The Impact of Learning Stations on High School Students Ability to Solve Linear Systems of Equations

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ABSTRACT

The purpose of this study was to determine the impact of learning stations on high school students' ability to solve linear systems of equations. The measurement tool was a performance assessment aligned with the Anne Arundel County Public Schools' Algebra 2 curriculum. The study was a true experimental design with 22 participants in group A receiving the treatment and 18 participants in group B receiving the control over a two-week period. A pretest posttest design was used for comparison between group A and group B. The null hypothesis states that learning stations have no impact on high school students' ability to solve linear systems of equations which was supported. Regarding the achievement gains between group A and group B, there was not a statistically significant difference. Research in the area of learning stations impacting math achievement should continue given the importance of engagement and differentiated instruction.

CHAPTER I

INTRODUCTION

Overview

When making decisions regarding an approach to teaching students, the teacher should take into consideration certain factors to guarantee the greatest opportunities for student learning. When students receive instruction, each student acquires information in different ways. Students' ability level, prior knowledge, interest level, and learning styles are important factors to consider when planning a lesson in order to accommodate all students. Fostering student engagement through active learning increases students' attention, improves focus, and promotes meaningful learning experiences. Research has shown that when students are engaged in the learning process, they take interest in the material, gaining deeper understanding of the content. Thus, research has been conducted to identify the most effective and engaging evidence based instructional methods. One instructional method that has been found to be effective is math learning stations.

Statement of Problem

The purpose of the study is to investigate the impact of learning stations on high school students' ability to solve linear systems of equations.

Statement of Research Hypothesis

The learning stations have no impact on high school students' ability to solve linear systems of equations.

Operational Definitions

The independent variables for the study are the ***math learning stations***. The treatment will consist of four stations, based on pretest data of group A, and focus on extension of material, teacher support, word problems and vocabulary with graphs. The dependent variable is the students' achievement in solving linear systems of equations measured by the post-performance assessment. According to this study, math learning stations are strategic locations within the classroom that foster student interaction with math problems in alternative ways.

CHAPTER II

REVIEW OF THE LITERATURE

This literature review investigates the impact of learning stations in mathematics at the high school level. Learning stations are physical locations in the classroom where students are asked to solve problems and answer questions using the materials provided (Schweitzer, 1995). Learning stations serve many purposes, including teaching concepts, integrating subject matter, building interest, and allowing for inquiry (Jarrett, 2010). Learning stations are relevant, foster discovery and interaction with the content, motivate students to want to learn more and promote individual talents and abilities (Ediger, 2011). Learning stations provide an alternative method to guide instruction for diverse learners, address learning styles, differentiate instruction, engage, group purposefully, and foster a positive learning environment.

The Role of Learning Stations in Mathematics Instruction and Learning

In the context of mathematics learning and instruction, learning stations are used as a strategy to meet student needs based on learning styles, providing learners with choice (Ediger, 2011). Math stations are one form of differentiation, which are set up as multiple locations, or stations, within the same classroom. Students use math stations to work on different activities relating to the same concept at the same time, with differentiation between stations focusing on content, process, or product differentiation. Differentiated math stations benefit every learner by taking into consideration the different ways that students learn mathematics and how they can show that knowledge (Andreasen & Hunt, 2012). Differentiated stations are different from traditional stations in the different level of assignments as opposed to one level for all students. Student assessment data drives the differentiated stations as opposed to traditional stations being based on whole group instruction. Teachers are able to accommodate students' different learning styles through differentiated stations, offering multiple ways to grasp concepts, and teachers can observe while making anecdotal notes about students' progress. Students may prefer hands on learning, while another learner may prefer tasks involving reading and writing (Ediger, 2011).

Another benefit is that learning stations support the 5E learning cycle model of inquiry, which recommends that lessons include the following stages in the order of engagement, exploration, explanation, elaboration and evaluation (Jarrett, 2010). The design of station activities can be created to engage students in a particular content and explore the content, which are the first two E's in the 5E model.

