

THE USE OF MATH JOURNALS TO IMPACT THE MATHEMATICAL WORD PROBLEM
SOLVING SKILLS OF SELF-CONTAINED MIDDLE SCHOOL
SPECIAL EDUCATION STUDENTS

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Submitted in partial fulfillment of the requirements

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by

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William Paterson University

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Self-Contained Middle School Special Education Students

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ABSTRACT

This study investigates the impact of incorporating writing, specifically through math journals, on the problem-solving skills of middle school self-contained special education students. This study is intended to answer the question of how the utilization of a math journal impacts the problem-solving skills of middle school self-contained special education students when addressing math word problems.

Motivated by the need to instruct students on mathematical problem solving strategies and address low standardized testing scores in mathematics, the study proposes a Daily Math Journal intervention to enhance critical thinking and writing skills. The central research question revolves around understanding how the utilization of math journals influences the problem-solving skills and perceptions of special education students when solving mathematical word problems. The study examines the research question using a mixed method approach to data collection and analysis.

Educationally, the study offers insights for teachers, highlighting the advantages and challenges of using math journals to enhance problem-solving abilities. The findings underscore the cognitive benefits of expressing critical thinking through writing and engaging in collaborative discussions, extending beyond the mathematics classroom.

Through this investigation, three key conclusions emerge: (1) Math journal use increases student engagement and enjoyment in solving mathematical word problems, (2) students' attitudes and confidence levels improve, and (3) problem-solving in mathematical word problems is positively influenced by incorporating writing in math journals. The research highlights the need for further investigation on this topic and the conclusions of this study and underscores the advantages associated with integrating writing into mathematics instruction.

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To my grandparents, who loved me, chose me, and believed in me enough to help me believe in me too. To my children, you are my why. Your love and support are everything to me. Thank you.

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CHAPTER 1

Statement of the Problem

Introduction

Writing is an essential skill across the curriculum, as it facilitates the thinking and expression of complex ideas. Additionally, it promotes communication and a sharing of ideas, which fosters increased understanding of the material. According to the National Institute for Literacy, research supports the idea that improving students' writing skills will improve their overall ability to learn (2007). Using writing as a tool for students to solve problems and become self-aware of their learning process can prompt students to elevate their thinking and look at problems more critically. Therefore, writing should be viewed as a tool to be used across all content areas, and for the purpose of this research, specifically within mathematics. Doing so would enhance the abilities of students to think more critically about mathematical problems and achieve a better success rate in problem-solving. (National Institute for Literacy, 2007).

Schools across the United States agree, as this thinking is supported by the development of the Common Core State Standards, which were designed (and adopted by most states in the United States) to provide more rigorous benchmarks in reading, writing, and mathematics across all grades. These standards were designed to incorporate writing into all areas of the curriculum. The use of writing across the curriculum offers students a wider variety of topics and situations in which to write and may enhance their overall writing ability while at the same time elevating their thinking in specific content areas.

The researcher's school district is actively looking for ways to improve scores on standardized testing, particularly in math. In this district, academic committees have been formed

to examine methods to help improve test scores. Although Greatschools.org (2023) indicates NJSLA state testing scores at this school district are slightly below the state average in both ELA and Mathematics, they report these scores to be well below the top performing schools in this state, and that these scores could indicate that many students are not performing at grade level. Addressing this issue could involve integrating writing throughout the curriculum, offering numerous chances for the refinement of writing skills. Additionally, another approach could be to teach students how to understand and apply strategies when solving mathematical word problems.

Ray et. al remind us that learning is multifaceted for middle school students, and that applying a variety of writing styles can help students learn about a variety of concepts in a more analytical style (2016). In the researcher's classroom experience, special education students are often particularly hesitant to attempt mathematical word problems independently, and when they do, they are often incorrect on even very basic problems. This lack of success can negatively impact their inclination to attempt this type of problem. As a class, this group will often work on word problems referred to as "Problem of the Day" as a group, and we identify keywords within the problem that can help solve the problem. The students have a much greater success rate when we work on problems in this way, and they can share ideas and listen to each other's thought processes. However, the researcher has identified a need to identify strategies to better equip students to know how to solve mathematical word problems.

