The Rise of Blended Learning in K–12: Teacher Perspectives on Khan Academy and Student Outcomes in Mathematics in Middle Schools

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Abstract

Blended learning (BL) has been part of adult education since the late 1990s (Glass & Welner, 2011). Recently, elementary and middle schools have started to adopt BL, changing the roles of students and teachers while cutting staff costs and improving student outcomes in an era of high pressure accountability. This study grounded in variation theory investigates the use of Khan Academy, an online math program, to personalize instruction at elementary and middle schools experimenting with BL by partially replacing traditional instruction. Profiling multiple schools in a comparative case study format, this study explores in what ways Khan Academy changes instruction and how effective it is in increasing test scores.

Introduction

Blended learning (BL) has been utilized for quite some time in higher education (Bonk, Kim, & Zeng, 2005; Glass & Welner, 2011). Much of the literature on BL focuses specifically on postsecondary education while not as much has been published about students enrolled in fully online and blended courses in primary and secondary schools (Picciano & Seaman, 2007). Toch (2010) proclaimed:

> We're headed to a world of "adaptive content libraries" and "recommendation engines" that string together customized "play lists" of learning activities for every student every day, on-demand tutoring, and "hybrid" education that weaves together live and online learning—a world captured in the name of a technology pilot project in New York City: School of One (p.72).

These experiments indicate that BL is an area of considerable growth and innovation for public schools (Staker, 2012). BL experimentation has accelerated the growth of commercial programs, but a few free options also exist. Khan Academy (KA) is one of the most popular free programs adopted by elementary and middle schools across the Unites States. It has been widely covered in print and digital media for its global reach and comprehensive library of subjects from mathematics to art in an unstructured, concept map-driven format, different from traditional, heavily structured education.

Recently, elementary and middle schools have started to adopt BL. At least 24 states and Washington DC have blended schools (Watson, Gemin, Ryan, & Wicks, 2013). BL changes the roles of students and teachers while helps to cut staff costs and improve student outcomes in an era of high pressure accountability. This mixed method study investigates the use of KA to improve and personalize math instruction at a middle school experimenting with BL to increase student engagement, to improve math test scores, and to supplement traditional curriculum. This study explores in what ways KA changes instruction and how effective it is in raising test scores. The findings show that schools utilize BL for many reasons, such as saving money, enabling teachers to spend more time with students who need support, and granting students greater access to math learning anytime and anywhere. The findings indicate that KA is as effective as traditional learning for middle school students, though the much-hyped KA videos were not as utilized by learners as other features. The paper concludes with a discussion of findings in relation to the role of technology in improving math instruction.

Blended Learning

In general, BL is a type of formal schooling in which a student learns in part through online delivery of instruction with student control over time, place, path, and/or pace, and in part at a supervised brick-and-mortar location away from home (Reay, 2001; Rooney, 2003; Sands, 2002; Ward & LaBranche, 2003; Young, 2002). BL purposes vary in terms of learning (Valiathan, 2002), such as skill-driven, self-paced learning with instructor or facilitator support; attitude-driven learning across various media to develop specific behaviors; and competency-driven learning, which blends performance support tools with knowledge management resources and mentoring. Driscoll (2002) has identified four BL models: combining or mixing web-based technology to accomplish an educational goal, combining pedagogical approaches (e.g., constructivism, behaviorism, cognitivism) to produce an optimal learning outcome with or without instructional technology, combining any form of instructional technology with face-to-face instructor-led training, and combining instructional technology with actual job tasks.

National Council of Math Teachers (NCTM) favors the strategic use of technological tools which can support mathematical procedures, skills, and the development of advanced mathematical proficiencies, such as problem solving, reasoning, and justifying (Gadanidis & Geiger, 2010; Pierce & Stacey, 2010). Despite their popularity in K–12 schools, few studies have been conducted on the effect of online learning programs, such as BL systems, on student outcomes. Means, Toyama, Murphy, Bakia, and Karla (2010) reviewed five experimental or quasi-experimental studies that compared online and blended programs with face-to-face instruction and met the criteria for inclusion in the meta-analysis. They found positive effects of BL programs on student achievement; however, as four of the five studies with positive results utilized researcher-developed assessments in algebra, history, and science to measure the effects (Long & Jennings, 2005; O'Dwyer, Carey, & Kleiman, 2007; Sun, Lin, & Yu, 2008), the findings cannot be generalized nor interpreted as evidence.

