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Abstract

To achieve the goal of 100% proficiency for all students in mathematics, a middle school in a large urban public school district in Omaha, Nebraska increased the frequency of instructional time in mathematics instruction for a group of seventh and eighth grade students. The purpose of this study was to determine if there was a difference in the performance of seventh and eighth grade students on the Nebraska State Accountability Mathematics Assessment (NeSA-M) using different frequencies of mathematics instruction, provided daily versus every-other-day. The Continuous Improvement Theory and Bloom’s Mastery Learning model were used as frameworks to investigate math achievement. A quantitative causal-comparative study was conducted using ex post facto achievement data. The analysis included the comparison of the mean differences in NeSA-M scores for seventh and eighth grade students using an independent samples t test. This analysis was completed to see if block scheduling frequency daily versus every other day was effective with student achievement for each grade level. There were unexpected results from this study as the two grade levels demonstrated different effects from the influence of increased instructional time on the growth of middle school students’ NeSA scores.

Introduction

Education is a fundamental aspect of the American culture and is essential to democracy and economic prosperity (Baker, Sciarra, & Farrie, 2010). Public schools provide an opportunity for all children to earn free and equal education. The No Child Left Behind Act (NCLB, 2001) shed light on the nation’s failure to effectively educate all students (Kress, Zechmann, & Schmitten, 2011). NCLB and The Every Student Succeeds Act (ESSA, 2015) require states and school districts to report student achievement, as well as disaggregated data by various subgroups, as a means to examine the success of the individual schools and districts. According to a report by the American Education Research Association (2016), more investigation is needed into what school structures are effective for middle schools. Although block scheduling was well represented in the data before 2000 this topic has rarely been found in the literature since then (Ellerbrock, Main, Falbe, & Franz, 2018). There is new urgency to investigate different time structures to help students achieve the more rigorous state standards related to the Common Core Standards. Vogler, Schramm-Pate and Allan (2019) found that seventh grade social studies students in block scheduled classes performed better on standardized state tests than traditionally scheduled students.

To meet the academic needs of all students, as well as have Adequate Yearly Progress (AYP), schools and districts have explored the most effective strategies of teaching mathematics to middle school students. Included in these strategies is the question of how much mathematics instructional time a typical middle school student receives. Urban school districts especially want to learn the techniques that will help decrease the achievement gap that exists in mathematics within their district. According to Evans, Tokarczyk, and Rice (2002), changing the school schedule to block scheduling and increasing mathematics instruction has resulted in improvement in student achievement, as evidenced by increases in average standardized test scores, a higher percentage of students earning honor roll, and a decrease in the failure rate. In fact, The National Council of Teachers of Mathematics (2014) indicated that the extended interaction time afforded by block scheduling has allowed students to develop mathematical concepts more fully with the increased time to interact with teachers. Interventions like these need to be put into practice to increase student achievement. The school system is responsible for taking control of the school-based variables that hinder students from academically achieving (Williams, 2011). To address such a need, this study compared the performance of seventh and eighth grade students on the Nebraska State Accountability Mathematics (NeSA-M) Assessment based on the frequency of math instruction in seventh and eighth grade students.

According to the Nebraska Department of Education State Report Card, in 2012 68% of the seventh grade students statewide who were assessed on the NeSA-M were proficient (Nebraska Department of Education, 2012). The same report showed only 62% of the eighth grade students statewide who were assessed on the NeSA-M were proficient (Nebraska Department of Education, 2012). In 2012, a middle school in Omaha, Nebraska, had only 47% of the seventh grade students and 30% of the eighth grade students assessed on the NeSA-M as proficient. To achieve the goal of all students learning and moving closer to 100% proficiency in mathematics, schools need to analyze the impact their current strategies have on student achievement in mathematics.

The goal in education is for all students to learn. Benjamin Bloom suggested that students learn at varying rates (Guskey, 2010). A strategy outlined by Bloom, known as Mastery Learning Model, suggests that if students are provided the necessary time and the appropriate learning environment, then nearly all students could be academically successful (Guskey, 2010). The National Council of Teachers of Mathematics (NCTM, 2006; 2014) suggested increasing the amount of mathematics instructional time to overcome any inequalities among subgroups. According to Patall, Cooper, and Allen (2010), increasing the amount of instructional time is just one of several factors that influences student learning. Patall et al. (2010) suggested that educational researchers conduct a well-designed research that will help determine under what condition, for whom, and when more instructional time will yield the greatest student achievement. The gap in the literature suggested by Patall et al. (2010) and Ellerbrock, Main, Falbe, and Franz (2018) guided this investigation to determine if more frequent instructional time in mathematics will yield greater student achievement and decrease the achievement gap in mathematics.