Therefore, implementing a Daily Math Journal in a middle school self-contained special education math class could be an exceptional way to encourage students to enhance their problem-solving skills. Offering a mathematical word problem to be analyzed in a daily journal can be a way to facilitate conversation among students, where they could share their thoughts

and rationale for the choices they made while utilizing the journal format. As students improve with this strategy, they may collaborate or share their thinking on solving the problem correctly. Writing should be a social event, where students can feel safe to share their thought processes, so therefore the use of writing in a math class the same way that it would in a writing class creates a social atmosphere where students can engage socially and share the thoughts they have written in a math journal. In the video *Can We Really Teach Writing*, Scott explains, “Students benefit from the teaching effect.” (TEDx, 2016). Therefore, encouraging students to share their expertise and thoughts after critically thinking about the problem through a written process may enable them to feel empowered by their knowledge and the ability to share it with their peers. Additionally, the researcher has observed that students often remember things differently when a skill or idea is demonstrated to them by a peer rather than a teacher. These types of interactions can lead to improved higher-level thinking skills by sharing ideas, making connections, and asking questions.

Research Question

Based on the problem identified above regarding students' ability to effectively solve word problems more independently, the primary question identified is: How does the utilization of a math journal impact the problem-solving skills of middle school self-contained special education students when addressing math word problems?. The research will focus on the ability of the students to work through the problems using journal writing and collaborative efforts, as well as the students' perceptions of this process.

Definition of Terms

This section defines terms that will be used throughout this research study. This research study is designed to answer the research question: How does the utilization of a math journal impact the problem-solving skills of middle school self-contained special education students when addressing math word problems?.

Self-contained special education class: The math class referred to in this study consists of 10 seventh and eighth grade classified students who receive instruction by a special education teacher for all academic subjects and one elective with the same group of students.

Math journal: a notebook that students use to write through the process of solving real-world math problems using prompts provided by the teacher.

Scaffolds: For this study, scaffolds refer to support (i.e.,) given to guide students by the researcher or using the math journal in collaborative problem-solving in mathematical word problem solving.

Zone of Proximal Development (ZPD): A theory developed by Lev Vygotsky (1978), which in this study suggests that learning occurs when students are challenged with tasks that are slightly beyond their current level of ability. The zone references the idea that what a child can do presently with assistance they will be able to eventually complete without assistance.

Higher level thinking: In this study, refers to the ability of students to think beyond their initial ideas by asking questions and sharing ideas.

Word problems: Word problems for this study refer to students' ability to solve real-world math problems such as, "Sam has 4 books. Jan gives him 3 more books. How many books does Sam have in all?".

Theoretical Rationale

This section presents the theoretical framework selected based on the research question. The research question is: How does the utilization of a math journal impact the problem-solving skills of middle school self-contained special education students when addressing math word problems?. This question was used to identify the theoretical framework. This framework includes the following theory: *Zone of Proximal Development* (Vygotsky, 1978).

Vygotsky (1978) suggests that learning occurs when students are challenged with tasks that are slightly beyond their current level of ability. Bodrova and Leong (1998) explain that The Zone of Proximal Development “defines development as the space between the child’s level of independent performance and the child’s level of maximally assisted performance” (p. 2). Vygotsky (1978) states that, “Rather, the developmental process lags behind the learning process; this sequence then results in zones of proximal development.” (p. 40). Abilities that a student has that are fully developed are where the student can function independently. He explains, “thus, the notion of a zone of proximal development enables us to propose a new formula, namely that the only "good learning" is that which is in advance of development.” (p. 39). Arming students with strategies they can use for mathematical word problem solving can help them become more independent with future mathematical word problem solving.

