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The Impact of Utilizing Non-Permanent Workspaces as a Formative Assessment Tool on Students' Outcomes and Attitudes Towards Mathematics in a Middle School Math Classroom

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Abstract

The present study investigated the effectiveness of utilizing non-permanent workspaces as formative assessment tools for middle school mathematics students in regard to their academic performance and feelings or attitudes towards mathematics. The researcher took two sections of eighth grade basic algebra students, and implemented the practice of utilizing non-permanent workspaces as formative assessment tools with one section, and similar formative assessment strategies with the other section of students, but without the non-permanent workspaces. The participants from both sections took a pretest and post-test to determine the academic effectiveness of implementing the non-permanent workspaces. The participants from both sections also completed an attitude survey in regard to their attitudes and feelings towards algebra after being taught either with or without the non-permanent workspaces. It was determined that the students who used the non-permanent workspaces both produced better mathematical results along with better attitudes towards mathematics.

Keywords: middle school mathematics, formative assessment, non-permanent workspace

CHAPTER 1

INTRODUCTION

Introduction

Grant Wiggins (2012), educator, author and former president of Authentic Education (a consulting, research and publishing company), once said, "Learners need endless feedback more than they need endless teaching" (p. 1). This quote is in support of the need for effective formative assessment in the regular education classroom. When considering the particular formative assessment strategies a teacher uses in their classroom, one must find the proper fit regarding their content and the group of students in which they are teaching. In the pursuit of providing better instruction to their students, the researcher of this study began utilizing non-permanent workspaces as a form of formative assessment. The researcher began to notice students gravitating towards working on the small whiteboards or apps on their iPads in which they could write and erase, rather than using their paper and pencils. Through this implementation and observations regarding non-permanent workspaces into their middle school mathematics classroom, the researcher was then curious about the impact of this particular formative assessment strategy on his students which led to the study that is provided within the content of this paper.

In the world of education, teachers are constantly looking for ways to help their students effectively learn the materials that are being covered. Formative assessment has been proven to be an effective tool in regard to students' success (Dunn & Mulvenon, 2009). A formative assessment is an informal assessment and teaching strategy, utilized by teachers to gauge where the students' current understanding regarding a specific topic is. Formative assessments are beneficial to both teachers and students, as it is beneficial for both parties to understand how well

they understand a given topic in a given moment under a structured, low-stress environment (Bakula, 2010). Given the benefits of formative assessments in a general sense, and based upon these statements, one can see how beneficial proper formative assessments could potentially serve a secondary mathematics classroom in particular. An increasing issue in mathematics education has been math anxiety (Luttenberger, Wimmer & Paechter, 2018). Anything secondary mathematics teachers can do to help reduce their students' potential math anxiety while still providing legitimate learning opportunities for their students should be considered. Looking for an effective formative assessment tool that serves a specific benefit in a mathematics classroom led to students working on non-permanent workspaces. In one particular study, students reported that they were more confident in their math abilities and felt more positive about the subject after the implementation and usage of non-permanent workspaces (McGregor, 2018). This all leads towards the included research regarding the impactfulness of students working on non-permanent work spaces as the use for formative assessment.

Brief Literature Review

There are many factors that come into play when considering what makes an effective formative assessment strategy. One such factor is immediate feedback. If students are given direct, immediate feedback on their mistakes, then they can begin recognizing and learning from their mistakes immediately (Mikes, 2021). Learning from one's mistakes is also proven to be one of the most effective ways to learn a new concept (Chialvo & Bak, 2008). If teachers are able to provide students an opportunity to learn in a way in which they receive immediate feedback and begin learning from the mistakes that they have made, the students may potentially see great outcomes from these learning opportunities. Utilizing non-permanent workspaces as a formative assessment tool fits in perfectly regarding this scenario. Another benefit to utilizing

non-permanent workspaces for students is that their work is officially non-permanent. Students experience less math anxiety and are more willing to make mistakes while working on non-permanent workspaces when compared to working on traditional surfaces (McGregor, 2018). Another piece of not only effective teaching, but more specifically, an effective formative assessment strategy is keeping the students engaged. If students are engaged in what they are doing in a classroom, whether it is an activity, game or hands-on learning opportunity, students are more likely to learn (Blazer, 2011). Again, working on non-permanent workspaces provides students with this opportunity. With support from the research and literature provided, the need for effective formative assessment strategies is evident for many reasons, and the research supports that using non-permanent workspaces as a formative assessment tool, could have positive impacts on students' learning.

Statement of the Problem

Many teachers use various forms of formative assessment strategies on a daily basis. Some of these particular strategies are naturally going to be more effective than others. The goal for all teachers should be to find specific formative assessment strategies that work best for their own teaching style, their particular group of students and the content in which they are teaching. In teaching mathematics, there are specific troubles concerning math students such as the aforementioned math anxiety and lack of confidence. Engaging students in their mathematics classrooms has also been a struggle for many math teachers across the country. The need for effective formative assessment strategies, combined with the specific problems that lie within most math classrooms such as math anxiety, lack of confidence and engaging students within the daily lessons, led to the provided research.

