Academic Achievement in BYOD Classrooms

Dean Cristol, PhD
The Ohio State University
Columbus, Ohio
cristol.2@osu.edu

Belinda Gimbert, PhD
The Ohio State University
Columbus, Ohio
Gimbert.1@osu.edu

ABSTRACT

A product of the new STEM democracy is the development of indigenous high-technology capabilities. We maintain when effective mobile learning is incorporated into a receptive learning environment student achievement will increase. Also, the ubiquitousness of mobile devices prepares students for the STEM focused globalized economy because the devices are consistently used for the communication and informational needs of students and teachers inside and outside of learning environments. Mobile learning devices (MLDs) are relatively affordable and accessible, and often reinforce difficult learning concepts and a mechanism for collaboration outside regular school hours. Mobile learning technology levels the learning field, due to the relatively low cost, accessibility in most households, including those that lack laptop or desktop computers and connection to the internet. Under *Bring Your Own Device* (BYOD) policy, this study centers on assessing the effectiveness of MLDs on the academic achievement of students in 8th and 10th grades. We were interested to understand the effectiveness of BYOD integration in the classroom based on student achievement and student response to determine the extent of variance, if any, between those classrooms that use BYOD technology extensively in comparison to those that do not. The study uses previously collected school system data (removing all individual identifiers by the school systemφs curriculum coordinator). This research is significant, since there is a paucity of large scale research to assess the level of student achievement, as expressed through standardized assessments, related to the BYOD policy.

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Two recent reports described the shifting trends of Science Technology Engineering Mathematics (STEM) education in the US and educationφs impact on the economy. The National Science Board (NSB, 2012) biennially mandated *Science and Engineering Indicators* (SEI) report provides a quantitative depiction of the America's science and engineering readiness. Indicators suggest that the US dominance has slipped in the areas of research and development. While the US is still a leader in STEM related research, the gap between the US and the rest of the world has contracted in the last decade. The report concludes that developed countries are no longer the controlling influence of STEM, but developing STEM professionals has become a ñdemocratizedò enterprise in many developed and developing countries. A product of the new STEM democracy is the development of indigenous high-technology capabilities.

In the second report, the Organization for Economic Cooperation and Development (OECD, 2010), *The High Cost of Low Educational Performance*, suggests the economic success of a country is less influenced by the quality of the schooling than by the quality of learning outcomes. The US moderate gains in student achievement seen in international surveys such as *Program for International Student Assessment* (PISA, 2010) can dramatically increase the gross domestic product (Fleischman et. al., 2010). We maintain when effective mobile learning is incorporated into a receptive learning environment student achievement will increase. Also, the ubiquitousness of mobile devices prepares students for the STEM focused globalized economy because the devices are consistently used for the communication and informational needs of students and teachers inside and outside of learning environments.

The use of technology is recognized in government legislation and by national educational associations as essential in all learning enviroments. The International Society for Technology in Education (ISTE, 2007, 2008) sets standards for the use of technology in educational environments, while the No Child Left Behind Act (NCLB, 2001), the Individuals with Disabilities Education Act (IDEA, 2004), the National Council of Teachers of Mathematics (NCTM, 2000), the National Science Teachers Association (NSTA, 2011), National Council for the Social Studies (NCSS, 2006) all expect that every student receives access to age appropriate curricula through essential technological tools. Shuler (2009) states, ñMore than half of the worldφs population now owns a cell phone and children under 12 constitute one of the fastest growing segments of mobile technology users in the U.S.ò (p. 4). In 2013, ñ78% of teens now have cell phones, and almost half (47%) of those own smartphones. That translates into 37% of all teens who have smartphones, up from just 23% in 2011ò (Madden et. al., 2013). The Horizon report (Johnson, Adams, & Haywood, 2011) suggests, mobile learning is an appropriate and dynamic use of technology that is readily available to most teachers and students (Franklin and Peng, 2008; Hooft & Vahey, 2007; Liu, 2007; Myers, 2003; Traylor 2009; Trotter, 2009). The Universal Design for Learning (UDL) advocates innovative design and delivery of instruction, such as mobile technology for students with a variety of learning needs (King-Sears, 2009).