Literature Review

To address the nation's priority in student achievement, educators need to effectively implement standards-based instruction, driven by investigations, discussions, and reflections (Kress et al., 2011). Block scheduling, a model in which students attend few classes per day for longer periods of time, has become an increasingly popular reform movement for schools and school districts to provide the extra time needed to implement these different strategies. Bloom suggested that students learn at varying rates (Guskey & Anderman, 2013). Additionally, Bloom suggested that if students were provided the necessary time and the appropriate learning environment, then nearly all students could be academically successful (Guskey & Anderman, 2013). Using Bloom's Mastery Learning Model, students who are unable to master a learning objective will be able to review it and retest until mastery was achieved (Guskey & Anderman, 2013). The challenge for educators is creating a learning environment that would provide the individual student with the time and conditions necessary for him/her to master the learning objective (Guskey & Anderman, 2013).

As part of the instructional process, Bloom's Mastery Learning Model integrates both formative and summative assessments. Formative assessments, such as classroom practice, are given more frequently to monitor students' understanding and adjust the instruction, through descriptive feedback, correctives, and/or enrichment activities, to improve learning (Cornelius, 2013). Summative assessments include the end-of-unit and high-stakes assessments to report student achievement or mastery of the content (Cornelius, 2013).

To reduce the achievement gap and create a learning environment for all students, Bloom suggested increasing the variation of instructional approaches and instructional time (Guskey & Anderman, 2013). By diversifying and differentiating instruction, educators can meet the needs of their students' varying learning styles and abilities. For a student to achieve mastery of a learning objective, the student must become actively engaged in his/her own learning (Guskey & Anderman, 2013).

No Child Left Behind stressed the importance of implementing standards in all subject areas (Augustine & Freeman, 2011). To implement standards-based instruction effectively, lessons need to be driven by investigations, discussions, and reflections (Flynn, Lawrenz, & Schultz, 2005). Block scheduling, a model in which students attend few classes per day for a longer period of time, has become an increasingly popular reform movement for schools and school districts to provide the extra time needed to implement standards-based instruction (Huelskamp, 2014).

An advantage of block scheduling is the effect of knowledge retention in skill/concept-based courses, such as mathematics and foreign language. Gregory and Herndon's (2010) investigation of block scheduling revealed the ability of students and teachers to concentrate more on fewer subjects, resulted in a deeper learning of the content. In addition, Gregory and Herndon (2010) noted that teachers were using more varied instructional practices due to the extended amount of class time. These advantages were echoed by the NCTM report (2014) where increased time also resulted in teachers spending more time ensuring student mathematical understanding.

However, Gregory and Herndon (2010) did note challenges that existed due to changing to block scheduling, such as developing new systems of accountability, communication, new computer software, planning courses to prepare for different mandated assessments, and new scheduling procedures. Time is necessary for lessons to be driven by investigations, discussions, and reflections. Block scheduling provides educators with the necessary time for varying instruction, encouraging a deeper understanding of the content, and time for re-teaching as needed. Students need time for the content they are learning to be processed.

Methods

To analyze the difference between pre-existing groups, this study used a quantitative causal-comparative approach to investigate if any differences exist between the frequency of block scheduled, mathematics instruction, offered daily versus every-other-day, and the performance of seventh and eighth grade students on the NeSA-M Assessment at a middle school in a large urban public school district in Omaha, Nebraska. The rationale behind this methodology selection was that currently within one large urban school district in the Midwest, there are several different time structures for mathematics instruction for seventh and eighth grade students. The purpose of this study was to examine if increased time on mathematics instruction led to increased student achievement in mathematics on the NeSA-M Assessment.

This study intended to determine which frequency of mathematics instruction, daily versus every-other-day, was necessary to increase student achievement in mathematics and to decrease the proficiency in mathematics gap between the seventh and eighth grade students at a middle school in Omaha, Nebraska and the rest of the state. The study intended to compare students' NeSA-M scale score to determine what differences existed between the frequency of mathematics instruction, daily versus every-other-day, and the performance of seventh and eighth grade students on the NeSA-M Assessment. The research questions of this study guided an investigation in the performance of seventh and eighth grade students on the NeSA-M Assessment between the categorical independent variable, the frequency of mathematics instructional time (90 minutes daily compared with 90 minutes every-other-day), and the dependent variables, the students' performance on NeSA-M Assessment for grade 7 and grade 8.