Researcher-developed assessments tend to over-align with the interventions evaluated; therefore, they may overestimate their effects. None of the studies in the meta-analysis reported BL programs using standardized external outcome measures. Similarly, packaged computer programs (i.e., not web based) did not provide evidence for positive effects on standardized tests. Borman, Benson, and Overman (2009) found that the Fast ForWord computer program did not have an effect on 8th grade students' language and reading comprehension on the Comprehensive Test of Basic Skills (CTBS/5). Likewise, Dynarski (2007) and Campuzano et al. (2009) evaluated the effects of multiple reading and mathematics software programs and did not find significant effects on Stanford Achievement Test (SAT-9 and SAT-10) scores.

The promise of blended and hybrid learning stems from its potential to increase personalization or differentiated instruction; to boost productivity, making students responsible for their own learning; and to monitor academic improvement rigorously, utilizing game-like technologies to track interaction. The U.S. Department of Education's National Educational Technology Plan (2010) noted, "Contemporary technology offers unprecedented performance, adaptability, and cost-effectiveness" (p. 4). While blended and hybrid learning systems are still in the early stages of development, significant growth is expected over the next decade (Horn & Staker, 2011). BL's definition changes depending on the medium and context utilized. First, BL may be an integrated combination of traditional learning with web-based activities. BL may also be a combination of media and tools employed in an e-learning environment (Oliver & Trigwell, 2005). In addition, BL may be a mixture of a number of pedagogic approaches, irrespective of technology use (Driscoll, 2002).

BL implementations in K–12 vary highly, making it difficult to compare across schools. Variations include teacher roles, scheduling, physical space, and delivery methods that are clustered into six models: face-to-face driver, rotation, flex, online lab, self-blend, and online driver (Murphy et al., 2014; Horn & Staker, 2011). Generally, K–12 BL models employ the first three types, face-to-face driver, rotation, and flex (Staker, 2012). The face-to-face driver BL retains teachers to deliver most of the curricula, as well as online learning on a case-by-case basis to supplement or remediate (Staker, 2012). The rotation model features a fixed schedule alternating between learning online in a self-paced environment and learning in a classroom (Staker, 2012). A teacher or paraprofessional usually oversees online work, depending on the BL implementation. The flex model delivers most of the curricula through an online platform. Teachers provide on-site support on a flexible, adaptive, and as-needed basis through in-person tutoring and small group sessions.

BL has multiple benefits for teachers, students, and schools. For teachers, benefits include the opportunity to focus on problem solving rather than direct instruction and to spend more time with low achievers. For students, benefits include control over time, place, path, pace, and differentiation in instruction. In this model, all students receive personalized feedback at the same time, rather than individually, as in a traditional setting. For schools, BL benefits include less work for teachers and financial savings. BL also supplements teaching with intervention to improve math outcomes. Typically, BL consumes 10% to 25% of instruction time; for example, Rocketship schools allocate one quarter of class time to BL and the remainder to instruction. KIPP schools spend 11% of their time on BL, where students study one period in an online-learning environment and one period in a traditional classroom for application and enrichment. Carpe Diem High Schools in Yuma, Arizona, rotate between online learning and traditional learning, allocating a significant portion of instruction time. In terms of KA and teaching math, teachers can rethink their use of instruction time. Typically, teachers decrease the time spent on direct instruction and allocate more time to KA. In 2010 and 2011, Los Altos Unified School District teachers utilized KA as an instructional tool to teach math in all 5th and 6th grades, later expanding to include 8^{th} grade. In this implementation, teachers differentiated instruction by decreasing traditional teaching. In a recent study of 20 public and choice schools, Murphy, Gallagher, Krumm, Mislevy, and Hafter, (2014) found a positive impact on student outcomes, while teacher perspectives varied.

Theoretical Framework

BL studies indicate improvements in learning (Oliver & Trigwell, 2005). These improvements show that some students experience variation in what they are studying with BL, though some improvements have been attributed to an increase in choice (Ramsden, 1991; 2003). On the other hand, some improvements can be explained by the novelty factor or Hawthorne effect. BL provides clear differentiation in learning experiences. For this reason, variation theory (Ling & Marton, 2011; Marton & Tsui, 2004) may explain observed improvements in student outcomes and offer guidance in the development of teaching approaches and the implementation of a BL program. The variation theory of learning is founded on the idea that variation must be experienced for learning to materialize. There is no discernment without deviation, and there is no learning without discernment; a feature of the world appears to the subject and is seen or sensed against the background of previous experiences, which are compared to the new feature (Oliver & Trigwell, 2005).