Purpose of the Study

Through firsthand experience, the researcher has noticed students gravitating towards working on non-permanent workspaces during work time rather than working on traditional surfaces (e.g., paper with a pen/pencil). Students have even asked to do their work on the non-permanent workspaces (in this case, small whiteboards) during tests and quizzes, rather than working on the paper. So clearly, there has been some draw from the students towards working on these non-permanent workspaces. This led the researcher toward utilizing the non-permanent workspaces more and more often during class, and particularly often utilizing them as a formative assessment tool while gauging and assessing how well the students knew a particular assignment without giving them a formal homework assignment, and before giving the students a summative assessment (quiz/test). This led the researcher towards the inquiry of whether or not the non-permanent workspaces were assisting the students and producing better results than if the students were not using the non-permanent workspaces.

Research Question

What impact does utilizing non-permanent workspaces as a formative assessment strategy in a middle school mathematics classroom have on student outcomes and their attitudes towards math class?

Definition of Variables The following are the variables of study:

- Independent variable: The independent variables in this study will be the usage of the non-permanent workspaces as a formative assessment strategy.
- Dependent variable: The students' outcomes. How well the students perform in class will be dependent on the change of formative assessment strategies.

Significance of the Study

The rationale for this research is the large, given amount of information surrounding the

importance of using effective formative assessment strategies in our classrooms, coupled with the specific problems that lie within many secondary mathematics classrooms such as math anxiety, low confidence, and engaging the students in the lessons. Students who experience math anxiety and/or low confidence in mathematics are proven to underachieve when compared to their peers who do not experience the same anxiety or lack of confidence (Pajares & Graham, 1999). Similarly, math lessons have been proven to be more effective if they are engaging to the students (Blazer, 2011). This research study will be of use to mathematics students and teachers alike as it combines the aforementioned issues within mathematics classrooms with the general need for well thought out formative assessment strategies and efficient feedback.

Research Ethics

Permission and IRB Approval

In order to conduct this study, the researcher sought MSUM's Institutional Review Board (IRB) approval to ensure the ethical conduct of research involving human subjects (Mills & Gay, 2019). Likewise, authorization to conduct this study was sought from the school district where the research project will be taking place (see Appendices D and E).

Informed Consent Letter

Protection of human subjects participating in research will be assured. Participant minors will be informed of the purpose of the study via the Method of Assent (see Appendix C) that the researcher read to participants before beginning the study. Participants were made aware that this study was conducted as part of the researcher's master degree program and that it will benefit their teaching practice. Informed consent means that the parents of participants have been fully informed of the purpose and procedures of the study for which consent was sought and that parents understood and agreed, in writing, to their child's participation in the study (Rothstein &

Johnson, 2014). Confidentiality was protected through the use of pseudonyms (e.g. Student 1) without the utilization of any identifying information. The choice to participate or withdraw at any time was outlined both verbally and in writing.

Limitations

Limitations of this study included the specific setting in which the survey was conducted, as well as the small sample size of students. A larger pool of students would likely produce more consistent and reliable results. Another limitation was the duration of the study, which lasted one week, a longer period of time could have produced different results. The natural parody between the two groups could have also played a factor in the results, as one section of students may have naturally been more inclined towards learning the specific lesson that was being taught, solving equations with the variable on both sides of the equal sign. The topic itself may have also contributed to these specific results.

Conclusions

There are several ways to promote greater student outcomes, and this should serve as one of the greater goals of all educators. Many teachers, as previously mentioned, implement several different teaching strategies and techniques intended to best serve their students. The research provided is aimed towards helping math teachers, and in turn, their students, through a specific formative assessment strategy that may help diminish specific issues that lie within math classrooms, and promote better student learning, achievement and outcomes.

CHAPTER 2

LITERATURE REVIEW

Introduction

The research included in this chapter supports the concept of using non-permanent workspaces as a formative assessment strategy in order to promote positive student outcomes and/or positive attitudes towards math class amongst middle school math students.

One way that teachers can promote better student learning is by providing their students with immediate feedback through formative assessments (Cherem, 2011). Utilizing formative assessments on a regular basis has been widely accepted as good teaching practice (Dunn & Mulvenon, 2009). Some formative assessment strategies teachers use to their advantage include exit slips, sample problems, think-pair-share and even handing out worksheets as practice for a particular topic. Recently, students working on non-permanent workspaces has become a trend in the world of secondary mathematics education, and there are more potential benefits to this new teaching strategy than what may originally meet the eye. Non-permanent workspaces could particularly be effective when used as a formative assessment tool. Utilizing non-permanent workspaces as a formative assessment tool refers to students working on a surface such as a large whiteboard on the wall, a small whiteboard, or on an iPad using an app such as PDF Expert, rather than sitting in their desk using traditional pen or pencil and paper to practice math problems within a daily math lesson. Utilizing non-permanent workspaces as a formative assessment tool could potentially have many positive impacts on the participating students including increased confidence and participation. According to authors Winters and Lynn (2020), students work in different ways and at different times, so true thinking experiences, then require varied learning spaces, or different options, for the students to work and learn. One of the

benefits of using non-permanent workspaces in the classroom, as mentioned earlier, is the benefit for both students and teachers towards utilizing non-permanent workspaces as a formative assessment tool. Formative assessment is vital to the learning that takes place within a classroom. The evaluation of what students know is a daily and dynamic process, in which a teacher must be mindful of in order to guide their instruction (Menendez, et. al., 2019). One of the benefits of using the non-permanent workspace as a formative assessment tool is that teachers are able to oftentimes give students immediate feedback, which is an essential piece of effective formative assessment (Mikes, 2021). If a student is given the opportunity to recognize whether or not they are doing a problem correctly immediately, then they can begin the process of learning from their mistakes. Learning from mistakes, as noted by authors Dante Chialvo and Per Bak (2008), is one of the most effective ways for a developing brain to learn. The other benefit of utilizing non-permanent workspaces as a formative assessment tool that is discussed within this research is the fact that the students' work is non-permanent. Rather than the traditional method of a student working on a paper with pen or pencil, in which their old work can still be seen, on a non-permanent workspace, a student can simply "wipe away" their old work and start with a clean slate. This process of a student's work no longer being permanent, is found to help relieve students of their math anxiety (McGregor, 2018).