Learning stations facilitate interactions among peers, shifting the focal point from the teacher to students and putting students in charge of executing their own problem solving and consequent learning (Martin & Green, 2012). Learning stations can be used as a way to locate and access information, analyze information, and/or react and respond to information (Spisak, 2014). Teachers can use the stations in a variety of different ways, including an introduction to a lesson or topic, part of an overall unit, review, a culminating activity or an extension activity. The learning stations encourages movement by the students within the classroom which fosters a natural facilitative structure that allows students to work both independently and within collaborative peer groups. As opposed to direct instruction, learning stations support the teacher guiding instruction and encouraging exploration. A learning station can provide an atmosphere for individual or small group inquiry (Olsen, 1975). Along with promoting exploration and communication amongst classmates, station teaching decreases student-to-teacher ratios and allows for more direct support and small-group instruction (Morehead & Grillo, 2013). Station teaching gives teachers flexibility to vary interactions such as teacher to student, student to student and student to hands on material (Suprabha & Subramonian, 2014). The teacher should assess students' depth of knowledge of a concept to make informed decisions when strategically grouping, during pre-planning time, according to the assessment data. Strategic and purposeful grouping will allow the teacher to focus on the needs of specific students and spend more time with the groups that require more assistance with the assigned task. The creative design of each station can be methodically built to address the students' deficits from the assessment data with the goal of supporting students within each of the purposeful groups. Rotating students through stations that support their academic weaknesses minimizes the frustration that students often experience and can reduce behavior problems. Small group instruction in station teaching also encourages all students to take learning risks, defend their awareness when grappling with challenging content and questions that support the development of metacognitive thought processes.

A research study conducted by Fung and Tan (2018) explored the relationships between student engagement and mathematics achievement for fifteen-year-old students from 11, 767 secondary schools in 34 countries who participated in the Program for International Student Assessment (PISA) 2012. The PISA 2012 assessed students' mathematics literacy involving the ability to formulate situations mathematically, situate problem solving scenarios, employ mathematical concepts, facts, procedures and reasoning and interpret, apply, and evaluate mathematical outcomes. The research study defines student engagement as students' sustained motivation in their lifelong learning for improvement and development in the context of modern knowledge-based economies. The research study measured affective engagement, behavioral engagement and cognitive engagement. Affective engagement is based on students' emotions in the learning process and toward schooling. Affective engagement was measured by two variables including InterestMath, which measured students' positive attitudes toward different mathematics learning activities, and PerceptionSch, which measures students' perceptions on the contribution of school learning to different aspects of their life. Behavioral engagement relates to what the students do during instruction and in school. There were two variables to measure behavioral engagement, including BehaviorMath, which measured the extent to which students exhibited different behaviors facilitating mathematics learning, and ActivitiesMath, which measured the frequency to which students engaged in different mathematics learning activities at and outside school. Cognitive engagement is focused on students' perseverance to solve mathematics problems and the use of cognitive strategies when handling a lot of information in mathematics problem solving. The two variables used to measure cognitive engagement were Openness, which measured students' use of different cognitive strategies in solving mathematics problems and Perseverance which measured different behaviors underscoring students' perseverance in mathematical problem solving. The researchers found that components of students' engagement (affective, behavioral and cognitive) were individually related to their mathematics achievement. The results of the research study show that students who were more engaged had higher levels of academic achievement, with cognitive achievement having the strongest relationship with achievement. The results suggest that students need to be more actively engaged and be provided with more open and interesting learning environment where students could enjoy autonomy to enhance achievement.

According to Spisak (2014), learning stations promote collaboration, reinforce curriculum and provide students with a different atmosphere and learning experience. Collaborative learning builds positive classroom culture encouraging students to trust their own thinking rather than depending on the teacher.

Disadvantages of Learning Stations

There are several disadvantages or limiting factors when implementing learning stations, including funding, time and space. According to Olsen (1975), the planning and development of a learning station requires plans for spending and accounting money. Learning stations can be costly to maintain on a consistent basis when schools do not have the budget for materials. Another issue that may arise is accommodating and managing a larger number of students, which will require more stations and more space to accommodate all students effectively. When there are larger numbers of students at stations, classroom management can become an issue as well. Another obstacle that may arise is the amount of time it takes to set up, maintain and clean up.

