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THE EFFECTS of TECHNOLOGY on ACADEMIC MOTIVATION and ACHIEVEMENT in a MIDDLE SCHOOL MATHEMATICS CLASSROOM

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The Effects of Technology on Academic Motivation and Achievement in a Middle School Mathematics Classroom

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Abstract: As classroom instruction and standardized testing rely more heavily on technology, teachers must assess the effectiveness of their technological tools. This study evaluated the effects of an online, standard-aligned practice program on student motivation and academic achievement in two 6th grade inclusive mathematics classrooms. The researchers used a variety of data sources, such as pre and post testing, surveying, and student reflections. The results demonstrated that student scores significantly improved and motivation remained consistent. By continuing to seek new and different technological tools, teachers can improve instruction and allow students to explore content in an exciting way.

As society relies more on technology, students must be able to use technology for problem solving, learning in higher education, succeeding in their future careers, and living their daily lives (Sullivan, 2014). To answer the demands of society, federal mandates, common curriculum standards, and standards-based testing are affecting education and demanding the use of technology (Berry & Ritz, 2004). This applies equally to general education and the education of learners with special needs.

As technology has developed and education has embraced technological tools, special education has also adapted to incorporate new strategies (Burdette, Greer, & Woods, 2013). Web-based instruction and practices have become more prominent in education, allowing students with a variety of disabilities to engage in online learning (Burdette et al, 2013). The internet also allows students to independently engage in relevant, organized, and simplified research (Bouck, Okolo, & Courtad, 2007). Web-based technologies help learners in the

acquisition of various skills, such as reading, writing, and comprehension in language arts, as well as mathematical problem solving.

Recent trends in mathematics instruction are based on five main components: problem-based learning, student-led solutions, risk-taking, having fun, and collaboration (Gasser, 2011). Effective mathematics instruction employs a combination of each of these facets.

Berry and Ritz (2004) claim that "mathematics is the language of the technological world" (para. 1). Within mathematics instruction, implementation of technology has taken many forms. Some programs are all-inclusive, providing interactive activities, lessons, videos, and assessments (Saultz & For California Education, 2012). Targeted programs provide differentiation for struggling students and allow students to work at their own pace (Saultz & For California Education, 2012). Technology-based mathematics tools are making mathematics instruction increasingly engaging (Kuhn & Dempsey, 2011). Part of what makes these tools so engaging is their real-world application, which allows students to practice skills in meaningful contexts (Berry & Ritz, 2004). In fact, some technology-based tools are so engaging, that students forget they are learning mathematics, and are truly immersed in the game (Kuhn & Dempsey, 2011). Teachers have reported that students eagerly search for solutions and ask for help so that they can continue on to the next phase of their math game (Kuhn & Dempsey, 2011).

Not all teachers, however, are effectively integrating technology into their mathematics curriculum. Flory (2012) found that some teachers even reported lower standardized testing scores while using technology in the classroom. Flory further states that it is not the use of technology itself that increases student performance and engagement, but effective

implementation. In order to guarantee that technology is used effectively in a mathematics classroom, teachers must be properly trained and motivated (Flory, 2012).

When technology is used appropriately, it can influence academic motivation. Grisham and Wosley (2006) state that technology empowers students providing them with an opportunity to shape their own learning. However, Jacobs (2013) claims that technology itself does not necessitate academic motivation. Research shows that teachers must employ technological opportunities that provide access to a larger community or goal in order to improve a student's academic motivation (Jacobs, 2013). Further study indicates that students with lower scores value technological instruction and homework tools more than their higher performing peers (Leong & Alexander, 2013). Participants in the study, Leong and Alexander report, say that this is because technology provides instant feedback with instructional assistance. Technology must be made relevant and useful in order for teachers to expect increased motivation among their students, especially those students who have special needs and require more attention from their teachers.

This action research study sought to explore the following research questions:

1. What is the effect of using web-based mathematics programs to improve student motivation and achievement in a sixth grade math classroom?
2. Is there a difference in student motivation and achievement between the general education population and the special education population?

The ideas behind this action research are constructivist in nature. The constructivist view postulates that students construct their own view of reality when engaging in explanation of the world around them. Teachers, therefore, should assume the roles of facilitators and help students

make sense of the information. One such technique that would allow for this student-teacher relationship is problem-based learning.