Non-Permanent Workspaces

The man who is credited with the rising popularity of students working on non-permanent workspaces, and specifically vertical non-permanent workspaces, is Peter Liljedahl. Liljedahl, with other educators, created what they called The Thinking Classroom. One of the goals of Liljedahl's Thinking Classroom was to create a secondary mathematics learning space which was hands-on, interactive and even fun, at times (Winters & Lynn, 2020). When

describing the purpose of the Thinking Classroom, Liljedahl (2021) stated, “Thinking is a necessary precursor to learning, and if students are not thinking, they are not learning” (p. 2). Specifically, The Thinking Classroom promotes student engagement, collaboration and active learning through particular teaching methods and classroom activities. The non-permanent workspace was a key component to Liljedahl’s concept. The idea behind a non-permanent workspace, as mentioned above, is that students have the opportunity to work out a problem and then get rid of their work as needed. In one particular study, students reported that they were more confident in their math abilities and felt more positive about the subject after the implementation and usage of non-permanent workspaces (McGregor, 2018).

Need for Effective Formative Assessment

Formative assessment is a necessary piece to most successful classrooms. Formative assessment generally refers to a wide range of methods teachers use to check-in with their students where they are regard to learning the material being taught in class. According to Wiliam (2011), the difference between formative and summative assessments can generally be described as formative assessment is “assessment for learning” and summative assessment is “assessment of learning” (p. 10). It has been found that effective formative assessment techniques can help build student confidence (Hattie & Timperley, 2007). Having confidence in mathematics can have a major effect on how well students do in their mathematics courses and the learning that takes place within them. If students are not confident in mathematics, when they get to a more complex problem that takes more effort to figure out, they will oftentimes not attempt the problem (Clarke et al., 2014). Students with this lack of self-efficacy are then proven to have lower math achievement (Pajares & Graham, 1999). Conversely, students who are

confident in their mathematical abilities, tend to achieve higher test scores than their peers with low confidence (House & Telese, 2014).

One of the key components to effective formative assessments is the feedback component (Jean & Mandernach, 2005). If students are not given proper and timely feedback, particularly in a math class, then the students will not have a base off of which they can build more knowledge. As Shute (2008) stated, "The premise underlying most of the research conducted in this area is that good feedback can significantly improve learning processes and outcomes, if delivered correctly" (p. 154). Formative assessments, particularly formative assessments utilizing non-permanent workspaces, can be utilized by teachers as an effective way to provide students the clear, quick and accurate feedback on their responses that they need, in order to learn.

Learning From Mistakes

While in the formative stages of learning new content, students will oftentimes, and inevitably, make mistakes. However, in terms of formative assessments, educators can help students view their mistakes in these formative stages as opportunities, rather than failures (Bostock, 2000). Failures in turn, can be used as building blocks for future successes. As Ingram (2008) stated, "Making mistakes is an integral part of learning mathematics and many recent initiatives have advocated teachers using mistakes in their teaching" (p. 1). If a teacher can effectively create a classroom environment and culture that appreciates and embraces learning from mistakes, students could see great benefits. This type of classroom culture would also increase students' confidence. The students would see that making mistakes does not mean that they are "not smart" but they are rather creating a base level towards a deeper understanding through trial and error (Dweck, 2008). While using non-permanent workspaces in math class, students were more accepting of making mistakes since their mistakes were non-permanent.

Keep the Students Engaged

Student participation and engagement is another key component to an effective classroom in regard to student achievement. Research has proven that teachers need to encourage active learning (Michael, 2006). Students must be engaged in what they are learning through doing, asking questions, answering questions and collaborating with one another, rather than simply sitting and listening. Math lessons tend to be more effective if teachers incorporate games and activities to engage their students with the material and the lesson (Blazer, 2011). Utilizing non-permanent workspaces as a formative assessment strategy kept students engaged with their daily lessons.

Theoretical Framework

The concept behind learning from utilizing non-permanent workspaces as a formative assessment tool can largely be related to the Cognitive Learning Theory. The development of the Cognitive Learning Theory has been deeply linked to Jean Piaget (Huitt & Hummel, 2003). Through this learning theory, it is believed that students learn by not only receiving new information, but they learn through reorganizing the information they had already learned either with new information or by adapting the old information that they had learned (McLeod, 2003). This can be related to the work that students do on their non-permanent workspaces. Once the students know whether or not they got a problem correct, they can then either wipe the slate clean and try to learn from their mistakes based on the new information that they learn or feedback, or modify their old answer, if they were not completely wrong. This constant process of applying new information to their prior knowledge and building towards a better understanding is well supported by the students using non-permanent workspaces as a formative assessment tool.

Research Question

What impact does utilizing non-permanent workspaces as a formative assessment strategy in a middle school mathematics classroom have on student outcomes and their attitudes towards math class?