The use of information technology provides new forms of learning, removing the limits of time and space from traditional education and empowering students to explore independently at their own pace. These new media present unfamiliar patterns, which would not possible without technology. The use of several teaching platforms helps students experience variety, providing unique opportunities to master content. In a BL environment, students may discern variation in critical aspects of a subject matter. The use of variation theory grounds BL in the design of varied experiences that ensure learning. Variation theory also places the emphasis on the learner rather than the teacher, the experience rather than the content, and pedagogy rather than technology.

Khan Academy (KA)

KA is a free online repository of videos in areas such as math, science, biology, economy, and art (Murphy et al., 2014). The videos offer direct instruction on key concepts, scaffolded according to difficulty through a concept map. The videos used in the present study are demonstrations coupled with step-by-step math problems completed by Salman Khan on a blackboard. The videos feature a voice-over by Khan defining mathematical concepts and solving problems. In addition to videos, the website offers a question generator to practice math problems and, similar to a video game, awards points and badges for answering a streak of 10 questions correctly. The program offers extensive analytics for teachers to monitor progress while students watch videos and solve problems in real time. KA allows students to move at their own pace, providing variation and differentiation, unlike traditional teaching, where all students receive the same information in the same way, regardless of mastery level. As students move through concepts and exercises, the software recommends new videos and questions. KA also allows teachers to flip the classroom, meaning students watch videos at home and teachers focus on working on math problems in class. As a form of BL, KA has been adopted by individual learners around the world as well as public schools in the United States. The literature on KA is sparse. Murphy and colleagues (2014) reported that teachers used KA primarily to supplement their own core instruction; the time students spent working on KA varied considerably across and within sites and by school year; KA is a free resource for districts and schools, an important factor in leaders' decisions to pilot this resource; positive relationships were found between KA use and better-than-expected achievement and non-achievement outcomes, including level of math anxiety and confidence in one's ability to do math; and the relative benefits of KA students with different levels of prior academic performance varied from teachers' perceptions.

Research Questions and Significance

BL is a learning model becoming more popular in K–12 schools. Policy makers and practitioners benefit from research on practices of curriculum programs, particularly in what ways they do or do not work and how effective they are. Differing from a traditional environment, BL presents learning experiences that purposefully combine face-to-face and online instruction by a teacher or facilitator. Glass and Wellner (2011) have stated that research on online K–12 learning is "extremely limited." Most literature is descriptive reports of BL in K–12 schools. The studies have also only focused on supplemental courses (Glass, 2009).

KA is one of the most widely utilized BL tools. Despite its wild popularity and numerous mainstream media reports from entities such as *Wired* and *60 Minutes*, no scientific studies have been conducted on KA. SRI is engaged in a study to report on its effectiveness with the participation of 21 public and choice schools; however, results released are mixed. This study is an early independent examination on how schools utilize KA. The research question undertaken in this study is in what ways schools utilize KA and what impact it has on student achievement.

Method

We adopted a mixed method design to study the research questions. The participants included teachers and administrators at three schools in California and Arizona. To study how schools use KA, we purposefully selected sites where questions about using KA to blend learning with traditional math instruction would be relevant to practitioners and policymakers (Patton, 1990). The qualitative data collection included interviews with four math teachers in the fall semester of 2012. We utilized a grounded theory approach (Strauss & Corbin, 1994) with an iterative analysis. We analyzed interview notes through the constant comparison method (Glaser, 1965; Lincoln & Guba, 1985). The findings emerged through the following analysis: (a) comparison within a single interview, (b) comparison of interviews within the same group, and (c) comparison of interviews from different groups (Boeije, 2002). The unit of analysis was apparent thematic concepts within each interviewee's response.