Problem-based learning requires that teachers present students with an abundance of information (Gasser, 2011). Gasser asserts that to be successful in such learning, students must sort through the problem to identify its parameters and then use their own creativity and interests to drive their individualized solutions. This type of problem solving promotes making connections as well as generalizing and applying skills (Cotic & Zuljan, 2009). Cotic and Zuljan (2009) add that such strategies allow for meaningful, applicable learning across varying ability levels. When students see the meaning behind their learning, they feel empowered and motivated to learn, which leads to higher achievement.

Much research has shown that academic motivation and achievement are linked (Akomolafe, Agunmakin, & Fassoto, 2013; Rowell & Hong, 2013). Akomolafe et al (2013) state that highly motivated students achieve at higher levels and are less likely to drop out of school. Rowel and Hong (2013) echo that students who are motivated value, and even enjoy, learning. In fact, Rowel and Hong point out that "studies have identified lack of motivation as a primary reason for underachievement" (para. 4). On the other hand, intrinsically motivated students are often on task, monitor their own progress, and engage in more creative and potentially risky activities. Rowel and Hong then add that when students monitor their own progress and receive positive feedback, they gain confidence and motivation to attempt more challenging activities, thus increasing overall achievement.

Gottfried, Gottfried, Cook, and Morris (2005) point out that intrinsic motivation becomes more stable as a child continues learning, while simultaneously assisting in improving academic

achievement. Ultimately, student motivation not only affects performance within the classroom, but also indicates future career success (Gottfried et al., 2005).

Many have studied the effects of technology within the classroom, but there is little research that investigates the effects of technology on academic motivation and achievement in an inclusive middle school mathematics classroom. This study seeks to bridge this gap and determine if access to technology-based activities improves students' motivation and success in an inclusive middle school mathematics classroom, and if there is a difference between improvements for students with and without special needs.

Method

Participants

Participants for this study included 33 sixth grade students and 20 of their parents. Of these students, 17 were girls and 16 were boys. All students were in an inclusion mathematics classroom; 9 of these students were classified as eligible for special education services. One student had an Intervention and Related Services Action Plan. The remaining students in the class were students without any identified disabilities and did not require special services.

Materials and Procedure

The study lasted for ten weeks. The researcher collected quantitative data from Study Island, an Edmentum product (Study Island, 2014). Study Island is a commercial product purchased by the school district. It is a web-based program and has two distinct parts, one for the instruction of Language Arts, another for Mathematics. The program contains a collection of standards-based assignments with tech-enhanced features like movable parts and interactive

graphs (Study Island, 2014). Interactivity is built in to support motivation. Students do all assigned work in the online environment. A teacher has a flexibility to turn assignments on and off, decide which problems are important, and what the deadlines for submission should be. Study Island reports individual student progress, question breakdown, time elapsed, and recommendations for further practice (Study Island, 2014). All data are available online for immediate access and feedback.

The researcher used an online pretest and posttest from Study Island to quantitatively assess student performance in mathematics. The assessment contained 30 multiple choice, short answer, and technology enhanced questions aligned to 6th grade Common Core State Standards and designed to mirror standardized PARCC questions. The researcher also assigned problems weekly from the Study Island question bank. Each assignment consisted of 10 questions based on one or two 6th grade mathematics standards.

The researcher used qualitative research instruments to measure academic motivation. To do this, the researcher administered Likert five-point scale pre- and post-surveys to the students and one Likert five-point scale survey to their parents. The parental survey was done at the end of the end of the study. These surveys measured student perceptions of their abilities in mathematics, their desire to succeed in math class, and their understanding of the usefulness of mathematics in the real world. Both the student and parent surveys contained 10 statements.

Additionally, at the beginning, middle, and end of the study, students were given a printed report of their performance on activities from Study Island and asked to reflect upon the data and their progress in their student journals. The researcher asked students to examine their scores and the concepts with which they struggled or excelled. By reflecting on their own

progress, students took ownership of their own learning and gained a better understanding of their overall performance. Examining the reflections allowed the researcher to glimpse how students viewed themselves as learners.