Conclusion

Utilizing non-permanent workspaces as a formative assessment tool has the potential to serve a great benefit to secondary mathematics students. As discussed, formative assessment along with timely and meaningful feedback to students are essential pieces to student learning. Through the use of non-permanent workspaces as a formative assessment tool, it also provides the teacher an opportunity to create a classroom environment in which students take risks, attempt problems they may not know how to do, and learn from their mistakes. Lastly, the utilization of non-permanent workspaces as a formative assessment tool can provide the teacher an opportunity to formatively assess their students in the form of a game or activity which could also serve to benefit their students.

CHAPTER 3

METHODS

Introduction

Based upon the strong support of evidence found for the necessity of effective formative assessment strategies, efficient feedback for students and the potential benefits of students working on non-permanent surfaces, the researcher determined to conduct an action research study regarding the effectiveness of utilizing non-permanent surfaces as a formative assessment strategy in a secondary mathematics classroom. Teachers are constantly looking for ways to promote student learning, and the study provided is aimed towards providing teachers with another strategy to utilize in their classrooms based upon the given results of the research conducted. In order to determine the effectiveness of utilizing non-permanent surfaces as a formative assessment strategy, research was conducted through teaching two separate sections of 8th Grade Basic Algebra (Prealgebra). Both classes received the same teaching instruction, however one class participated in particular activities in class on non-permanent workspaces, while the other group of students participated in the same activities with paper and pencil. More details and the results are provided in the rest of this chapter.

Research Question

What impact does utilizing non-permanent workspaces as a formative assessment strategy in a middle school mathematics classroom have on student outcomes and their attitudes towards math class?

Research Design

Determining the best way in which to test the benefits of a specific formative assessment strategy proved to be difficult for the researcher. After brainstorming and researching the best

way to attempt this, it was determined that a quantitative approach was best. The teacher taught two sections of the same class, being 8th Grade Basic Algebra. Based on this information, the researcher decided to teach both classes the same topic, while one class received the instruction with activities incorporating non-permanent workspace based formative assessments, while the other class received the same instruction, however the same formative assessment techniques were based on permanent workspaces (paper and pencil/pen). It was determined that the data needed to be carefully analyzed, which is explained in more detail in the "data collection" section below. According to Mills (2018), a consideration for teachers while gathering quantitative data is to utilize teacher-made tests and attitude scales. These are the two particular strategies used in gathering the provided data. The teacher-made tests were used to gauge the students' understanding of the topic that was taught, and the attitude scales provided valuable information regarding the students' attitudes regarding the non-permanent workspace based formative assessments. The data was then analyzed to determine the effectiveness of the researcher utilizing non-permanent workspaces as a formative assessment strategy based on the student outcomes and the students' responses to the attitude scales.

Setting

The study was conducted in a rural town in northeastern Minnesota. The school building in which the research was conducted houses students in grades 7-12 in which there are 361 total students. The population of the town in which the school is located is 649. The school also draws students from neighboring small towns. The most common employment opportunities in the area are working in the trades, nearby plants, and local hospitals and jails. It is not a very diverse community. Out of the school's 361 students, 84.8% of the students are Caucasian, 11.4% identify as two or more races, and 2.2% are Hispanic or Latino. Beyond that, there are two

students each regarding American Indians, Asians and African-Americans. In the school, 23.3% of the students receive free or reduced lunches and 14.1% of the students receive special education services. The town's makeup could widely be considered to be lower middle class, and there is a great sense of community and pride within the school district.

Participants

There were a total of 34 students who participated in the study, two sections of 17 students each. Thirty-five percent of the students were male and 65% were female. Out of the 40 students, all 40 were Caucasian. Additionally, out of the 40 students in the study, two of them were receiving special education services, one in each class. The makeup of the two classes compared similarly with one another.

Sampling

A convenience sample was used in this study. As described by Elfil & Negida (2017), "It is called convenient sampling as the researcher selects the sample elements according to their convenient accessibility and proximity" (para. 8). The group of students involved in the study were the students that were taking the course at the time the research was being conducted.

Instrumentation

There were three particular instruments used in this study. The first two were the teacher-made pre-test and post tests. The third instrument used was an attitude scale used to gauge the students' attitudes towards their mathematics course (Appendix B). This instrument was used for both groups of students after the unit in which non-permanent workspaces was incorporated in class.

Data Collection

In terms of student outcomes, data was collected by using a pretest and a post-test for both groups of students and then comparing the sets of data. Various considerations came into play when determining the way in which data was collected. A pretest/post-test analysis was decided upon due to the nature of teaching all of the students the same topic with the consideration that the makeup of the two sections of students was very similar. Other than student outcomes, the researcher also wanted to gather information from the students regarding how they viewed different aspects of mathematics after using non-permanent workspaces. Both Group A and Group B were given the same Attitude Scale-based survey after the targeted unit was taught.

Data Analysis

After gathering the data as mentioned above, an average quiz score was generated for the entire class. The classes' average quiz scores were compared from Group A to Group B to determine whether or not utilizing non-permanent workspaces as a formative assessment strategy produced better student outcomes than the students performing the same activities on permanent workspaces. For example, if Group A's average quiz score was higher than Group B's, one could suggest that the non-permanent workspaces proved to be beneficial to student outcomes. Conversely, if the differences were similar between the two groups, then one could conclude that the non-permanent workspaces did not have a considerable effect on student outcomes.

The students' attitude scale scores were compared between Group A and Group B. The results of the attitude scale implied whether or not the particular teaching strategy during this targeted unit had an impact on the students' attitudes towards their math class. If the scores were higher for either group after the targeted unit, then the formative assessment enhanced the attitudes of students towards mathematics. And conversely, if the scores were lower for either

group after the targeted unit, then the formative assessment hindered the attitudes of students towards mathematics. Again, the researcher compared the results of Group A to Group B to make a conclusion based on data.

