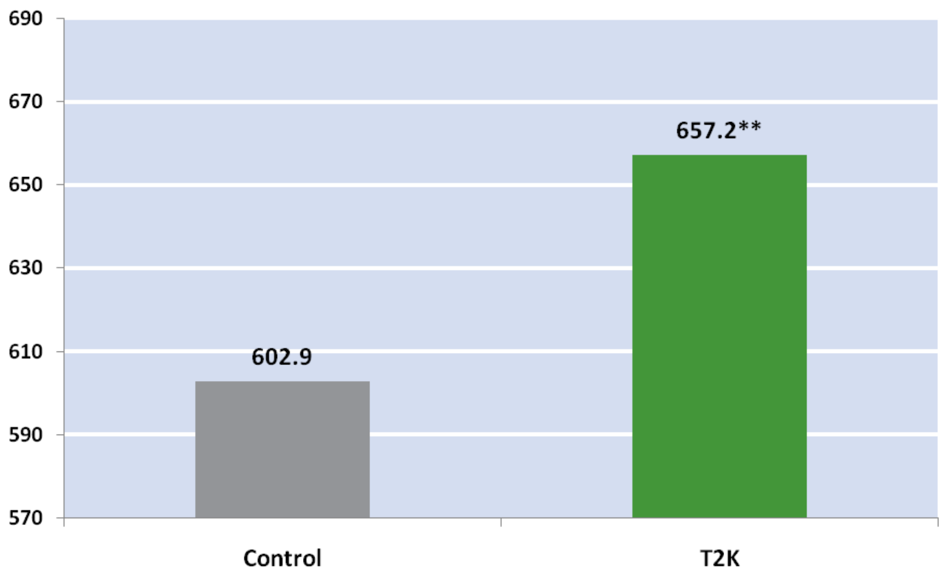
The instruments comprised Texas Assessment of Knowledge Skills (TAKS) standardized tests on Mathematics, Reading and Writing and an adopted Mathematics reasoning test (Hershkovitz, in preperation). Mathematical reasoning refers to the ability to analyze mathematical situations and construct logical arguments (Francisco, & Maher, 2005; Stiff, & Curcio, 1999; Yackel, & Hanna, 2003). The Mathematics reasoning test was based on open-ended questions related to graphs and tables theme in 4th grade Texas curriculum that was taught in both the control and Time To Know classes. Thus, the assessment was most similar to a unit test, with items drawn from state-wide standardized tests from New York, Virginia, and Texas. The answers to the open-ended questions were qualitatively analyzed and coded (Strauss, & Corbin, 1998). The test items were piloted in a California 4th grade classroom and conducted four cognitive interviews. The data was used to determine whether the length of the test was within reason for 4th grade students and whether there were any items that led to floor or ceiling effects. The cognitive interviews provided important data about the misinterpretation of items, prompts and validity issues. The piloting of these items led to final round of revision and creation of a final tool.

Results

The results indicated that participation in Time To Know (T2K) program contributed significantly to 4th grade students' academic outcomes in reading, writing and Mathematics, as measured by TAKS standardized tests. After controlling for gender, at-risk status, and 2009 reading TAKS scores (ANCOVA), the Time To Know students (M=657.2, SD=88.3) significantly outperformed the control students

(M=602.9, SD=104.4) on the 2010 reading TAKS, F(4, 95)=10.8, p<.01 (see Figure 5).

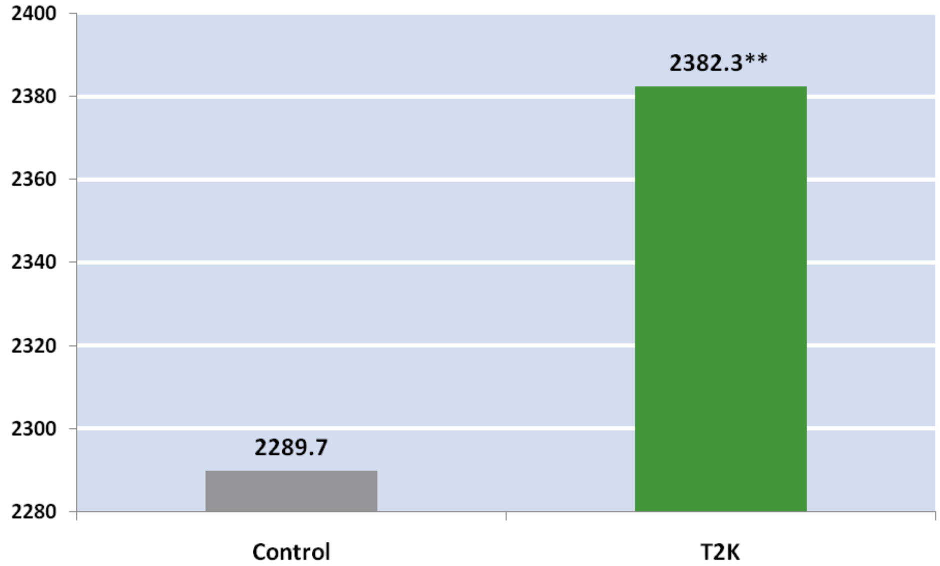
Figure 5: The impact of Time To Know program on reading standardized test achievements (Scale 117-853)