Zone of Proximal Development (ZPD) is often depicted as a series of concentric circles. The innermost circle is the set of skills a student can learn on her own, without any help. Next is the ZPD, or skills a student wouldn't be able to do on her own but can do with a teacher or peer helping them. Beyond that, the outer circle represents skills the student can't do yet, even with help. In the ZPD, Vygotsky (1978) believed that for children to exceed their learning potential, they would require a scaffold or support from a teacher or peer that can lead them to develop the ability to achieve independence in tasks beyond their ability level. Vygotsky explains, “We

propose that an essential feature of learning is that it creates the zone of proximal development; that is, learning awakens a variety of internal developmental processes that can operate only when the child is interacting with people in his environment and in cooperation with his peers.” (1978, p. 40). Scaffolds exist to support students in moving to their zone of proximal development. The support provided by a teacher or peer is one example of a scaffold. “The term “scaffolding” was coined by Bruner (Wood, Bruner, & Ross, 1976) to specify the types of assistance that make it possible for learners to function at higher levels of their zones of proximal development.” (Bodrova & Leong, 1998, p. 3). Bodrova & Leong state, “For scaffolding to be successful, teachers must help learners develop strategies they can apply to novel problems they will encounter, not just answers to specific questions.” (1998, p. 4). A variety of scaffolds may need to be implemented to support individual learning styles and levels, to withdraw them as a student can accomplish a task independently. In this study, use of a math journal formatted as a graphic organizer to guide students through the problem-solving process, will act as a scaffold to support students’ understanding of how to work through a math problem using writing as a tool.

Vygotsky (1978) felt that by implementing a collaborative learning scaffold, students will be able to master goals that they have not been able to reach while working independently. Vygotsky felt, “What the child is able to do in collaboration today he will be able to do independently tomorrow.” (p. 211). Working collaboratively, students can share their thought process, which can elevate thinking and create a learning environment that allows students to learn from each other and build on each other's strengths. When students work together, they can share ideas, help each other solve problems, and provide support and encouragement to one another. Encouraging students to share the ideas contained in their math journals will act as a

collaborative learning scaffold, whereby students can gain insight into different thought processes in mathematical problem solving.

Educational Significance

The purpose of this study is to examine the research question: How does the utilization of a math journal impact the problem-solving skills of middle school self-contained special education students when addressing math word problems?. This question is significant because it is imperative that educators understand the impact of incorporating writing into content areas, specifically mathematics. Educators across the nation, but particularly special education teachers, will benefit from this research so that they will be able to weigh the advantages and disadvantages of utilizing a math journal to facilitate students' ability to solve word problems.

Furthermore, providing students with the opportunity to articulate their thought processes and engage in challenging discussions enhances cognitive abilities. The act of expressing critical thinking through writing and collaborating with peers not only cultivates essential real-world skills but also equips students with a valuable tool for attaining greater success in various aspects of their future, extending beyond the mathematics classroom.

CHAPTER II

Review of the Literature

Overview

This chapter provides an overview of the literature and studies relevant to the primary question identified in this study. The research question is: How does the utilization of a math journal impact the problem-solving skills of middle school self-contained special education students when addressing math word problems? The review of the literature examines research studies related to Mathematical Writing for Problem Solving, Writing as a Tool to Promote Self-Confidence in Mathematical Problem Solving, and Assessment of Mathematical Writing. These concepts connect to the research question. Several studies will be used to support each of these three concepts.

Mathematical Writing for Problem Solving

The integration of effective writing strategies into mathematics education enhances students' problem-solving abilities by encouraging them to articulate their thought processes and apply logical reasoning, with the intention of ultimately fostering a deeper understanding of mathematical concepts. Hebert et al., (2019), examined the effectiveness of a mathematics-writing (MW) intervention for late elementary students who are at risk of experiencing learning difficulties. The researchers aimed to discover whether a MW intervention delivered over several weeks would be effective in improving MW's organizational and mathematical content scores.

This study, which took place in a university reading center, consisted of sixty-six fourth and fifth grade students, considered to be struggling in reading. Since the participants of the study had only been screened for reading ability, there was no prior knowledge of their

mathematical capabilities. Following pre-testing, students were placed in groups of one or two, based on scheduling. Students had 12 30-minute sessions. Overall, the mixed method study found that following intervention, students with learning disabilities showed moderate to large improvements. Researchers were encouraged by these results, given that the study occurred over a short period of time. Further research is necessary to determine if combining that intervention method with mathematical topics could influence mathematical comprehension and result in even more significant improvements. Further investigation is necessary to formulate a theoretical framework explaining the mechanisms through which writing influences mathematical ability. Moreover, Hebert et al. stated that further research is necessary to determine to what degree a MW intervention can impact test scores on standardized testing.