Research Question and System Alignment

Table 3.1.

Research Question Alignment

Research Question	Variables	Design	Instrument	Validity & Reliability	Technique (e.g., interview)	Source
What impact does utilizing non-permanent workspaces as a formative assessment strategy in a middle school mathematics classroom have on student outcomes and their attitude towards mathematics?	IV: Utilizing non-permanent workspaces as a formative assessment strategy in class instruction. DV: Student outcomes and attitudes towards mathematics.	Quantitative data collection and analysis.	Table of Student Outcomes Attitude Scale	The differences between students' average quiz scores and targeted quiz scores were calculated and compared. Attitude Scale scores were given before and after the targeted unit for each group and then analyzed.	Comparing quantitative data between the two groups of students.	Two eighth grade classrooms with students in the researcher's class. Student total: 40

Procedures

One section of Basic Algebra students served as Group A (the group who works on non-permanent workspaces during formative assessment activities) and the other section of

students served as Group B. The average quiz scores of each individual student were calculated up until the point in which this study occurred, and then a Group Average was calculated for both Group A and Group B. These scores served as a baseline for this study. After teaching the targeted unit to both groups, a unit quiz was administered for each group. The students' quiz scores were again calculated. Additionally, each group of students completed an attitude scale-based survey before and after the targeted unit. Similarly the changes and differences of the attitude scale scores between the two different groups were analyzed.

Ethical Considerations

To protect the participants of this study, each participant was provided and turned in an informed consent form for their parents. Additionally, all students who participated in the study were kept anonymous by replacing students' names with "Student 1A", "Student 2A", etc. The results of the data collected were used for no more than the purposes of this particular study. No risk or harm of any kind was intended throughout this study and the activities conducted throughout this study were similar activities that would have taken place on a daily basis within the mathematics classroom.

Conclusions

The research design was carefully thought out in order to best serve the researcher's mathematics students. Through several considerations, the research included was conducted in a thorough and reasonable manner which produced legitimate and meaningful results. In the next chapter, the researcher provided the results from the study.

CHAPTER 4

DATA ANALYSIS AND INTERPRETATION

Introduction

The research conducted was to gain an understanding of the potential benefits regarding a specific teaching strategy, utilizing non-permanent workspaces as a formative assessment tool in a middle school mathematics classroom. Two sections of the same course, eighth grade Basic Algebra (pre algebra), were taught the same topic of solving equations with the variable on both sides of the equal sign. One section of students, Group A, received instruction with the use of non-permanent workspaces (small whiteboards) as a formative assessment tool, while the other section of students, Group B, received similar instruction with similar formative assessment strategies that were conducted on permanent workspaces (paper with pencil/pen). All of the students from each section had just finished learning about solving multi-step equations in which there was only a variable present on one side of the equal sign. Through the use of a teacher-made pretest/post-test and a survey, the results are presented in this chapter.

Data Collection

The data collected was completed through the use of a pretest/post-test, along with a survey regarding the students' attitudes towards algebra. The data collected was done so over one week of class time. On Monday, a pretest was conducted to determine the students' knowledge regarding the topic that would be taught, solving equations with variables on each side of the equal sign. No students from either section of classes got any of the problems correct on the pretest, determining that none of the students had prior knowledge as towards how to solve the type of equation that was taught the rest of the week. Tuesday through Thursday lessons were conducted, including notes and various formative assessment activities conducted

with each section of students. The students in Group A conducted their work and participated in the formative assessment activities using small whiteboards (a non-permanent workspace). Students in Group B participated in similar formative assessment activities, conducting their work on paper, with a pen or pencil (permanent workspaces). After the lesson on Thursday, students completed a survey displaying their feelings at that moment about algebra. In this survey, students were given two words on a scale from 1-7 (e.g. hard (1) and easy(7)), and they selected the number between 1-7 to describe their personal feelings about algebra. On Friday, the students were given a post-test to display what they had learned throughout the week.