Mobile learning provides flexibility and a mechanism for students to experience education seamlessly in most learning environments (Ash, 2009; Johnson, Adams, & Haywood, 2011; Manzo, 2009; Shuler, 2009). Many school systems are using mobile technology as a way for students to connect to the outside world (Ash, 2009). Mobile learning devices (MLDs) are relatively affordable and accessible, and often reinforce difficult learning concepts and a mechanism for collaboration outside regular school hours. Many management skills used by teachers in the classroom are transferable to learning activities on the studentsô MLDs and teaching students accountability for what they are learning (Franklin & Peng, 2008). Mobile learning technology levels the learning field, due to the relatively low cost, accessibility in most households, including those that lack laptop or desktop computers and connection to the internet (Prensky, 2012). ñIt is no longer a question whether we should use these devices to support learning, but how and when to use themò (Trotter, 2009, p.1).

Those school systems who understand the value of mobile learning face the issue of how mobility should be provided to the students. Those school systems that adopted a system financed one-to-one policy, where each student is given a computer; found that the policy increased student and teacher technology use and increased student engagement and interest (Bebell & OøDwyer, 2010). Even though the one-to-one research demonstrates positive effects, the financial burden is large causing many school systems to adopt a Bring Your Own Device (BYOD) policy. BYOD allows students and teachers to bring their own mobile devices, which is financially viable in lieu of mounting fiscal challenges many school systems are facing (Raths, 2012).

Under a BYOD policy, this study centers on assessing the effectiveness of MLDs on the academic achievement of students in 8^{th} and 10^{th} grades. We were interested to understand the effectiveness of BYOD integration in the classroom based on student achievement and student response to determine the extent of variance, if any, between those classrooms that use BYOD technology extensively in comparison to those that do not. The study uses previously collected school system data (removing all individual identifiers by the school systemøs curriculum coordinator). This research is significant, since there is a paucity of large scale research to assess the level of student achievement, as expressed through standardized assessments, related to the BYOD policy. Success of high school students in the program will indicate a level of successful technology facilitation (Druin, 2002).

Context

The Mountainville School District is a rural school district located in Midwest United States. This district is comprised of more than 2000 students across four facilities: a primary school (grades K-2), an intermediate school (3-5), a middle school (6-8) and the high school (9-12). Students in the district are predominantly white (94%) with a significant number of students (44%) identified by the state as ñeconomically disadvantaged.ò The larger community features a population heavily engaged in the manufacturing industry (28%) with a median annual household income of nearly $50,000 (U.S. Census, 2011). Mountainville School District accomplished an ñExcellentò designation by the state Department of Education by meeting every state indicator for excellence during the latest yearly reports (ODE, 2012).

As part of its overall mission and vision, the local school district has taken measurable steps to expand the role of technology in the schools through the investment of a full-time technology supervisor. This individual is responsible for coordinating all technological needs across the district and resolving issues such as bandwidth congestion, hardware and software upgrades and professional development in educational technology.

In 2007, the technology coordinator began a pilot project with eight grade 3-5 teachers using PDAs as a learning tool. The objective was provide these devices in their classrooms for a month and see how the teachers responded. Because of the positive responses from the initial group of teachers and subsequent teachers, the school system eventually purchased 630 mobile learning devices for all the grade 3-5 students. In 2011, the school system faced large scale budget difficulties. They had to choose to discontinue one of the longest running successful mobile learning program in the country or continue the program in the upper grades by implementing a BYOD program. The system elected to begin a pilot BYOD program in grades 6 through 12. The coordinatorøs biggest concern was when a BYOD program is implemented, not every child can financially afford their own device which decreases the ability to be equitable because some studentsô families cannot afford a device creating the fundamental issue not everybody has access. Recently, the coordinator led an effort to write a mobile learning policy focusing on device usage in a BYOD environment and providing the necessary resources to ensure connectivity throughout the educational environment.

Method

There are issues related to using standardized assessments as indicators of student learning and retention (Czubaj, 1995; Froese-Germain, 1999). This study does not look to refute or address issues associated with the validity or equity of standardized assessments within education. Rather, this project looks to utilize normalized tests as an initial indicator of variance within student groups. This practice of utilizing standardized assessments as a first-step in examining a specific treatment and phenomena is well established (Rost, 1973; Ulmer, 1991) and is used in this study to help develop a baseline of understanding the level of MLD effectiveness.