In summary, the research highlighted the effectiveness of the MW intervention, the characteristics of the study participants, the study design, and the improvements observed. There is a need for further research to deepen the understanding of the intervention's impact on mathematical learning.

Taban and Cadorna (2019) further explored the use of writing in mathematics with their research. This study consisted of 40 college students enrolled in the Bachelors of Elementary program at the University of Northern Philippines, Vigan City. This research employed qualitative research methods to conduct an exploratory investigation. The study aimed to document the mathematical problem-solving experiences of students by incorporating journal writing and organizing their work into a portfolio. The students were assessed on three main components in solving word problems, namely: identifying known and unknown variables, performing operations and algebraic methods, and writing reflections.

In this investigation, it was observed that journal writing emerged as a successful approach, evident in the students' portfolios. The students achieved satisfactory scores and recognized the importance of including comprehensive information in their solutions, such as clarifying the given problem information and the required information. While documenting detailed procedures for each step may be time-consuming, they found it to be beneficial, as it enhanced their ability to recall essential properties, definitions, axioms, theorems, and operations.

The utilization of journal writing as a strategy for addressing worded math problems had a positive impact. This approach resulted in a noticeable improvement in their attitudes and perspectives when it came to solving such problems. It fostered a more positive attitude for mathematics and contributed to the enhancement of their understanding of mathematical concepts. The conclusion of the study was that incorporating an emphasis on writing into classrooms is an effective strategy for student learning. Educators may implement a weekly requirement for students to compose a journal entry, which can significantly enhance both their mathematical thinking and writing abilities. .

In summary, this study indicated that journal writing as a strategy in mathematical problem solving had lasting impact. Students demonstrated a better understanding of mathematical concepts, thereby increasing their enjoyment of mathematics and an improvement in attitudes toward the subject.

In another study, Siskawati et al. (2023) examined ways to utilize writing to find a pattern of correcting mathematical understanding errors in solving mathematical problems for junior high school students. The researchers suggested that in order to perform well in mathematics,

one must have a deep understanding of basic mathematical concepts to successfully solve mathematical problems.

This month-long study consisted of three 8th grade students during the 2022/23 school year. The researchers utilized a qualitative approach, consisting of observations, test results, and interviews. The assessment utilized was a mathematical problem-solving test on Geometry. There were also guidelines utilized for the interview. Throughout the process, researchers noted the importance of teacher-student interactions, and the discussions that ensued by students' referring to questions they noted in their written maps and notations.

The conclusion of the study indicated that examining students' writing of what they do/do not understand about the problem enabled educators to identify and correct errors in mathematical understanding and promote effective problem solving in students. Researchers also noted that for this study, reminding students of prior knowledge and writing down all that they know about the problem at the onset led to greater success in problem solving.

In summary, the research explores various themes related to the improvement of mathematical understanding and problem-solving skills among junior high school students, with an emphasis on the role of teacher-student interactions, qualitative research methods, and the importance of a deep understanding of basic mathematical concepts.

Powell et al. (2021), examined the use of mathematical writing in the classroom by educators in different regions of the United States. This study analyzed questions such as: what do educators perceive as the purpose and importance of Mathematical Writing, or MW, how do educators engage students in MW, what is the mathematics, writing, and MW confidence and anxiety levels of educators, and does educators' experience and confidence level (for

mathematics, writing, and MW) predict the frequency with which they use MW when for the grade level they teach and the number of students in special education in their classrooms?