** p<.01

Given the fact that 4th grade was the first year for TAKS writing scores, the analysis included TAKS reading scores as the covariate, along with gender and at-risk status. TAKS reading and writing are moderately correlated (r=.62, p<.01). Therefore, controlling for 2009 reading TAKS, gender and at-risk status (ANCOVA), Time To Know students (M=2382.3, SD=167.4) significantly outperformed their counterparts (M=2289.7, SD=149.9) on the 2010 reading TAKS assessment, F(4, 94)=9.8, p<.01 (see Figure 6).

Figure 6: The impact of Time To Know program on writing standardized test achievements (Scale 1504-2885)

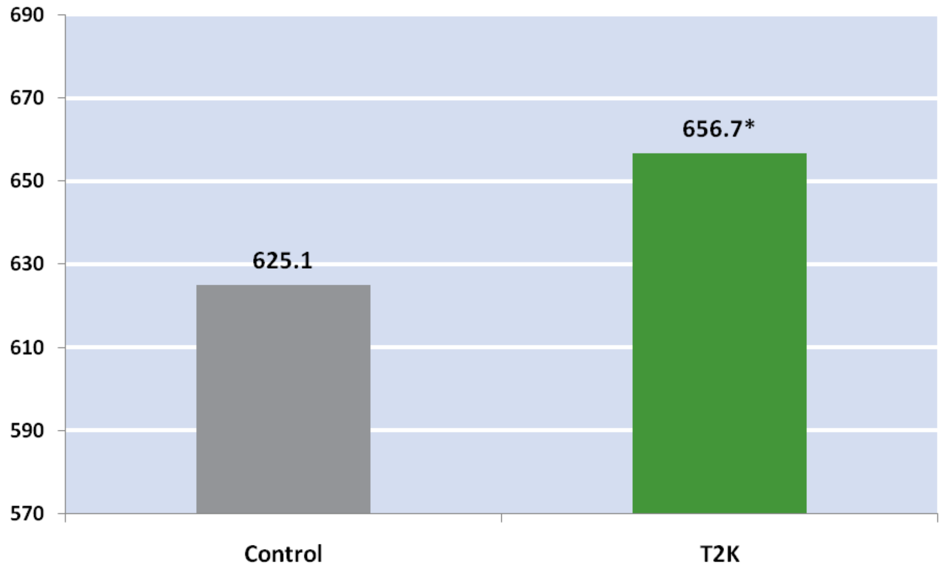


** p<.01

Time To Know students (M=656.7, SD=83.0) scored significantly higher than the control students (M=625.1, SD=91.4) on the Mathematics TAKS test, even after controlling for previous years TAKS scores (ANCOVA), gender, and at-risk status, $F(4,95)=6.5$, $p<.05$ (see Figure 7).

Although not significant, a trend was found in the context of at-risk students, showing that at-risk and non-at-risk students in the Time To Know classrooms Mathematics score similarly. Whereas, in the control classrooms, the at-risk students Mathematics score much lower than the non at-risk population (see Figure 8).

Figure 7: The impact of Time To Know program on Mathematics standardized test achievements (Scale 169-842)



* p<.05

Figure 8: The differential impact of Time To Know program on Math standardized test achievements: At-risk status (Scale 169-842)