The districtôs technology coordinator provided information about individual teachers that consistently utilized MLDs inside and outside of the classroom. From this information, 12 teachers were identified as those that utilize MLDs in their daily instruction. Individual interviews were conducted with a sample of these identified teachers to understand their methodology of incorporating MLDs within their daily instruction. These methods included, but were not limited to:

- Utilizing MLDs to clarify complex issues and/or promote classroom discussion of a complex issue in depth
- Having students use MLDs within larger project-based learning initiatives to support a specific point of view or analyze potential bias or difference of perspective
- Examining alternative ways to complete a task or process utilizing video content developed by their peers in other locations and classrooms

Utilizing scores from state achievement assessments from two consecutive years of student data, we were able to subdivide students into categories that included:

- Students whose teachers encouraged and supported the use of MLDs in their classroom.
- Students whose teachers did not support or did not fully integrate MLD usage in their classroom.

Any teacher that was not identified by the technology coordinator as a teacher who utilized MLDs consistently in their classroom was considered utilizing MLDs infrequently. Student scores were divided between these two classifications.

The normative assessments utilized are state achievement assessments. The first set of data originated from scores students attained while completing the assessment in the Spring of their 8th grade year. The second set represents the scores of students completing another set of assessments in the Spring of 10th grade year. Students in the 10th grade need a passing score determined by the Department of Education to graduate and students not meeting the minimum passing score must retake the assessment in their 11th and 12th grade years. The 8th grade assessment is not connected to individual student matriculation, as the derived scores are utilized only to measure student proficiency and school performance. Both assessments are unique; however, as the 8th grade assessment focuses only on reading, math and science; while the 10th grade assessment includes assessment components in writing, reading, math, social studies and science. No students complete both the 8th grade and the 10 grade assessment.

Individual student scores are calculated by the state Department of Education utilizing a scale to indicate levels of proficiency. Raw scores, based on an incorrect/correct binary, are scaled utilizing a Rasch ability estimate, which is then migrated to the appropriate scaled score. Each scale is designed to establish a score of 400 as a level of proficiency in all content areas for the 8th and 10th grade assessments.

Grade & Subject	***Scaled Score Range***	***Number of Questions***
8th Grade - Reading	263-541	48
8th Grade - Math	283-557	46
8th Grade - Science	256-556	48
10th Grade ï Reading	261-557	48
10th Grade - Math	384-565	46
10th Grade ï Writing	378-566	48
10th Grade ï Science	209-591	48
10th Grade ï Social Studies	231-579	48

Table 1. ***Scaled Score Range by Grade and Subject***
(source: Ohio Department of Education, 2012)

From the list of students completing both assessments, numerous layers of analysis were then conducted; with an initial examination of the potential impact MLDs have on student performance as a whole, followed by an examination of how subsets of the total student population may have been affected by the use of MLDs. Using a simple one-tail T-test, a uniform level of significance (p=.05) was established based on previous studies of this type.

Limitations

The primary limitation with this study centers on the total number of scores for the 8^{th} grade and 10^{th} grade population in the Mountainville school district. The district has a limited number of students in each grade classification; it became increasingly difficult to locate students who were not exposed to the treatment associated with the utilization of MLDs in specific academic content areas. For example, the numbers of students enrolled in the districts reading, writing and math courses that were not associated with the utilization of MLDs was insufficient in number for a viable statistical analysis. As a result, it was not possible to measure the significant effect levels for portions of the testing population in specific academic domains. This limitation will be corrected in future studies with the inclusion of multiple school districts and a larger sample population.

Findings and Analysis

In the larger population, the overall effect of the utilization of MLDs showed positive results in terms of student test scores in all instances with the exception of one (8^{th} grade math). Significantly higher recorded scores in the groups exposed to MLDs on a consistent basis highlight these positive results. The most dramatic increase was seen in the 8^{th} grade math population, where students utilizing MLDs scored, on average, 52.34 points higher on the state assessments than their peers who did not use MLDs. The one exception to this pattern centers on the 8^{th} grade science scores in 2011, where non-MLD students scored slightly higher than the MLD population (a variance of 3.55 points).