Researchers utilized a program called Market Data Retrieval (MDR). This program collects data from a variety of sources, including surveys, interviews, and focus groups. For the purposes of this study, a survey was used, consisting of questions that gathered both qualitative and quantitative data. In total 281 educators participated in this study, which consisted of educators of mathematics in grades ranging from kindergarten through 12th grade, including educators from the seven geographic regions that were chosen by Market Data Retrieval: Pacific, Mountain, North Central, South Central, South Atlantic, Mid-Atlantic, and New England. Of the 281 educators surveyed, slightly more than half indicated they taught MW to students. This varied by grade level, with grades 3-5 utilizing MW the most. The study found that educators overwhelmingly agreed that the practice of MW helped students to understand mathematical concepts, explain procedures, and complete word problems.

In conclusion, future research is needed on the various components of MW and which components are essential for utilizing MW with students effectively and promoting engagement among students.

Gallagher-Immenschuh (2020), examined the perceptions of students' on how language arts skills impact their mathematical abilities, particularly in terms of problem solving, retention, and mathematical ability using a qualitative phenomenological case study. This study consisted of 6 participants, ranging in age from grades 4-6, at an after-school tutorial center in Central Texas. Students attending this after-school center had been enrolled by their parents for a variety of educational concerns but did attend local schools. Students were instructed to use a language arts approach known as ICE (Identify Cite Explain) to write through their thinking process in

solving mathematical problems. Utilizing phenomenological case study and observation, and it was noted that with instruction, each student applied ELA skills to writing through solving math problems with success, with minimal input from the instructor.

Gallagher-Immenschuh found that with some coaching combined with feedback from the researcher, all participants were able to take teacher input and apply language arts skills to successfully solve math word problems. There is sufficient evidence contained in this study to support further research in integrating math in all areas of the curriculum. The author also recommends additional research into understanding what strategies would be effective in blending ELA with math would be beneficial, and potentially lead to changes in curriculum standards. In summary, arming students with a strategy such as ICE enabled students to apply skills from language arts to mathematical problem solving with success.

Writing as a Tool to Promote Self-Confidence in Mathematical Problem Solving

In mathematics, self-confidence can play a critical role in conquering complex problem-solving challenges. Self-confidence significantly enhances mathematical problem-solving skills by empowering individuals to approach challenges with a positive mindset, leading to greater persistence and creative thinking when faced with complex problems. A high level of self-assuredness in mathematical abilities can help learners overcome self-doubt and anxiety, ultimately improving their capacity to tackle mathematical tasks with greater success. Kaur and Prendergast (2011) investigated how students' perceptions on the use of writing in mathematics impacts their self-confidence and enjoyment in mathematics following a short intervention. This study included fifty-five students ages 12-15, with a mean age of 13 years old and consisted of 38 males (69%) and 17 females (31%), utilizing a mixed-method approach. Quantitative data was collected in the form of a questionnaire, which was given before and after the intervention.

Qualitative data was collected in the form of a written reflection by students, who were reflecting on their writing experience. Items included in the study were taken from Trends in International Mathematics and Science Study (TIMSS) 2011 8th grade mathematics assessment. The mathematical writing was 'explanatory', where students explained their mathematical reasoning in writing.

The results of this study revealed that students experienced increased levels of enjoyment and self-confidence after the brief intervention. Qualitative data suggested that one of the reasons for students' enjoyment and enhanced comfort was that the written work was not subject to formal grading. It was indicated that these findings underscore the necessity for additional research on the topic of mathematical writing, and the impact on self-confidence and enjoyment on improving outcomes in mathematical problem solving.

Zeleny (2013) also addressed the use of journal writing in mathematics to promote confidence in problem solving. This study examined the impact of journal writing on college students. Eighty-three participants ranging in age from 18-48 years of age participated in this mixed method, two phase research study. Phase one consisted of quantitative analysis. Features of this analysis included pre-measures, the writing intervention, post-measures, and the quantitative analysis. The qualitative components of phase two consisted of qualitative interviews, supportive qualitative data, themes/codes and mixing the quantitative and qualitative data. The results of the data were mixed. While the quantitative analysis indicated minimal distinctions, the qualitative data revealed that writing assumed a significant role in the students' mathematical coursework procedures. The researcher hypothesized that variables such as the timing of the assessments during more or less stressful parts of the semester may impact the data.