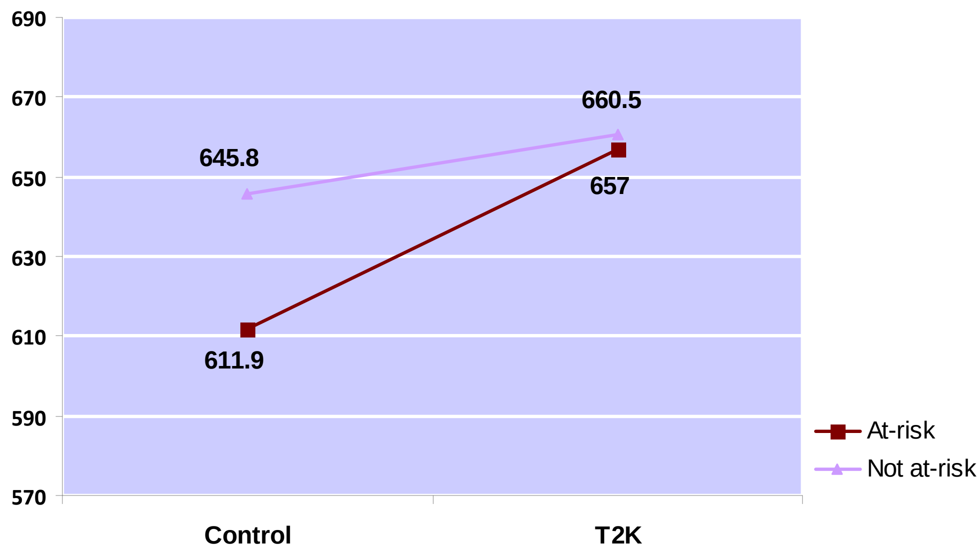


Figure 9: The impact of Time To Know program on Math reasoning (Scale 0-50)

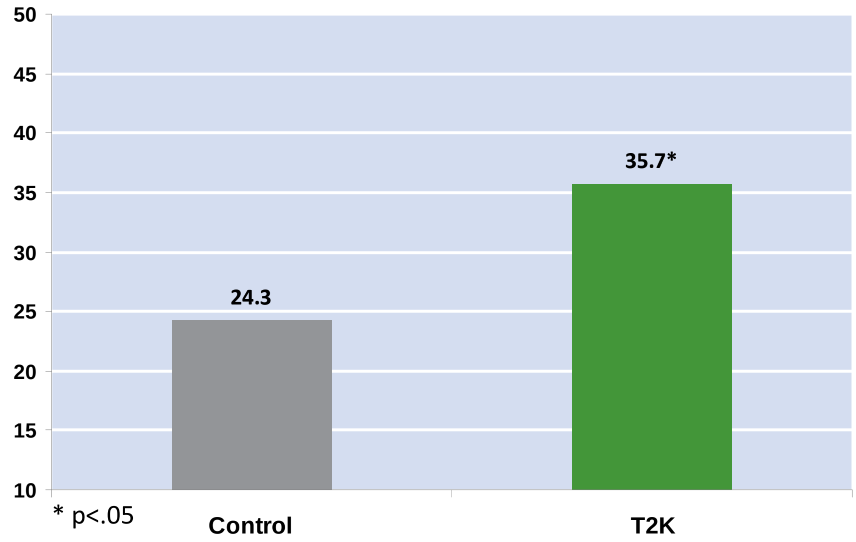
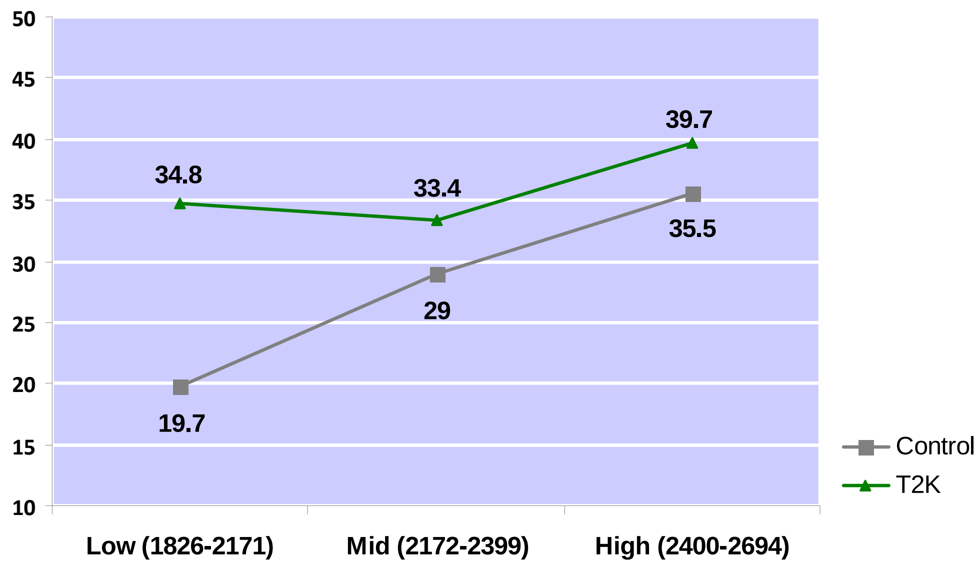


Figure 10: The differential impact of Time To Know program on Mathematics reasoning (Scale 0-50): Grouping by 3rd grade TAKS scores



After controlling for students' third grade math TAKS scores, gender and at-risk status (ANCOVA), there was a statistically significant difference between the Time To Know and control students in the context of Mathematics reasoning (see Figure 9). Time To Know students (M=35.7, SD=8.1) far out-performed the control students (M=24.3, SD=11.3) on the Mathematics reasoning assessment overall ($F(4,95)=5.7$, $p<.05$).