This study focused on the achievement differences due to frequency of instructional time in mathematics between two groups. The two groups of students studied received Nebraska standards-based mathematics instructions, attended the same middle school in a large urban public school district in Omaha, Nebraska, have similar socioeconomic backgrounds, and took the NeSA-M Assessment in the spring of 2014. The teachers in this study were provided professional development by the district to ensure that students were being taught the proper Nebraska State Standards, as well as using the same instructional techniques.

The NeSA-M Assessment data was collected from the Data Recognition Corporation (DRC) and the school district's research department for 90 seventh grade students and 116 eighth grade students who received every-other-day mathematics instruction and 38 seventh grade students and 67 eighth grade students who received daily mathematics instruction in a middle school in a large urban public school district in Omaha, Nebraska. Using the significance level of 0.05 and the effect size of 0.5, a power analysis was completed for a t test with two independent means. The result of the power analysis was a statistical power set at 0.7, requiring 39 participants/students in each group.

To test the research questions, an independent sample t test was conducted to determine if there were significant mean differences in seventh graders' scale scores, as well as eighth graders' scale scores, on the NeSA-M Assessment as a function of frequency of mathematics instruction. An independent sample t test was used in this study because the research questions were comparing only two groups (students receiving mathematics instruction daily and students receiving mathematics instruction every-other-day).

Results

Research Question #1 Results

The first research question was:

RQ1: Is there a statistically significant difference in performance between the frequency of mathematics instruction, daily versus every-other-day, of seventh grade students on the Nebraska State Accountability Seventh Grade Mathematics Assessment?

The following hypotheses supported this research question:

$H1_0$: There is no statistically significant difference in performance between the frequency of mathematics instruction, daily versus every-other-day, of seventh grade students on the Nebraska State Accountability Seventh Grade Mathematics Assessment.

H1a: There is a statistically significant difference in performance between the frequency of mathematics instruction, daily versus every-other-day, of seventh grade students on the Nebraska State Accountability Seventh Grade Mathematics Assessment.

To summarize the descriptive statistics associated with the first research question, all seventh grade students (n = 128) in this study had a NeSA-M scale score mean of 67.37 out of 200 for the 2012-2013 school year and a NeSA-M scale score mean of 67.31 out of 200 for the 2013-2014 school year (Table 1). The students who received 90 minutes of mathematics instruction daily scored a mean growth in NeSA-M scale score of 8.37, while the students who received 90 minutes of mathematics instruction every-other-day scored a mean growth in NeSA-M scale score of -3.62.

Table 1. Descriptive Statistics for Growth in 7th and 8th Grade NeSA-M Scale Scores

NeSA-M Scale Score	7th Grade				8th Grade			
	n	*M*	*SD*	*SE*	*n*	*M*	*SD*	*SE*
2012-2013 Score	128	67.37	24.48	2.16	183	65.76	24.73	1.83
2013-2014 Score	128	67.31	20.49	1.81	183	65.32	22.59	1.67
Growth in Score for Daily Instruction Group	38	8.37	13.18	2.14	67	1.03	16.22	1.98
Growth in Score for Every-Other-Day Group	90	-3.62	16.72	1.76	116	-1.29	16.40	1.53
Growth in Score for All Students	128	-0.06	16.64	1.47	183	-.44	16.33	1.21

Note. n—Sample Size; M—Mean; SD—Standard Deviation; SE—Standard Error

To test the first hypothesis, an independent sample *t* test was conducted to determine if any statistically significant differences existed in seventh grade students' NeSA-M growth scores across the two school years as a function of mathematics instruction frequency. The results indicated that there was a significant difference in seventh grade NeSA-M growth scores between students receiving mathematics instruction daily (M = 8.37, SD = 13.18) and students receiving mathematics instruction every-other-day (M = -3.62, SD = 16.72), t (126) = 3.93, p = 0.00 (Table 1 and 2). Therefore, the null hypothesis was rejected indicating that there was a statistically significant difference between the frequency of mathematics instruction, daily versus every-other-day, and the growth of seventh grade students' scores on the NeSA-M Assessment. Seventh grade students who received 90 minutes of mathematics instruction daily had a statistically significantly higher growth in their NeSA-M scale score than seventh grade students who received 90 minutes of mathematics instruction every-other-day.