The quantitative data source was student level North West Evaluation Association’s Measurement of Academic Progress (MAP) Mathematics test data. The quantitative data analysis included regression analysis. We performed multiple regression analyses to determine any significant effect when KA was utilized as an intervention compared to prior years without KA. The school administered the NWEA’s MAP mathematics tests in September 2012 (pretest) and May 2013 (posttest) to 6th grade students in the experimental group, which supplemented face-to-face math instruction with the KA BL program. The school also conducted the same test in the prior year to 6th grade students in the control group, who only received traditional instruction. NWEA’s MAP assessment in mathematics is aligned with national standards developed by the National Council of Teachers of Mathematics. Our analysis included both general NWEA mathematics scores but not subtest scores for problem solving, number sense, computation, measurement and geometry, and statistics and probability. All scores are on the RIT scale using Item Response Theory (IRT) and have the same meaning, regardless of the grade of the student.

Findings

The findings suggest a number of reasons that teachers use KA: as an intervention, a differentiation, a homework tool for easy grading and tracking, and a supplement to traditional instruction and to individualize math instruction to the levels of learners. The reaction to videos by teachers and students were mixed, while exercises appeared to be more engaging. Game-like features to reward student work were motivating for students, while real-time monitoring, scoring, and reporting provided useful tools to teachers; however, teachers appeared to rely on student behavior and their own observations to check understanding.

Videos versus Practice Tests

The findings suggest that students tended to avoid videos and instead focused on practice tests. The tests made students more responsible for their learning and more engaged in the learning process, as they sought hints or peer support to solve math questions while progressing through the concept maps. One teacher emphasized that videos were not sufficient to self-teach, saying, “Videos are useful but they are not enough to teach the concepts, especially to low achieving students,” despite the fact that he utilized a higher percentage of his time for BL (40% direct instruction vs. 60% KA). Another teacher shared the perspective of some students, who said that “exercise questions are not always covered in videos. Videos may sometimes be irrelevant.”

In reinforcing the preference for practice tests by students, a teacher who tended to use KA as a homework tool claimed, “I have observed that most students do not prefer to watch a video to learn the practice. Instead, they click the hint part and learn the practice step by step. Videos are sometimes helpful, but I do not think they have been used frequently.” Another teacher provided clues as to why students did not prefer videos: “Videos are not aligned with Common Core. It helps students know how to solve questions faster. It teaches test techniques." The students sought quick support to figure out how to solve the math problems rather than watching the videos. For this reason, students used the hint functionality embedded in each question. While hints provided an alternative to videos and peer assistance, it may have diminished the students' ability to grasp the concept and apply mathematical reasoning. Overall, teachers found the quick, personalized feedback useful; one teacher summed up the feedback received by students from KA, saying, "It gives instant feedback to students. To me, this is the greatest strength."

Despite a lack of enthusiasm for videos, one teacher suggested:

> Videos are great. They are simple, short, and very practical. I cannot say it is good for everybody since one size does not fit all. However, it is a great source for many students. When a student misses a class, it was the only source for him/her to learn the missed topic.

The teacher also acknowledged the value of practice exercises:

> As I said, I extensively used videos (almost a year, every Friday was my Khan Academy day). However, I have used exercises only few times. What I noticed is videos are great as supplementary materials but exercises are the main component for remedial learning. I believe that exercises make the difference, not the videos.

Another teacher used KA videos for enrichment material:

> I have used Khan Academy videos in my pre-calculus classes. …I was showing these videos as enrichment–supplement materials. I was selecting these videos as representative videos so that they would be the summary of the week. However, I did not use them for intervention.

High-Achieving versus Low-Achieving Students in KA

The teachers also emphasized that low-achieving students needed extra help before watching the videos. One teacher stated, "I think low achievers do not benefit more from Khan Academy unless they have some fundamentals." On the other hand, high achievers need little support, similar to face-to-face instruction: "High achieving students may fully comprehend the concepts on their own pace by using Khan Academy only." Another teacher explained:

> Definitely traditional, direct instruction is needed for most of the students. I have a student, and he has mastered almost 350 skills so far. He mastered many skills that I have not taught him before. He does not need my help, and he is self-motivated and learning from Khan Academy. However, these students are few and most of them need direct instruction.

High-achieving students were more engaged with KA and became confident and competent in math over time with mastery challenges. One teacher noted:

> From my observation, low achievers are engaged in Khan Academy, but not as much as high achievers. They are doing their homework on Khan Academy, but they do not do their mastery challenges as much as high achievers. I am not requiring them to do their mastery challenges.

KA offers variation to students in a personalized way via a math content library with a recommended task list to improve math skills as well as customized activities for every student with accompanying, on-demand videos.