There was a significant interaction between Mathematics reasoning scores and the condition, grouped by 3rd grade TAKS levels of achievement (i.e. students were grouped into 3 categories by the achievement level in previous year Mathematics TAKS scores). As Figure 10 illustrates, there is a much greater difference between Time To Know and control students who performed in the lowest 3rd grade Mathematics TAKS scores (1826-2171). This result indicates that Time To Know program seems to help lower performing students even more than higher performing students.

Discussion

Meaningful learning and achievement gains are more likely to emerge from innovative teaching and learning involving individualized, problem-based instruction, increased motivation, and engagement (Cuban, 2003, 2006; Jonassen, 2008; Salomon, 2002). The goal of this study was to examine the impact of a comprehensive teaching and learning one-to-one computing environment on Mathematics and ELA learning achievement. The findings showed that learning in Time To Know program significantly affected Mathematics and ELA students' achievements, as well as Mathematics reasoning. The study showed a differential impact of Time To Know program. Lower performing students were contributed even more from the participation in the program than higher performing students. Moreover, the achievement gap between at-risk and non at-risk students was narrowed. These empirical evidences are consistent with other studies' emphasizing the role of technology in promoting at-risk students in Mathematics (Edmonds, & Li, 2005), ELA (Blachowicz et al., 2009; Goetze, & Walker, 2004) and the social-educational importance of bridging the digital divide (Moore et al., 2002). Overall, the findings of this are showing the high potential of one-to-one computing learning environments, in which a comprehensive digital curriculum is combined with a constructivist-oriented teaching platform.

The study's rationale and findings lead to three main implications. One implication applies specifically to Mathematics and ELA: Learning in Time To Know one-to-one computing settings environment, leads to significant improvement in academic outcomes, as well as, higher-order thinking skills in Mathematics. The second implication emphasizes to social role of technology-rich learning environments: Year-long learning in technology-rich environment is bridging the gap between high and low achievement students, as well as promoting effectively academic outcomes of at-risk status students. The third implication pertains to the effects of one-to-one computing settings learning environment more widely: Intertwining digital content that is aligned with state standards and a constructivist-oriented teaching platform, enables a significant empowerment of learning processes, which leads to better understanding of the content.

Current 2010-2011 school year preliminary evaluation study findings in the same Dallas-area schools implemented the program (Rosen & Beck-Hill, in preparation), show significant effects of Time To Know program on 4th and 5th grades students' math and ELA learning achievements (as measures by TAKS), more effective teaching practices (based on surveys, interviews and observations), decrease in discipline issues and higher attendance (as documented in school records), compared to the control groups. These consistent highly positive findings on Time To Know program efficiency shed a light on a range of possible educational benefits from 1:1 computing comprehensive educational technology environments in U.S. K-12 educational system.

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About the Company

Time To Know (http://www.timetoknow.com) was founded in 2004 as an Israeli educational technology philanthropic endeavor by an accomplished business person who is also an education advocate, in response to the many challenges facing schools worldwide and the lack of meaningful change in education practices. Based on the positive feedback around the globe, a for-profit company was later formed to take Time To Know to market. The Time To Know holistic solution is made up of an interactive core curriculum and a digital teaching platform, designed specifically for one-to-one computing classrooms of the 21st century. It is currently available for fourth and fifth grade math and reading/language arts. An online platform with robust teaching and learning tools provides a teacher-centric solution combined with a curriculum that meets state standards and engages students in learning. After officially launching its Digital Teaching Platform in 2007, Time To Know will be implemented in 150 classrooms in Israel and 120 classrooms in Texas and New York, USA by the end of the 2010-2011 school year. Time To Know was also chosen to participate in New York City's Innovation Zone (iZone) program. The company consists of hundreds of experts in pedagogy and computer based-learning; creative professionals in video, animation, and music; writers, academics, and engineers, who work together to deliver relevant and engaging content so that students can learn in new and meaningful ways.

About the Author

Dr. Yigal Rosen is Assessment and Evaluation Team Leader in Time To Know. His research interests focus on developing and assessing higher-order thinking skills in technology-rich learning environments, collaborative problem-solving, and evaluation of technology-rich learning environments. He is a faculty member at the University of Haifa, Faculty of Education. Dr. Rosen obtained his Ph.D. degree from the Faculty of Education at the University of Haifa, Israel. He was a post-doctoral fellow at Graduate School of Education at Harvard University and School of Education at Tel Aviv University. Dr. Rosen has also been a classroom teacher in computer science, math and science at elementary, middle and high school levels.