Table 2. Independent Sample t-test Results for Growth in 7th Grade NeSA-M Scale Scores (N=128)

Growth in 7th Grade NeSA-M Scale Scores	Levene's Test for Equality of Variances		t test for Equality of Means			
	F	*Sig.*	*t*	*df*	*Mean Difference*	*Std. Error Difference*
Equal Variances Assumed	2.96	0.09	3.93	126	11.99	3.05

Research Question #2 Results

The second research question was as follows:

RQ2: Is there a statistically significant difference in performance between the frequency of mathematics instruction, daily versus every-other-day, of eighth grade students on the Nebraska State Accountability Seventh Grade Mathematics Assessment?

The following hypotheses supported this research question:

$H2_0$: There is no statistically significant difference in performance between the frequency of mathematics instruction, daily versus every-other-day, of eighth grade students on the Nebraska State Accountability Seventh Grade Mathematics Assessment.

H2a: There is a statistically significant difference in performance between the frequency of mathematics instruction, daily versus every-other-day, of eighth grade students on the Nebraska State Accountability Seventh Grade Mathematics Assessment.

To summarize the descriptive statistics associated with the second research question, all eighth graders (n = 183) in the sample had a NeSA-M scale score mean of 65.76 out of 200 for the 2012-2013 school year and a NeSA-M scale score mean of 65.32 out of 200 for the 2013-2014 school year (refer to Tables 1 and 3). The students who received 90 minutes of mathematics instruction daily had a mean growth in NeSA-M scale score of 1.03, while the students who received 90 minutes of mathematics instruction every-other-day had a mean growth in NeSA-M scale score of -1.29.

To test the second hypothesis, an independent sample *t* test analysis was used. It was conducted to determine if any statistically significant differences existed in eighth grade students' NeSA-M growth scores across the two school years as a function of mathematics instruction frequency. The results indicated that there was not a significant difference in eighth grade students' NeSA-M growth scores between students receiving mathematics instruction daily (M = 1.03, SD = 16.22) and students receiving mathematics instruction every-other-day (M = -1.29, SD = 16.40), t (181) = 0.93, p = 0.36 (see Table 1 and 3).

The analysis failed to reject the null hypothesis. This indicated that there was no significant difference between the frequency of mathematics instruction, daily versus every-other-day, and the performance of eighth grade students on the NeSA-M Assessment. Eighth grade students who received 90 minutes of mathematics instruction daily did not indicate a statistically significantly higher growth in their NeSA-M scale score than eighth grade students who received 90 minutes of mathematics instruction every-other-day.

Table 3. Independent Sample t test Results for Growth in 8^{th} Grade NeSA-M Scale Scores (N=128)

Growth in 8^{th} Grade NeSA-M Scale Scores	Levene's Test for Equality of Variances		T test for Equality of Means			
	F	*Sig.*	*T*	*df*	*Mean Difference*	*Std. Error Difference*
Equal Variances Assumed	0.08	0.78	0.93	181	2.32	2.51

Limitations

This study was limited to one middle school in Omaha, Nebraska due to the school's diverse mathematics courses offered. By focusing on one middle school, the sample population had similar socioeconomic and racial makeup. The different instructional methods and strategies used by each teacher when teaching the different mathematics standards was another limitation of this study. In addition to the varied instructional methods and strategies used by each teacher, the teachers involved in this study had diverse educational backgrounds, as well as teaching experience.

Since this study was limited to one middle school in Omaha, Nebraska, the ability to have a large sample population was a challenge. To staff the daily mathematics course and remain on budget, the middle school had to limit the number of daily mathematics courses offered. As a result, there were only 38 seventh grade students and 67 eighth grade students enrolled in the daily mathematics course which limited the statistical power to 0.7.