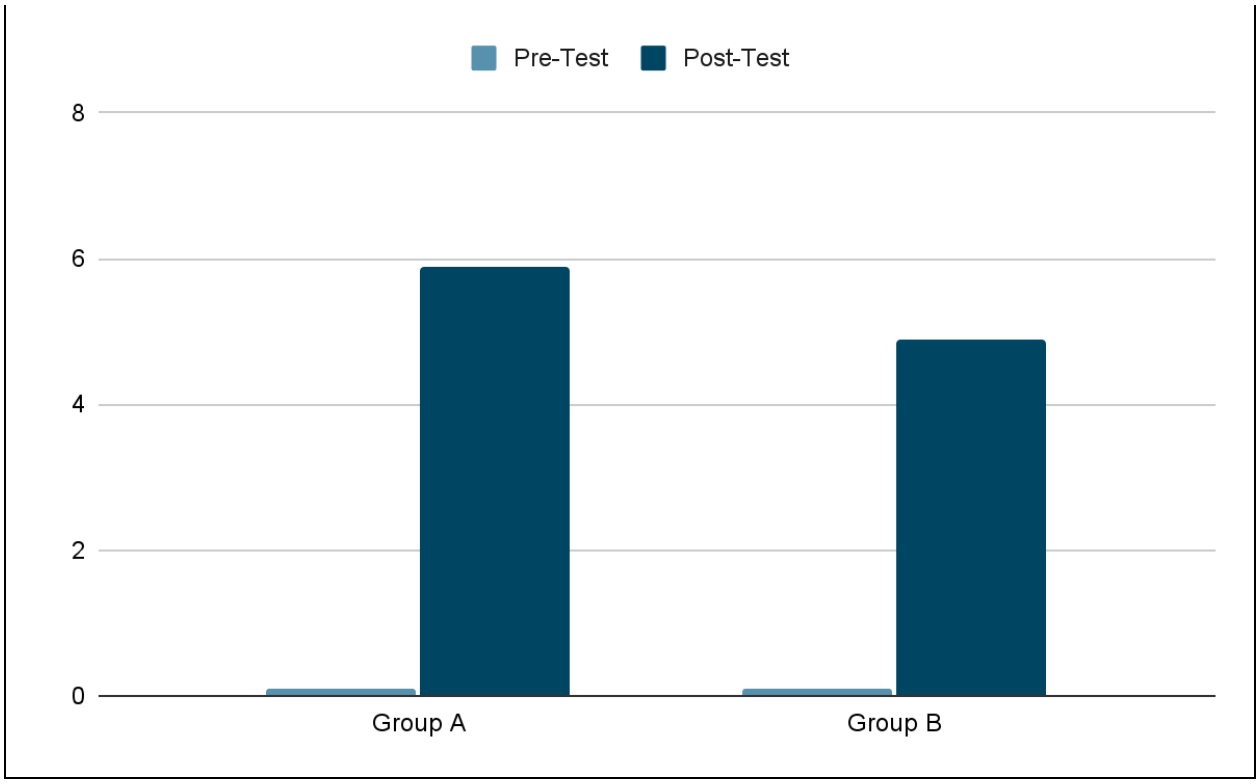
The data presented in this chapter reflects the students' comparative pretest and post-test results, as well as the results from the attitude survey between students from Group A and Group B.

Results

Research Question: What impact does utilizing non-permanent workspaces as a formative assessment strategy in a middle school mathematics classroom have on student outcomes and their attitudes towards math class?

Table 1 represents the average pretest and post-test scores for students from both Group A and Group B. Both tests had eight total questions, and the average score shows the average amount of questions students from each group answered correctly. The average score for both groups on the pretest was zero, as none of the students answered any of the questions correctly on the pretest. The students from Group A then answered an average of 5.9 questions correctly on the post-test, while students from Group B answered an average of 4.9 questions correctly.

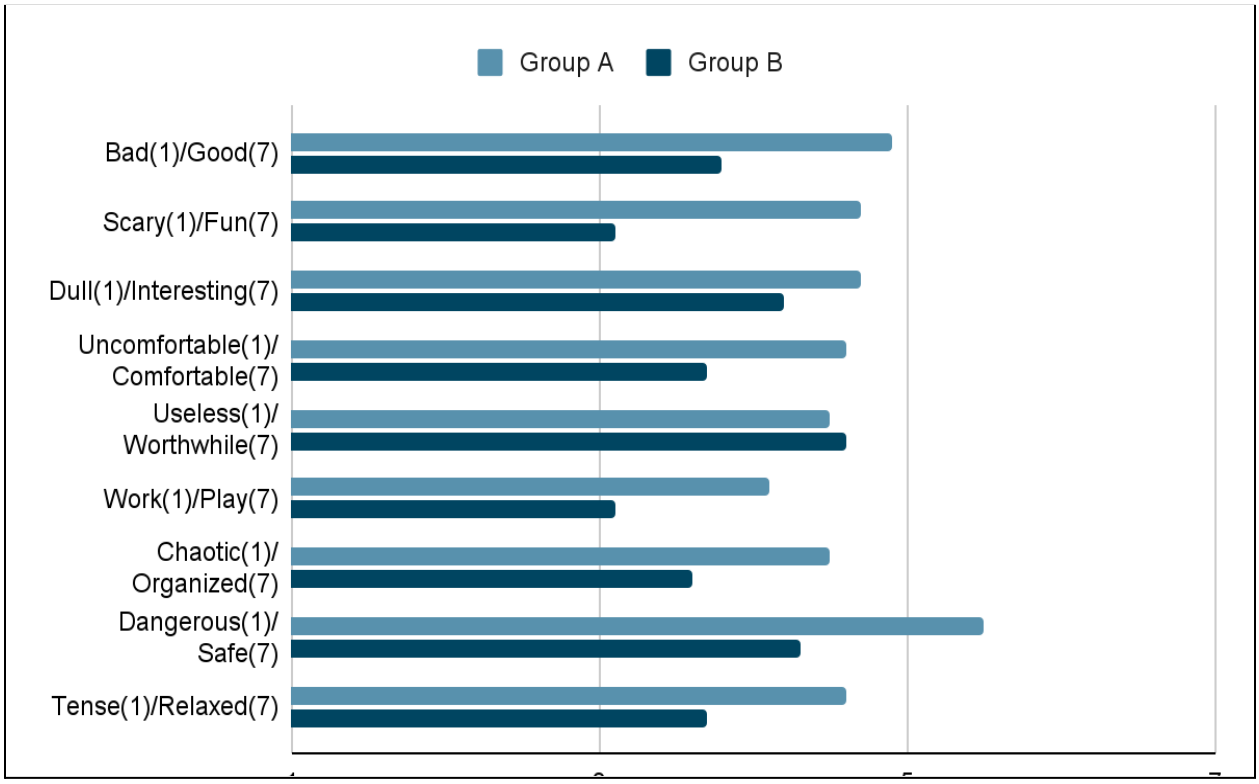
Table 1: Pretest and Post-Test Scores



In Table 2 below, the results from the attitude survey are shown. Students were given two words on a scale, and were to rate how they felt between those two words between 1-7 when the two words were put on either end of the scale. For example, the first two words were “good” and “bad”, with “bad” being 1 and “good” being 7. So if a student rated their response as a 1, that would show that they thought algebra was bad, and vice versa. The table below shows the average rating for each pair of words for both Group A and Group B.