Results and Analysis

Quantitative Findings

Pre-and-post test results. The results of the pretest and posttest, measuring academic achievement in 6th grade math skills and applications are presented in Table 1. The number of students taking pre and post test are not the same as many students were absent on the day of the post-test. Running a t-test of grade level results, assuming unequal variances, indicated that student performance in 6th grade mathematical content improved significantly: $t(49) = 3.49$, $p < 0.001$. Standard deviations convey that there was a large degree of variation in student performance, especially on the posttest for students in the General Education group. Nevertheless, mean scores for the General Education group indicate that students in this group had performed better than students in the Special Education group.

Table 1
Study Island Pre-and-post Test Results, Mean Percent

	Pretest			**Posttest**		
	N	**Mean**	**Standard Deviation**	**N**	**Mean**	**Standard Deviation**
Total Class	33	62.75	14.28	25	77.18	15.53
General Education	24	65.09	14.65	17	81.14	38.76
Special Education	9	56.53	11.92	8	67.05	19.97

On the pre-and-post tests, as well as on 6 out of 8 weekly assignments, the General Education group outperformed the Special Education group, as seen in Table 2. Both groups

consistently completed assignments, but averages were higher for the General Education group. The exceptions to this trend are weeks 5 and 6. Students in both groups performed very similarly, and means were within one percentage point of each other in week 5. During week 6, the Special Education group broke the pattern and scored 8.44% higher than the General Education group. On the pre-and-post tests, the General Education group increased 13.80% and the Special Education group increased 9.27%, revealing slightly greater gains within the General Education group.

Table 2
Weekly Assignment Results, Mean Percent

	Total Class		**General Education**		**Special Education**	
	N	**M(SD)**	**N**	**M(SD)**	**N**	**M(SD)**
Unit Rates	33	66.51(21.60)	24	71.05(19.47)	9	54.41(23.45)
Division	32	57.50(21.10)	24	59.17(20.83)	8	52.50(22.52)
Decimals	33	47.58(29.37)	24	51.25(27.24)	9	37.78(34.20)
Percent	33	69.90(24.09)	24	71.96(24.18)	9	64.42(24.37)
Writing and Evaluating Expressions	31	43.23(26.76)	23	43.04(22.85)	8	43.75(37.77)
Equivalent Expressions	33	37.78(27.88)	24	35.48(26.90)	9	43.92(31.13)
Integers	33	66.36(19.81)	24	69.58(20.10)	9	57.78(17.16)
Problem Situations	32	66.43(23.14)	24	70.73(20.09)	8	53.51(28.13)

Student Likert survey pre-and-post test results. The results from the motivation surveys are presented in Table 3.

Table 3
Student Likert Survey Pre-and-post Test Results

	Pretest*	**Posttest****

	Mean	Standard Deviation	Mean	Standard Deviation
Math is fun.	4.03	0.84	3.89	0.91
I like playing math games.	4.24	0.82	4.31	0.82
Math grades are important to me.	4.12	0.99	4.31	0.90
Math is easy for me.	3.16	1.07	3.18	0.97
Knowing math is important in real life.	4.14	0.91	4.24	1.07

*N = 26, **N = 31

Parent Likert Survey Results. Parents took the Likert scale survey to further the researcher's understanding of student motivation. Results of the parental survey are displayed in Table 4.

Table 4
Parent Likert Survey

	Mean	Standard Deviation
My child enjoys math.	3.40	1.10
My child studies math independently.	3.15	1.25
Math grades are important to my child.	4.38	0.70
My child finds math easy.	2.78	1.19
My child feels that knowing math well is important in real life.	3.60	0.74

N = 20

Qualitative findings

PARCC preparation. The examination of student reflections showed that , 66.67% of Special Education students felt that Study Island helped to prepare them for the PARCC assessment, while only 25% of General Education students felt that they benefitted from the Study Island assignments. Of the 7 students who attributed their improvement to Study Island, 3 students were General Education students and 4 were Special Education students. Overall, the

General Education students performed better, but had a more negative outlook on their Study Island experience than did the Special Education Students.

Difficulty of Content and Presentation. Many students reported that Study Island contained difficult questions (30% of students reported this on their first reflection, 6% on the second, and 33% of the students reported it on the third reflection), more difficult than the content covered in class. This is mirrored by the low averages for each of the assignments, particularly in weeks 3, 5, and 6. As Study Island recently revamped their questions to better align to the PARCC, the difficulty of the content and problem solving requirements was above the expected level, and this was apparent in the student reflections and attitudes in addition to assignment scores.