Grade	*Year*	*Subject*	*N*	*MLD Score Mean*	*Non-MLD Score Mean*	*Δ*	*P-Level*	*Met Significance Levels*
8	2011	Reading	167	429.79	415.55	+14.24	0.002	Yes
		Math	160	414.03	417.58	(- 3.55)	0.382	No
		Science	167	415.67	405.23	+10.44	0.000	Yes
	2012 (*)	Reading	151	431.76	387.78	+43.98	0.000	Yes
		Math	150	427.34	375.00	+52.34	0.000	Yes
10	2011(**)	Science	180	456.06	418.27	+37.79	0.000	Yes
	2012(***)	Social Studies	179	421.78	+16.36	+17.25	0.000	Yes
		Science	179	453.37	421.88	+31.49	0.000	Yes

Table 2. Aggregate Data – MLD vs. non-MLD Instructional Use

Notes* - 8^{th} grade Science scores in 2012 were excluded from analysis due to limited sample size
** - 10^{th} grade reading, math and writing scores in 2011 were excluded from analysis due to limited sample size
*** - 10^{th} grade reading, math and writing scores in 2012 were excluded from analysis due to limited sample size

As sub-groups in the larger population were examined, we continued to see measurable variations of student performance between the MLD and non-MLD population. When segregating the scores according to gender, patterns regarding enhanced student performance with the utilization of MLDs in daily instruction emerge. In this population, the analysis of scored based on gender comparisons (male-male; female-female), higher scores were reported for those students utilizing MLDs in their classroom in all instances. This is most evident in the 8^{th} grade female math population, where individuals enrolled in classes utilizing MLDs on a regular basis scored 65.95 points higher on average on the 2012 assessment compared to their peers who did not use MLDs in their classes.

Grade	*Subject*	*Gender*	*N*	*MLD Score Mean*	*Non-MLD Score Mean*	*Δ*	*P-Level*	*Met Significance Levels*
8	Reading	Male	83	428.82	384.67	+44.15	0.000	Yes
		Female	68	435.27	392.33	+42.94	0.000	Yes
	Math	Male	82	423.38	378.60	+44.78	0.000	Yes

		Female	68	431.95	366.00	+65.95	0.000	Yes
10	Social Studies	Male	86	440.20	421.26	+18.94	0.002	Yes
		Female	93	436.58	420.53	+16.05	0.005	Yes
	Science	Male	86	455.00	420.73	+34.27	0.000	Yes
		Female	93	445.89	421.22	+24.67	0.006	Yes

Table 3. 2012 Assessment Results – MLD vs. Non-MLD; Gender Segregation

Notes: 8th grade science scores excluded due to limited sample size of non-MLD courses;
10th grade reading, math and writing scores excluded due to limited sample size of non-MLD courses

Discussion and Implications of Practice

The findings in this study led to a preliminary conclusion that there is likely some positive effect of MLDs in regards to student performance on standardized assessments. This is evident through seven of the eight measured areas in the total district population. Further, there is a positive trend indicated throughout the total district population as the average test score for those utilizing MLDs show a 25.5 point increase as compared to their peers who do not utilize MLDs. This data is even stronger when the gender variable is analyzed as all four measured areas we saw increased scores, and measures of statistical significance, students utilizing MLDs on a frequent basis through an average score increase of 32.7 points in each measured content area. It should be noted that this study was conducted in a BYOD environment, but the authors do not claim the policy had an effect on those classrooms that reportedly used MLDs in a consistent manner.

It is important to note, however, that overall student enthusiasm for school or learning or teacher effectiveness in MLD or non-MLD courses was not studied or analyzed. Nor was the type of student device being utilized studied or how it was utilized in the classroom context on a regular basis. While experiential teacher commentary was collected in a limited fashion, further study as to the specific means of MLD implementation and student receptivity to MLD usage must be done to place these assessment-driven results in the proper context.

One factor was apparent, however, when researchers did inquire as to the effective classroom operations where MLDs were used on a regular basis. As one teacher in the district stated, ñUsing MLDs in the classroom is a leap of faith. You have to believe the students will use the technology appropriately and effectively ï which takes giving up some level of control.ò The process as to how to effectively empower student utilization of MLDs is worthy of future study, as is how students themselves perceive courses where MLDs are utilized. Ultimately, they are the final consumers of both the classroom instruction and the technology, and they will have the final determination of its overall effectiveness.

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