Teacher Role Change

One teacher shared his strategy for BL and KA, commenting:

> I have not asked them to watch a video at home and learn the skills and exercise at school. I am teaching the skills at school, and they are practicing at home. I normally assign them five skills in a week. I sometimes let them work in class (last 10 minutes or last 5 minutes), since they have iPads.

Teachers have more time to spend with low-achieving students, while academically talented kids no longer face a ceiling that disengages them from a sustained and speedy pace. They still need to be connected to a network of adults supporting in different ways; however, not all students need the same level of support. Some students are self-learners, and adult guidance is enough to help them through the schooling process, as exemplified by the above quotes. Some students need additional one-on-one time with teachers to close gaps due to social, cultural, or economic struggles.

KIPP, Uncommon Schools, and Achievement First have tried to increase contact between students and adults in their schools with longer daily and yearly instruction periods. Most Magnolia teachers routinely work 12-hour days, often 6 or 7 days a week, as the schools seek to suffuse students' lives with learning opportunities and support. The foundations of such schools rest on student-adult connections that do not exist in many urban schools. However, KIPP schools in Los Angeles, California, have been experimenting with BL in middle schools, recently deciding to expand to a greater number of schools. BL allows teachers to focus on students who are not performing as well rather than distributing teacher attention to all students equally in a typical direct instruction classroom. One teacher stated, "It [KA] allows teachers to set goals based on students' deficiencies and gives practice tests. In addition, students are able to watch videos and reinforce their learning. The program enables the teacher to monitor students' progress effectively."

Typically, teachers are responsible for the needs of all students; however, they often do not have enough time for it, due to ever increasing workloads ranging from accountability to instruction. Another teacher extolled KA's role in supporting math instruction, suggesting, "Data generated shows you how many questions a student solves. Additionally, students accumulate points, and as they progress, this information helps teachers to do the progress monitoring." In other words, KA offers variation in teaching, allowing teachers to focus on students who need additional support.

KA also saves time for teachers when grading homework. One teacher who utilized KA as a homework tool as well as a BL tool shared enthusiastically:

> Giving homework and grading them is one of the challenges for math teachers. Teachers are giving homework so that students practice what they have learned in class. Khan Academy is giving immediate feedback to them. Also, it is very easy to grade homework for the teacher. Teachers can easily track their students.

Personalized Math Instruction

One-to-one instruction is probably the most desirable method for teaching. Bloom (1984) argues that an important task of research and instruction is to find ways to accomplish the high level of learning attained with tutoring (Annania, 1982, 1983 & Burke, 1984) and identifies as the 2 sigma problem. However, there is no way to achieve this in a traditional classroom. Computer technologies accessed via PC or iPads may help to support a one-to-one teaching environment, with certain limitations. In this regard, as one teacher explained, KA supports a certain level of personalization in math instruction:

> I think it [personalization] is one of the strongest parts. Students are mastering the skills they practiced before. So, it differs from student to student. There are 550 skills, and each skill has four levels: Practice, Level 1, Level 2, and Mastered. KA does not allow mastering a skill in a day. You have to wait for a certain amount of time to pass to the next level. Students are getting more points and badges while they are doing their mastery challenges. Therefore, a mastery challenge might be used for a motivational tool, for example, 100 skills need to be mastered in order to get the first sun badge.

KA does not replace traditional learning. Some schools use Khan Academy as an intervention tool to supplement math instruction to increase proficiency in high-stakes testing. Most teachers reported that KA helped to improve student outcomes on these tests; thus, a motivation to use KA emerged. None of the teachers interviewed talked about replacing traditional math teaching with KA. For all of them, KA was an intervention resource providing variation to enrich teaching that complemented existing math instruction.

Impact on Student Achievement

The descriptive statistics indicated a slightly higher scaled score in STAR high-stakes testing in California for the treatment group, who utilized KA in a BL format (Table 1).

Insert Table 1 Here

To measure the impact of KA on student achievement in math, we first conducted an independent samples t-test (Table 2) using SPSS 21.0. The mean scores for MAP testing do not have a clear pattern for the control or treatment groups.

Insert Table 2 Here

There was a significant effect for the control group on the winter MAP, $t(27) = 2.71$, $p < .008$, with the control group achieving higher scores than the treatment group. The reason for this surprising finding may be implementation fidelity. The treatment group started KA late in winter, so the impact was not fully demonstrated on winter test results. Other independent variables such as the fall MAP or STAR tests did not yield significant differences to guide inferential statistics for this analysis.
To understand KA usage patterns among treatment and control students, we conducted a linear regression analysis using SPSS 21.0 (see Table 3).