Discussion and Implications

A theoretical implication for the results relates to Bloom's Mastery Learning Model suggesting that if students were provided the necessary time and the appropriate learning environment, then nearly all students could be academically successful (Guskey & Anderman, 2013). In order to create an appropriate learning environment for all students, educational organizations must exhibit the six Essential Attributes, which includes being (a) results-oriented; (b) research-based; (c) data-driven; (d) focused on quality and equity; (e) collaborative in form; and (f) ongoing and self-renewing (Lezotte & Snyder, 2011). The first research question was used to investigate whether the frequency of mathematics instruction, daily versus every-other-day, had an impact on the performance of seventh grade students on the NeSA-M Assessment. The data analysis indicated that seventh grade students who received 90 minutes of mathematics instruction daily had a statistically significantly higher growth in their NeSA-M scale score than seventh grade students who received 90 minutes of mathematics instruction every-other-day. The results from the first research question support Bloom's Mastery Learning Model, as well as the six Essential Attributes. Additionally, these results are supported by the NCTM (2014) findings that increased time allowed for increased student-teacher interaction to deepen knowledge of mathematical concepts with more time to practice and fully engage in the material. La Prad (2015) also found that block scheduling facilitated the use of math labs, problem solving and 21st Century skills. Similarly, Herro and Quigley (2016) reported that longer blocks of time facilitated STEAM project work. Further, Bohanon et al. (2016) indicated that block scheduling allowed for greater intervention and team-teaching. Thus, educators need to continue to implement different strategies, such as block scheduling that allow for longer periods of instructions to create a learning environment where all students can achieve at higher levels. In addition, educators need to develop conversations amongst each other to discuss other strategies including team teaching and problem-solving skills through project based learning that would create successful learning environments for all students.

The second research question addressed whether the frequency of mathematics instruction, daily versus every-other-day, had an effect on the performance of eighth grade students on the NeSA-M Assessment. The results indicated eighth grade students who received 90 minutes of mathematics instruction daily did not have a significantly higher growth in their NeSA-M scale score than eighth grade students who received 90 minutes of mathematics instruction every-other-day. Similar findings were reported by Dağlı (2019) indicating that increased instructional time does not always result in an increase in standardized test performance. Bachman et al. (2015) as well as Sonnenschein and Galindo (2015) found that the amount of instructional time spent on specific content and skills contributed more to performance than only increased instructional time. Based on the results of the second research question, the researcher suggests educators compare their current instructional practices with the Continuous Improvement Theory and the six Essential Attributes. Educators should collaborate and develop strategies to create an environment of continuous improvement and academic success that is research-based, and data driven. Additionally, as Bloom's Mastery Learning Model suggests, educators should analyze the data to determine students' strengths and challenges and develop a plan of action that involves formative feedback, as well as specific remediation activities that will increase learning (Guskey & Anderman, 2013).

The insights that this study may bring to education revolves around Bloom's Mastery Learning Model and the six Essential Attributes. When the frequency of instruction increases, educators have an increase opportunity to use and analyze formative assessments to deliver quality, specific remediation, and extension activities to improve academic achievement. The study indicated that increasing the frequency of mathematics instruction may increase the performance on the NeSA-M Assessment. Therefore, educators need to perform formative feedback frequently, to determine the strengths and challenges of their students, as well as their teaching strategies. Based on their formative feedback, educators need to collaborate with others to seek out research-based strategies that will assist them in increasing student learning.

Recommendations for Future Research

Based on the mixed findings of this study, as well as its research design and population, the following recommendations for future investigations may enhance the literature on this topic.

- Future researchers can conduct a qualitative study to investigate the differences in findings between the seventh and eighth grade students. A future study can focus on instructional strategies and teaching styles of each teacher, along with how students are engaged with their learning.

- The current study focused on the growth in NeSA-M scale scores only, future researchers can conduct a qualitative study to investigate the attitudes and beliefs of the students enrolled in the different mathematics courses. In addition, the data collection instrument could include the students' perceptions of their mathematics ability and an evaluation of their teacher's instructional approach.

- The current study focused on the growth in NeSA-M scale scores from one school year to the next, future researchers can consider expanding the study by investigating the impact of the increased frequency of mathematics instruction on student achievement over multiple years.

Conclusion

The results from this study were mixed. The seventh-grade students who received 90 minutes of mathematics instruction daily indicated a significantly higher growth on their NeSA-M scale score than seventh grade students who received 90 minutes of mathematics instruction every-other-day. The eighth grade students who received 90 minutes of mathematics instruction daily did not show a significantly higher growth in their NeSA-M scale score than eighth grade students who received 90 minutes of mathematics instruction every-other-day. Since the seventh and eighth grade results from this study were not the same this could be used to optimize and differentiate the funding and resources needed for seventh and eighth grades, respectively. By increasing the offering of daily math for seventh graders it will build a stronger foundation for them as they move into eighth grade where a less frequent offering appears to be to their advantage. Such evaluative practices and evidence-based decision making can be re-evaluated in the future to see if this phenomenon remains or changes over time.

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