Table 2: Attitude Survey Averages

Pair of Words	Group A	Group B
Bad(1)/Good(7)	4.9	3.8
Scary(1)/Fun(7)	4.7	3.1
Dull(1)/Interesting(7)	4.7	4.2
Uncomfortable(1)/ Comfortable(7)	4.6	3.7
Useless(1)/ Worthwhile(7)	4.5	4.6
Work(1)/Play(7)	4.1	3.1
Chaotic(1)/ Organized(7)	4.5	3.6
Dangerous(1)/ Safe(7)	5.5	4.3
Tense(1)/Relaxed(7)	4.6	3.7



Data Analysis

The results above suggest two potential outcomes from this research: students had better academic performance when utilizing non-permanent workspaces as a formative assessment strategy, and the use of non-permanent workspaces as a formative assessment strategy also promoted more positive student attitudes towards algebra.

Seeing as how none of the students present in the study answered any of the pretest answers correctly, that suggested that none of the students in either Group A or Group B had prior knowledge regarding the topic that was taught during this study. Then when Group A outperformed Group B, answering an average of 5.9 questions correctly compared to 4.9 questions correctly, one could consider that the use of non-permanent workspaces during the lessons throughout the week may have had an impact on the two groups. As Dweck (2008) suggested, students can produce better results when they are willing to learn from their mistakes. Through the researcher's observations, as the students in Group A worked on the non-permanent workspaces, they were very quick to wipe away a problem that they had messed up on while working on their small whiteboards once they realized what they had done wrong, and then try it again. This was a very different attitude when compared to their peers in Group B who generally would get a problem wrong, and then just wait to try the next problem. The process of recognizing their mistakes, and then trying to correct their mistakes likely had a positive impact on the outcomes of students from Group A.

The results from Table 2 also suggest that students generally had more positive attitudes towards algebra after a week of using non-permanent workspaces in class when compared to the students who worked on more permanent workspaces. According to the results present in this study, students in Group A considered math to be more fun, comfortable, organized and safe when compared to the students in Group B. This supports what Blazer (2011) suggested, in regard to the importance of keeping students engaged within a math lesson. The students working on non-permanent workspaces reportedly had more fun and math felt slightly more like play when compared to work, when compared to students in Group B. Keeping students engaged through what seem like game-like learning activities can be a great way to promote student

success (Blazer, 2011). Having a positive attitude towards math can only promote positive student outcomes with middle school math students.

Recommendation for Future Research

The results produced from this study are relative only to the setting of this particular study which is a limitation of the generalizability of this study. Future researchers may consider a larger sample size of students to conduct this study on. The fact that these were only two sections of students in one particular school is another limitation to the results of this study. Students in one class or the other may have already been stronger math students than in the other class, or may have already had better attitudes towards algebra when compared to their peers in the other section of Basic Algebra. Another consideration to get a better understanding of the results of this study would be to conduct this study for a longer period of time, and/or with a different topic taught.

Conclusion

Based on the results from this study, utilizing non-permanent workspaces as a formative assessment tool is a way to promote better student outcomes, both in terms of students' success and students' attitudes towards algebra. There were some limitations to this particular study, however, there are still meaningful results to support this conclusion, along with the research provided.

CHAPTER 5

IMPLICATIONS FOR PRACTICE

Introduction

The purpose of this study was to determine the effect of utilizing non-permanent workspaces as a formative assessment strategy on middle school mathematics students. Through the research from the experts, along with the results produced by this study, it is suggested that student outcomes are positively related to the use of non-permanent workspaces as a formative assessment tool.

Action Plan

Utilizing the small whiteboards (non-permanent workspaces) will continue to be a larger part of the learning process within my classroom. Students enjoy working on them, look forward to working on them, and through the results of this study, are suggested to benefit from working on them. They are a versatile tool, as students can work on them alone, with a partner or in a small group which can all serve a purpose within a mathematics classroom. I hope to get more whiteboard spaces on the walls in my classroom to further explore the potential possibilities and benefits of non-permanent workspaces in a mathematics classroom.

Plan for Sharing

I will share the results of my study with my colleagues as well as the mathematics teachers in my neighboring districts. I will consider sharing the specific formative assessment strategies I use with non-permanent workspaces at our local district workshops, and potentially at the Minnesota Council of Teachers of Mathematics Conference, as they are always looking for teachers to share their personal teaching strategies that may have positive outcomes for their mathematics students.

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Appendix A

Informed Consent Letter

Dear Parent or Guardian,

Your child has been invited to participate in a study to determine if a particular teaching strategy is beneficial to our mathematics students at Barnum High School. We are trying to determine if utilizing non-permanent workspaces will produce better mathematics results and/or greater attitudes towards mathematics.