Effective Implementation of Learning Stations

When introducing stations, setting expectations and goals for each station is important. To keep classroom management problems to a minimum, the teacher should make expectations clear at the outset (Jarrett, 2010). When designing stations, the instructions are important, especially when accommodating different grade levels and diversity in reading ability. The instructions can be illustrated with photos or diagrams, read to the students, or read by an advanced reader to classmates. Stations can be used in any order, as they are all related and provide students the opportunity to review, practice, and receive tips on how to decode the information in problems (Morehead & Grillo, 2013). Ediger (2011) suggests that each learning station have concrete, semi-concrete and abstract materials accessible to stimulate and motivate pupil learning. The concrete materials include objects, items and realia for pupils to learn from. The semi-concrete materials included slides, video, and computers, and the abstract learning materials include textbooks and workbook problems, worksheets, reading activities, writing experiences, listening/participating through discussions and recordings. Suprabha and

Subramonian (2014) suggests that students who benefit from concrete examples can participate in a station learning activity with concrete materials prior to moving on to more abstract concepts. According to Olsen (1975), learning stations can provide four types of instruction, including parallel classroom instruction, reinforcing a curriculum area, providing enrichment to various subject areas, or providing the framework for a unit correlating different subject areas. The stations are set up to support the needs of each group of students for which the mathematics teacher can customize support at each station (Morehead & Grillo, 2013).

The Impact of Learning Stations on Student Learning in Mathematics

According to Spisak (2014), with the utilization of learning stations, teachers see measurable growth in curriculum and critical thinking. Morehead and Grillo (2013) assert that station teaching provides co-teachers with both time and a method to successfully instruct smaller groups of students in the use of tools and content in any subject area but is particularly well suited to mathematics and science. Station teaching enables co-teachers to divide the content to parallel teach, thereby reducing student-to-teacher ratio. Stations can focus on reading, writing, or social skills depending on the targeted needs of individual students, while also providing support for a wide range of skills for all students (Suprabha & Subramonian, 2014). Vocabulary stations support developing content area literacy for students with reading problems who struggle in mathematics and science due to challenges with the vocabulary (Morehead & Grillo, 2013). Teachers can use content enhancement routines that support application of direct instruction to teach vocabulary in learning mathematics and science, along with research-based tools, including graphic organizers, concept maps, memory devices and scaffolding, that enable students to grow the content area vocabulary needed for rich dialogue involving mathematics and science content.

Station teaching can also be applied to differentiate high quality Tier 1 instruction within a response to intervention model. Within Tier 1 of a multi-tier approach, all students receive high quality, scientifically based instruction provided by qualified personnel (RTI Action Network, 2019). All students are screened periodically to establish an academic and behavioral baseline for identification of struggling learners who need additional support. The students requiring additional support through universal screenings and/or statewide or districtwide assessments receive supplemental instruction during the school day. Based on progress monitoring data, the identified students will return to class or move to Tier 2, where the instruction is matched to their needs and the intensity of instruction increases. By using stations, teachers are able to infuse best practices, targeted supports, and ongoing dialogue into instruction (Morehead & Grillo, 2013).

Morehead and Grillo (2013) suggest that the station teaching model is an effective way to teach secondary science and mathematics content while increasing student learning gains. A research study conducted by Hall and Zentall (2000) investigated the effects of a learning station on completion and accuracy of middle school students’ homework. The results of the study suggest, when using the intervention as designed, that the learning station improved the completion and accuracy of math homework for two of the three participants. The intervention was not beneficial for one participant because the participant did not use the learning station as intended.