Insert Table 3 Here

In this analysis, the dependent variable is assumed to be a linear function of one or more independent variables, plus an error introduced to account for all other factors. In our models, the spring math MAP score is the dependent variable, while winter and fall math MAP scores are independent variables. In our five regression models, we controlled for the treatment group through our dummy variable, which is 1 for KA and 0 for no KA. The first model in Table 3 provides results of simple regression analysis for the treatment group (D = 1). The results are statistically significant for the fall math MAP test but not the winter test. The second model in Table 3 is a simple regression analysis for the control group (D = 0) and suggests that the control group scores did not indicate a statistically significant result compared to our independent samples t-test analysis. The third regression model is for the pooled sample, and the results indicate that the coefficient for the winter math MAP is statistically significant (p = 0.001). The fourth model introduces the dummy variable into the regression equation, which indicates that both the winter (p = 0.002) and fall (p = 0.034) tests were statistically significant. The final model considers the interaction of independent variables with the dummy variable in the regression equation, in which none of the variables were statistically significant. The regression analysis indicates that the treatment group score was nine points higher than the control group score. Overall, the regression results provide evidence that KA had a statistically significant effect on MAP math scores in both winter and fall.

The qualitative findings from this study suggest that BL offers personalization, differentiation, cost effectiveness, and improved pedagogy. These findings confirm previous studies on BL. Osguthorpe and Graham (2003) reported six reasons to use BL: pedagogical richness, access to knowledge, social interaction, personal agency, cost effectiveness, and ease of revision. Graham et al. (2005) further found that people overwhelmingly chose BL for improved pedagogy, increased access, and cost effectiveness. All these factors for experimentation offer convincing arguments for the greater use of BL in public education.

Discussion

Given their expected growth in K–12 education, rigorous research on the effectiveness of BL programs is essential. To date, research has been limited, especially when considering the use of technology with young students. Oliver and Trigwell (2005) have argued that the term “blended learning” is most widely used within the training tradition, rather than within public education; however, recent budgetary challenges in public education are forcing public schools to adopt BL. Schools are experimenting with BL to improve student outcomes, to differentiate instruction, to cut costs, and to give teachers more time with low-performing students. Research on BL approaches has reported increased levels of active learning and learner-centered strategies (Collis, 2003; Hartman, Dziuban, & Moskal, 1999; Morgan, 2002; Smelser, 2002). This study’s positive findings about the effects of KA instruction are likely to increase the adoption of BL in K–12, especially in light of the relatively lower costs, time, and workload requirements. In interpreting these findings, we suggest to educators and policymakers that while the findings need to be confirmed with other quantitative and qualitative studies, they should serve as an encouraging statement on the impact of KA in a BL format. The findings from this study merit sustained use of KA in BL; however, more rigorous, longitudinal evaluation is needed to build best practices, especially as interventions for diverse student populations with larger samples.

References

Anania, J. (1982). The effects of quality of instruction on the cognitive and affective learning of students. (Doctoral dissertation, University of Chicago, 1981). Dissertation Abstracts International, 42, 4269A.

Anania, J. (1983). "The influence of instructional conditions on student learning and achievement." Evaluation in Education: An International Review Series, 7, 1, 1-92.

Bloom, B. S. (1984). The 2 sigma problem: The search for methods of group instruction as effective as one-to-one tutoring. Educational researcher, 4-16.

Boeije, H. (2002). A purposeful approach to the constant comparative method in the analysis of qualitative interviews. *Quality and quantity*, *36*(4), 391-409.

Bonk, C., Kim, K. J., & Zeng, T. (2005). Future directions of blended learning in higher education and workplace learning settings. In P. Kommers & G. Richards (Eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2005* (pp. 3644–3649). Chesapeake, VA: AACE.

Borman, G. D., Benson, J. G., & Overman, L. (2009). A randomized field trial of the Fast ForWord Language computer-based training program. *Educational Evaluation and Policy Analysis*, *31*(1), 82-106.

Burke, A.J. (1984). Students' potential for learning contrasted under tutorial and group approaches to instruction. (Doctoral dissertation, University of Chicago, 1983). Dissertation Abstracts International, 44, 2025A.