Your child has been selected to participate due to the fact that they are in my regular education classroom. Participation is voluntary and that choosing not to participate will not attract any penalty and also the participants may withdraw their participation at any time without any penalty. If you decide to participate, please know that your child will be asked to do the following; these are typical classroom activities that involve no academic or emotional risk to your child. Your child will either be in Group A, participating in classroom activities that involve non-permanent workspaces, or Group B, participating in similar classroom activities that do not involve non-permanent workspaces. Your student's score on an end of the unit quiz will be analyzed to determine the effectiveness of this particular teaching strategy. Your student will complete an attitude scale survey after the lesson to determine the effectiveness of this particular teaching strategy on students' thoughts and attitudes towards mathematics.

Principal Jodi Fanth has already granted me permission to conduct this study in my classroom. Since this information is being used as part of my completion of my Master's Degree from Minnesota State University - Moorhead, I am additionally required to seek the permission of my students' guardians in order to use the information gathered in my final paper that I am required to do as part of my degree. Please remember, that this study will in no way hinder your student's learning, and by participating in this study, could provide myself and our other math teachers with beneficial information towards teaching our students here at Barnum High School.

Please feel free to contact me with any questions you may have regarding this study. You may reach me here at school 218-389-3273 ext. 1106 or by email at rminkkinen@isd91.org.
You may also contact Principal Investigator Dr. Tiffany Bockelmann at 218-780-0757, or by email at tiffany.bockelmann@mnstate.edu. Any questions about your rights may be directed to Dr. Robert Nava, Chair of the MSUM Institutional Review Board, at 218-477-4308 or by email at irb@mnstate.edu.

By signing below, you are making a decision whether or not to allow your child to participate. Your signature indicates that you have read the information provided above and have decided to allow your student to participate.

Name of Student (print): _____

Parent/Guardian (signature): _____ Date: _____

Appendix B
Attitude Scale-Survey

The following survey is a modified version of the Attitude to Subject of Chemistry Inventory by Christopher F. Bauer of the University of New Hampshire, and I found this while peer reviewing Wade Hukriede's Methods Chapter in ED 603. (the word chemistry was changed to algebra)

A list of opposing words appears below. Rate how well these words describe your feelings about **algebra**. Think carefully and **try not to include** your feelings toward math teachers or math course. For each line, choose a position between the two words that describes **exactly how you feel**. The middle position (4) is if you are undecided or have no feelings related to the terms on that line.

Algebra IS

1. Bad	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Good
2. Scary	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Fun
3. Dull	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Interesting
4. Uncomfortable	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Comfortable
5. Useless	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Worthwhile
6. Work	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Play
7. Chaotic	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Organized
8. Dangerous	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Safe
9. Tense	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Relaxed
10. Insecure	|_ 1 _|_ 2 _|_ 3 _|_ 4 _|_ 5 _|_ 6 _|_ 7 _|	Secure

Appendix C

Method of Assent

The students involved in this study were told what would be conducted in their classroom, assured that there was no risk involved to them and signed the consent form, along with their parent/guardian. Students were also made aware that participation is voluntary and that choosing not to participate would not attract any penalty and also the participants may withdraw their participation at any time without any penalty.

Appendix D

IRB Approval

Institutional Review Board

MINNESOTA STATE UNIVERSITY MOORHEAD

DATE:	December 2, 2021
TO:	Tiffany Bockelmann, Ed.D, Principal Investigator Robert Minkkinen, Co-investigator
FROM:	Dr. Robert Nava, Chair Minnesota State University Moorhead IRB
ACTION:	**APPROVED**
PROJECT TITLE:	[1833344-1] The Impact of Utilizing Non-Permanent Workspaces as a Formative Assessment Tool on Students' Outcomes and Attitudes Towards Mathematics in a Middle School Math Classroom
SUBMISSION TYPE:	New Project
APPROVAL DATE:	December 2, 2021
EXPIRATION DATE:	
REVIEW TYPE:	Exempt Review

Thank you for your submission of New Project materials for this project. The Minnesota State University Moorhead IRB has APPROVED your submission. This approval is based on an appropriate risk/benefit ratio and a project design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

This submission has received Exempt Review based on the applicable federal regulation.

Appendix E

District/Administrator Approval

3675 County Road 140
Barnum, MN 55707

Dear Mrs. Fanth,

I plan on conducting a study to determine whether a particular teaching strategy is beneficial to our mathematics students at Barnum High School. I am trying to determine if utilizing non-permanent workspaces will produce better mathematics results and/or greater attitudes towards mathematics.

If you grant me permission to conduct this study, please know that our students will be asked to do the following. These are typical classroom activities that involve no risk to our students. The students will either be in Group A, participating in classroom activities that involve non-permanent workspaces, or Group B, participating in similar classroom activities that do not involve non-permanent workspaces. The students' scores on an end of the unit quiz will be analyzed to determine the effectiveness of this particular teaching strategy. The students will also complete an attitude scale survey after the lesson to determine the effectiveness of this particular teaching strategy on students' thoughts and attitudes towards mathematics.

Again, I am seeking permission to conduct this study in my classroom as part of my completion of my Master's Degree from Minnesota State University - Moorhead. Please remember, that this study will in no way hinder any student's learning, and by participating in this study, could provide myself and our other math teachers with beneficial information towards teaching our students here at Barnum High School.

Please feel free to contact me with any questions you may have regarding this study. You may reach me here at school 218-389-3273 ext. 1106 or by email at rminkkinen@isd91.org.

Below you are making a decision whether or not to allow me, Robert Minkkinen, to conduct this study at Barnum High School.

Name (print): Jodiann Fanth

Signature: Jodiann L Fanth Date: 11/4/2021