Zeleny concluded that, although there are few mixed-methods studies investigating the intersection of writing and mathematics among college students, increased familiarity with the connection between writing and mathematics can help students perceive it as a valuable tool. Integrating writing into mathematics education can potentially aid teachers in effectively assisting students thereby enhancing the overall quality of their mathematics education. Future research into this subject, specifically regarding the mixed results of the study would be needed to provide more insight.

Guce (2018) investigated the impact mathematical journal writing had on the attitude of forty-four 11th grade students who participated in the mixed method research over one semester. Attitudes towards mathematics were measured by the following questions: liking or disliking mathematics, tendency to engage in or avoid mathematical activities, a belief that one is good or bad in mathematics, and a belief that mathematics is useful. At the onset of the investigation, most students were considered to be in a range of slightly disliking mathematics to slightly liking mathematics.

Following the study, students indicated that journal writing was useful for many reasons such as the teacher's ability to identify issues a student is facing, a different way of communicating in a mathematics class, and the ability to reflect on what they have learned. Teachers recognized the journal as a tool for open communication and a tool for assessment and to determine instruction. The conclusion of the study determined that implementation of a math journal improved the overall attitude of students in two ways. First, students liked the subject better when using a math journal and indicated an overall increase in confidence in their problem-solving abilities. Second, students were overall more willing to engage in mathematical

activities. Additionally, students felt that they were developing a closer relationship with their teachers by having the ability to share their thoughts in a journal.

The study concluded that the advantages of incorporating writing into a mathematics class should not be overlooked, as these written exercises serve to strengthen the bond between teachers and students, fostering a more effective learning environment.

Assessment of Mathematical Writing

The methodologies employed in the evaluation of mathematical writing are necessary in promoting effective mathematical communication. Mathematical writing assessment is essential for evaluating a student's comprehension and communication of mathematical concepts. It not only helps educators gauge a student's grasp of mathematical principles but also cultivates crucial skills in conveying complex ideas, which are valuable both academically and in real-world applications. Hughes, Markelz, and Cozad (2019) evaluated a range of mathematical writing in elementary school students, and how it is assessed by teachers. This study was conducted at a large, northeastern research-intensive university in the USA, and consisted of 135 participants, divided into two cohorts. Research was conducted via survey and analyzed both quantitatively and qualitatively. Respondents were given little guidance in how to assess the writing, as the researchers were looking to evaluate how respondents proceeded based on their own interpretations. An important finding of the study was that there was little discrepancy in assessment between written samples that were well written versus those containing spelling and/or grammatical errors both in problems that were solved correctly and incorrectly but matched in math and writing outputs. The need for a rubric and training was noted; particularly for problems that had multiple components involved in the grading process.

Questions arose during the research process about whether variables such as reader fatigue, varying perspectives, misinterpretations or misunderstanding of mathematical concepts impact student scores, and therefore require additional research. However, findings from this research study offer some insight into how individuals with varying backgrounds score mathematical writing. In conclusion, the results of this study indicate the need to develop rubrics to indicate the requirements of mathematical writing to ensure equality in scoring.

Kesorn et al. (2020) examined the development of a mathematical assessment tool to evaluate the reading, writing, and analytical thinking of fourth grade students. The researchers employed a mixed method approach to 1) analyze how students solve mathematical problems; 2) develop an assessment tool; 3) validate the tool; and 4) reflect to assess the need for changes to the assessment. The researchers utilized interviews as well as think-aloud problems in an assessment for data. The study was used to develop an assessment tool that was valid, reliable, and of a high and precise quality. Researchers used feedback from the think-aloud problems students completed to improve the assessment.

The results indicated that this assessment model was valid. Four experts provided validation on the content of this assessment. The results of the Likelihood-Ratio test indicate that the multidimensional model demonstrates a superior fit when compared to the unidimensional model. This suggests that each item is suitable for evaluating students and is pertinent to the newly developed dimensional examination framework. The study concludes that as teachers develop assessments, it is imperative that teachers ensure that those assessments have a diagnostic relevance to their classroom content. The authors also state that assessment tools can be critical in driving instruction to improve mathematical educational outcomes. In conclusion,

student assessments in mathematical reading and writing such as this will enable students to reflect on their mathematical knowledge and enhance their skills.