Campuzano, L., Dynarski, M., Agodini, R., & Rall, K. (2009). Effectiveness of Reading and Mathematics Software Products: Findings From Two Student Cohorts. NCEE 2009-4041. *National Center for Education Evaluation and Regional Assistance*.

Collis, B. (2003). Course redesign for blended learning: modern optics for technical professionals. *International Journal of Continuing Engineering Education and Lifelong Learning, 13*(1/2), 22–38.

Driscoll, M. (2002). Blended learning: Let's get beyond the hype. *E-learning*, *1*(4).
Dynarski, M. (2007). *Effectiveness of reading and mathematics software products findings from the first student cohort: report*. DIANE Publishing.
Gadanidis, G. & Geiger, V. (2010). A social perspective on technology enhanced mathematical learning—from collaboration to performance. ZDM, 42(1), 91–104.
Glaser, B. G. (1965). The constant comparative method of qualitative analysis. *Social Problems,* 12(4), 436-445.
Glass, G. V. (2009). *The realities of K–12 virtual education*. East Lansing, MI: Great Lakes Center for Education Research and Practice. Retrieved from http://greatlakescenter.org/docs/Policy_Briefs/Glass_Virtual.pdf
Glass, G. V., and Welner, K. G. (2011). *Online K–12 schooling in the U.S.: Uncertain private ventures in need of public regulation.* Boulder, CO: National Education Policy Center. Retrieved from http://flaglerlive.com/wp-content/uploads/online-schooling.pdf
Graham, C. R. (2005). Blended learning systems: Definition, current trends, and future directions. In C. J. Bonk & C. R. Graham (Eds.), *Handbook of blended learning: Global perspectives, local designs.* San Francisco, CA: Pfeiffer Publishing.
Hartman, J. L., Dziuban, C., & Moskal, P. (1999, August). *Faculty satisfaction in ALNs: A dependent or independent variable?* Paper presented at the Sloan Summer ALN Workshops: Learning Effectiveness and Faculty Satisfaction, Urbana, IL.
Horn, M. B., & Staker, H. (2011). *The rise of K–12 blended learning*. Retrieved from The Clayton Christensen Institute for Disruptive Innovation website: http://www.christenseninstitute.org/publications/the-rise-of-K–12-blended-learning/
Ling, L. M., & Marton, F. (2011). Towards a science of the art of teaching: Using variation theory as a guiding principle of pedagogical design. *International Journal for Lesson and Learning Studies*, *1*(1), 7-22.
Long, M., & Jennings, H. (2005). "Does it work?" The impact of technology and professional development on student achievement. Calverton, MD: Macro International.
Marton, F., & Tsui, A. B. M. (Eds.). (2004).Classroom discourse and the space of learning. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.
Means, B., Toyama, Y., Murphy, R., Bakia, M., & Karla, J. (2010). *Evaluation of evidence-based practices in online learning: A meta-analysis and review of online learning studies.* Washington, DC: U.S. Department of Education, Office of Planning, Evaluation, and Policy Development. Retrieved from http://www2.ed.gov/rschstat/ eval/tech/evidence-based-practices/finalreport.pdf
Morgan, K. R. (2002). *Blended learning: A strategic action plan for a new campus.* Seminole, FL: University of Central Florida.
National Educational Technology Plan Technical Working Group. (2010). Transforming American education: Learning powered by technology.
O'Dwyer, L. M., Carey, R., & Kleiman, G. (2007). A study of the effectiveness of the Louisiana Algebra I online course. Journal of Research on Technology in Education, 39(3), 289–306
Oliver, M., & Trigwell, K. (2005). Can "blended learning" be redeemed? *E-learning and Digital Media*, *2*(1), 17–26.
Osguthorpe, R. T., & Graham, C. R. (2003). Blended Learning Environments: Definitions and Directions. *Quarterly Review of Distance Education*, *4*(3), 227-33.
Patton, M. Q. (1990). *Qualitative evaluation and research methods* . SAGE Publications, inc.
Picciano, A. G., & Seaman, J. (2007). K-12 Online Learning: A Survey of US School District Administrators. *Journal of Asynchronous Learning Networks,11*(3).

Pierce, R., & Stacey, K. (2010). Mapping pedagogical opportunities provided by mathematics analysis software. International Journal of Computers for Mathematical Learning. 15(1), 1–20.

Ramsden, P. (1991) A Performance Indicator of Teaching Quality in Higher Education: the Course Experience Questionnaire, Studies in Higher Education, 16, pp. 129-150.