In their reflections, students indicated that there were many questions which required multiple answers or lengthy processes, and even some which were worded strangely. Some students reported that Study Island recorded an answer as incorrect even when it was the right answer. The researcher reported that some questions were strangely written and confusing, and that even the teachers often had trouble deciphering what the problem required students to do.

Consistent Motivation and Perspective. While survey results did change from pre to post, responses were generally similar and not statistically significant. Parental responses were lower than student responses on most questions, but higher for the statement, "Math grades are important to my child." Similar results from these two instruments show that parents and their children have similar views on what mathematics instruction means to these two groups. The results allow the teacher-researcher to conclude that students generally have a positive view of math, care about their performance, and recognize math's practical implications. Furthermore,

continued completion of weekly assignments showed that students were engaged and wanted to succeed.

In the reflections, however, the picture was different. Only 34.48% of students reported enjoying the Study Island assignments on the first reflection, and this percentage was dramatically lower (9.09%) on the second reflection. When asked if students enjoyed completing online assignments like Study Island, one student responded, "Anything but Study Island!" Another student remarked that Study Island "does not help… it's very boring and it's also very confusing." Several students reported that Study Island was good practice. One student wrote, "I am sort of enjoying it because it is hard and takes up time and it is sort of fun because it is good practice." This allows for the conclusion that even if children do not quite enjoy this technology based tool, they will continue using it and strive for success, because doing well in mathematics is important to them.

Triangulation

These trends provide clear answers to each of the research questions. Students did improve their academic performance during this study. However, these results are not solely reliant upon completing the Study Island assignments. Students still experienced regular classroom instruction during this time, and it is unclear how much the technology use contributed to improved performance. Still, it is clear that the General Education group made greater academic gains during the course of this study than did the Special Education group. All participants remained relatively constant with respect to academic motivation for the duration of this study, and using this particular technological tool did not cause motivation to increase. The fact that the students stopped enjoying the use of the tool after a certain period of time is also

telling, indicating that the variation of technological approaches may be a better way to sustain enjoyment and motivation when teaching and learning mathematics.

By incorporating several quantitative and qualitative measures in this study, the researchers were able triangulate the effects of using web-based mathematics programs on academic motivation and achievement. Students' open-ended questionnaires triangulate with both parent and student Likert surveys. Additionally, weekly Study-Island based assignments along with the pre- and post- tests all served to assess academic achievement. As a special education mathematics teacher, one of the researchers especially values the results as she uses them to inform her classroom teaching strategies and resources.

Discussion

These findings partially support previous studies. Eyyam & Yaratan (2014) found that technology had positive effects on both academic achievement and academic motivation. However, Shapley, Sheehan, Maloney, and Caranikas-Walker (2011) found that technology produced a general trend toward academic improvement, but this increase was not significant. This study shows that although students significantly improved, it is impossible to tease out that this improvement was solely due to the use of technology. Additional research would enhance the findings of this study and provide further insight into the link between technology and academic achievement.

Previous studies of motivation indicated that students enjoyed technology and were more engaged when technology was used consistently in a mathematics classroom. This study did not indicate that there is a direct link between the consistent technology use and increased motivation to learn or succeed in mathematics. Further research must be done to continue analyzing the

correlation between educational technology use and academic motivation in mathematics instruction.

Limitations

While this study somewhat supports the findings from previous studies, the current study is not without limitations. Perhaps the greatest limitation was the Study Island website itself. The website was recently redesigned to align to the PARCC test, greatly increasing the difficulty of the content. In addition, the redesign might needed more proofing from the content specialists, as some wording was confusing and some answers while coded as correct, were not.

This study was also limited with respect to time. The students struggled to adjust to the new format of Study Island during this short 8 week time frame. Furthermore, the study involved a small number of students all of whom were part of one grade level in school studying under the same teachers. Continuing to research the effects of technology on middle school math classrooms is vital for improving instruction and remaining relevant with today's educational trends.

Conclusion

In general, teachers should employ research techniques in their classrooms on a regular basis. Understanding the effects of certain strategies or tools can only serve to increase the overall effectiveness of instruction. Observing the impact of instructional practices on student motivation and achievement provide teachers with valuable information. Teachers can then adjust their methods to better reach their students and promote a healthy learning environment.

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