Summary

Creating a learning environment to address the needs of all learners and give students choice to demonstrate their deeper understanding of course content is critical. According to Andreasen and Hunt (2012), differentiated math stations benefit every learner by taking into consideration the different ways that students learn mathematics and how they can show that knowledge. Learning stations let teachers choose where to interact with students. Educators are able to teach and re-teach students who need support and prompt students to synthesize at other stations. Mathematics educators must have a grasp of different evidence-based strategies, including learning stations, to engage students and differentiate math instruction.

CHAPTER III

METHODS

Design

This study is a true experimental design using a convenience sample and utilizing random assignment. The study was considered a convenience sample because the participants are students of the researcher. The participants were randomly chosen from one of the researcher's two different Algebra classes. Group A was assigned as the treatment group and group B as the control group. The participants in each group were given the same pretest and posttest.

Participants

The participants were selected from a public high school located in Anne Arundel County School District in Maryland. The participants are currently enrolled in a high school Algebra 2 co-taught math class, and the students are in 9^{th} through 12^{th} grade ages ranging from 16-18 years old. The total number of subjects in group A Algebra 2 class is 22 students, including 7 students with special needs. The total number of subjects in group B Algebra 2 class is 18 students with 4 students having special needs. The students with special needs have a 504 plan and Individual Education Plans with disabilities including specific learning disability (SLD), other health impairment (OHI), and autism (ASD).

Instrument

The instrument used for this study was a performance assessment aligned with the Anne Arundel County Algebra 2 curriculum. The assessment includes six questions, including true and false, multiple choice and word problems with rubric.

Procedure

The pretest will be administered to group A and group B, which are two different Algebra 2 classes. According to the pre-assessment, group A will be strategically grouped, and each sub-group will be placed at a different math learning station. Following the learning stations instruction, the posttest will be administered to group A. For group B, following guided instruction, the posttest will be administered. The treatment time will last for 2 weeks.

CHAPTER IV

RESULTS

Analysis of Data

This research study investigates the impact of learning stations on high school students' ability to solve linear systems of equations.

A pretest and posttest on linear systems of equations were given to 22 participants, group A, who received learning stations instruction, and 18 participants, group B, who received guided instruction. The null hypothesis that learning stations have no impact on high school students' ability to solve linear systems of equations was supported. A median test was used because the score change distributions were not both normal. The median test results indicated there was no significant difference based on pretest and posttest score changes between treatment and control group.

The research results are presented in the following figure and tables. Although group A station 2 had the highest growth, the median gain difference among the five approaches (4 stations and Group B) was not statistically significant ($p=0.322$) at 0.05 level. $p=0.87$, $p > 0.05$, There is also no statistically significant difference on score change between group A and group B ($p=0.87$) at 0.05 level. The figure and tables indicate the research results below.