Ramsden, P. (2003) Learning to Teach in Higher Education. London: Routledge Falmer.

Reay, J. (2001). Blended learning: A fusion for the future. *Knowledge Management Review*, *4*(3), 6.

Rooney, J. E. (2003). Blending learning opportunities to enhance educational programming and meetings. *Association Management*, *55*(5), 26–32.

Sands, P. (2002). Inside outside, upside downside: Strategies for connecting online and face-to-face instruction in hybrid courses. *Teaching with Technology Today*, *8*(6).

Smelser, L. M. (2002, March). *Making connections in our classrooms: Online and off*. Paper presented at the Annual Meeting of the Conference on College Composition and Communication, Chicago, IL.

Staker, H. (2012). *The rise of K–12 blended learning: Profiles of emerging models*. Retrieved from The Innosight Institute website: http://www.innosightinstitute.org/innosight/ wp-content/uploads/2011/05/The-Rise-of-K–12-Blended-Learning.pdf

Strauss, A., & Corbin, J. (1994). Grounded theory methodology. *Handbook of qualitative research*, 273-285.

Sun, K. T., Lin, Y. C., & Yu, C. J. (2008). A study on learning effect among different learning styles in a Web-based lab of science for elementary school students. *Computers & Education*, *50*(4), 1411-1422.

Toch, T. (2010). In an era of online learning, schools still matter. *Phi Delta Kappan*, *91*(7), 72–73.

Valiathan, P. (2002). Blended learning models. *Learning circuits*.

Ward, J., & LaBranche, G. A. (2003). Blended learning: The convergence of e-learning and meetings. *Franchising World*, *35*(4), 22–23.

Watson, J., Murin, A., Vashaw, L., Gemin, B., & Rapp, C. (2013). *Keeping pace with K–12 online learning: An annual review of state-level policy and practice.* Durango, CO: Evergreen Education Group. Retrieved from http://kpk12.com/reports/

Young, J. R. (2002). “Hybrid” teaching seeks to end the divide between traditional and online instruction. *Chronicle of Higher Education*, A33.

Table 1: Descriptive Statistics

	Dummy	N	Mean	STD	Std. Error
Mathematics_SS	No_Khan	77	332.62	61.362	6.993
	Khan	82	347.70	64.731	7.148
MAP_MATH_Spring	No_Khan	26	215.00	15.176	2.976
	Khan	63	217.59	13.551	1.707
MAP_MATH_Winter	No_Khan	25	216.84	13.810	2.762
	Khan	72	207.76	14.612	1.722
MAP_MATH_Fall	No_Khan	25	214.04	12.361	2.472
	Khan	67	209.93	11.107	1.357

Table 2: Independent Samples T-Test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Mathematics_SS	.154	.696	-1.505	157	.134	-15.072	10.017	-34.857	4.714
			-1.507	156.985	.134	-15.072	10.000	-34.824	4.680
MAP_MATH_Spring	.627	.431	-.791	87	.431	-2.587	3.272	-9.091	3.916
			-.754	42.312	.455	-2.587	3.431	-9.510	4.336
MAP_MATH_Winter	.015	.901	2.713	95	.008	9.076	3.346	2.434	15.719
			2.788	44.035	.008	9.076	3.255	2.516	15.636
MAP_MATH_Fall	.344	.559	1.533	90	.129	4.115	2.685	-1.219	9.448
			1.459	39.342	.152	4.115	2.820	-1.588	9.817

Table 3: Regression Results for Multiple Models

	Regression Models				
MAP_MATH_Spring	1	2	3	4	5
	D=1	D=0			
Intercept	53.33 (32.26)	14.00 (36.25)	52.43** (25.00)	14.00 (37.89)	31.62 (24.34)
D				39.33 (49.36)	9.03*** (2.78)
MAP_MATH_Fall	0.50** (0.22)	0.66* (0.34)	0.63*** (0.18)	0.66* (0.36)	0.57*** (0.17)
MAP_MATH_Winter	0.29* (0.15)	0.28 (0.31)	0.15 (0.13)	0.28 (0,32)	0.29** (0.13)
D*MAP_MATH_Fall				-0.15 (0.42)	
D*MAP_MATH_Winter				0.01 (0.35)	
R^2	0.382	0.393	0.472	0.474	0.473

*p<.01 **p<.05 ***p<.00