Figure 1. Pre and Post Comparison Among Five Approaches

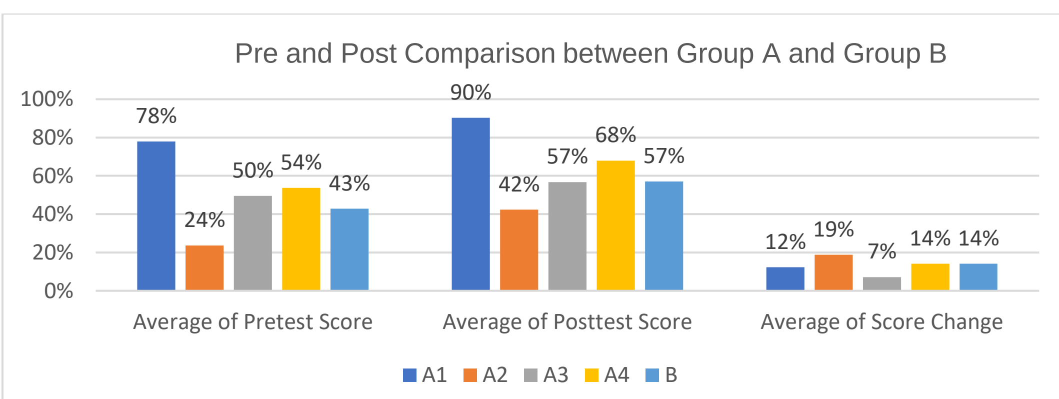

Table 1

Comparison of Score Changes between 2 Groups and 4 Stations

Statistics

Group and Station		**Pretest Score**	**Posttest Score**	**Score Change**
B	N	18	18	18
	Mean	43%	57%	14%
	Std. Deviation	19%	19%	14%
A1	N	4	4	4
	Mean	78%	90%	12%
	Std. Deviation	0%	4%	4%
A2	N	8	8	8
	Mean	24%	42%	19%
	Std. Deviation	11%	15%	20%
A3	N	5	5	5
	Mean	50%	57%	7%
	Std. Deviation	8%	14%	10%
A4	N	5	5	5
	Mean	54%	68%	14%

	Std. Deviation	11%	17%	10%

Table 2

Comparison of Score Changes between 2 Groups

Statistics

Group (A/B)		Group (A/B)	Pretest Score	Posttest Score	Score Change
A (Treatment)	N	22	22	22	22
	Mean		46%	60%	14%
	Std. Deviation		22%	22%	14%
B (Control)	N	18	18	18	18
	Mean		43%	57%	14%
	Std. Deviation		19%	19%	14%

CHAPTER V

DISCUSSION

This research study investigates the impact of learning stations on high school students' ability to solve linear system of equations. The null hypothesis that learning stations have no impact on high school students' ability to solve linear systems of equations was supported. Statistical analysis of the data indicated there was no statistically significant difference on score change between group A and group B in either approach used or between the 4 stations and group B.

Implications of Results

The results indicate that the learning stations instructional approach does not impact a high school student's ability to solve linear system of equations. This finding suggests that differences of scores are due to participants' different levels of academic ability. Therefore, suggesting that while higher and lower performing math students receive the differentiated learning station instruction, the cognitive ability of participants may be a factor in math achievement. This research study did not take into account factors that may affect math achievement including attention span, interest in mathematics and behavior toward testing which directly affect academic achievement.

Threats to Validity

In this research study, there were several threats to validity. This research study used convenience sampling, which was a selection of a small sample size from the researcher's classes. The classes were co-taught including students with learning disabilities and different cognitive ability levels. Thus, there may be difficulty generalizing the results of this research study to the entire population.

Another threat to validity of this research study was the learning stations instruction being conducted over a two-week period. The daily high school schedule in Anne Arundel County School District has students alternating an A and B day schedule which would only allow the students to receive the treatment every other day.

Connections to Previous Studies

There are previous research studies supporting station teaching to increase engagement and academic achievement.

Fung and Tan (2018) conducted a research study exploring the relationships between student engagement and mathematics achievement in secondary schools. The researchers found that it is more important for students to be cognitively than affectively or behaviorally engaged in their mathematics learning. The research results showed the more engaged students had higher levels of academic achievement.

Suprabha and Subramonian (2014) researched co-teaching models including station teaching and the effect on language learning. Their research found that the station teaching format has all the advantages of small group instruction and encourages a better understanding and deeper learning via lesson related discussions and/or activities. This research study concluded that there is a need to utilize various models of co teaching to increase effectiveness of the learning station model.

Finally, Hall and Zentall (2000) determined that learning stations to have a positive effect on accuracy of math homework for middle school students. The research study found that when students followed the learning station guidelines, math completion and accuracy improved.

Implications for Future Research

The student participants in this study had different levels of academic ability. In future studies the researcher could attempt to control the student sample by identifying students with similar academic abilities. At the same time considering and choosing students with similar stressors both inside and outside the school setting could be helpful, including but not limited to, academic course selections, academic course load, extra-curricular activities, socioeconomic status and parent involvement.

Researchers may find benefit in conducting the study using a larger sample size. This could be done using multiple groups if the sample size was much larger.

Summary

In summary, the results of the research study were not statistically significant, as there was not enough gain difference between the two instructional approaches. Further research involving the learning stations instructional approach should be conducted to support the research question.

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