Summary of the Literature Review

This section of chapter two provides a summarization of the studies used in this literature review. Studies selected for this literature review were determined based on the research question. The research question is: How does the utilization of a math journal impact the problem-solving skills of middle school self-contained special education students when addressing math word problems? There were many similarities and some differences amongst the studies in the literature review.

Overall, these studies collectively emphasize the positive impact of writing in mathematics education, with specific focuses on various aspects such as problem-solving Hebert et al. (2019), and Gallagher-Immenschuh (2020), confidence Guce (2018), attitude Kaur and Prendergast (2022), and assessment methods Kesorn et al. (2020). These studies also highlighted the need for further research to explore specific components, strategies, and the integration of writing with mathematical concepts. Another comparison among all the studies in the literature review was the impact of writing on mathematical problem solving, regardless of age or learning ability. Both Hebert et al. (2019), and Gallagher-Immenschuh (2020) examined the effects of mathematical writing intervention for late elementary students who are experiencing learning difficulties and found it impactful, as did Taban and Cadorna (2019) with their college aged subjects and Siskawati et al. (2023) with junior high school students. However, in the Taban and Cadorna (2019) study as well as the Siskawati et al. (2023) study, students were not experiencing learning difficulties, but their findings also supported the findings of Hebert et al. (2019) and

Gallagher-Immenschuh (2020) regarding the positive impact writing had on mathematical problem solving.

Among studies where the participants were educators, Powell et al. (2021) determined that educators perceived MW as helpful for students' understanding of mathematical concepts. Hughes et al. (2019) determined that educators did see a need for rubrics to ensure fair and objective assessment. In both studies, educators felt that further research and training was necessary to determine what quality mathematical writing skills are most helpful and engaging for students.

Siskawati (2023) found a correlation between writing in mathematics and a deeper understanding of the material. It was also noted that this process had a positive impact on student-teacher relationships. These findings were supported by Guce (2018), who also wrote that students were overall more willing to engage in mathematical activities. In both studies, students felt that they were developing a closer relationship with their teachers by having the ability to share their thoughts in a journal. Another study that supported the connection of writing in mathematics to promote understanding of the material was that of Kesorn (2020). In his development of a multi-dimensional mathematical writing assessment tool, Kesorn (2020) noted that the use of an assessment tool for writing in mathematics can serve to inform the educator's instructional process, thereby promoting a deeper understanding of the material.

Another comparison among the studies of the literature review was the impact of writing in mathematics on confidence. In comparing studies on journal writing in mathematics, Guce (2018) found that journal writing had a profound impact on student's levels of confidence. This confidence improved students' attitudes towards mathematics and level of engagement. Kaur and Prendergast (2022) supported Guce's findings, stating that student's mean enjoyment level

of mathematics increased as a result of using a math journal. Zeleny (2013) also supported these findings with research on journal writing, finding that students felt it became an integral part of their problem-solving process. Finally, it should be noted that each of the studies identified a common need for additional research regarding their specific inquiries concerning the role of writing in mathematics education.

One difference among all the studies was Zeleny (2013). This study on journal writing in mathematics was the only study where the results of the research were mixed. The quantitative research indicated minimal impact of journal writing in mathematics, but the qualitative results indicated a positive impact. In the student interviews (qualitative research), students indicated that journal writing had become an important part of their mathematical experience. Zeleny (2013) also indicated that there are very few mixed method studies on the process of writing in mathematics, and further investigation is needed.

Chapter III

Research Design

Introduction

All students can benefit from the use of writing in mathematics. The use of journal writing is one method in which to approach the use of writing in mathematics. Through an examination of key considerations and best practices, this chapter seeks to outline the design and implementation of the study on the question: How does the utilization of a math journal impact the problem-solving skills of middle school self-contained special education students when addressing math word problems? This chapter explores the intricacies of developing a comprehensive plan of action for this project.

For this study, the researcher conducted a mixed method research study. Efron and Ravid explain that by combining both research methods in one study, the researcher can employ multiple means to analyze a variety of angles of the same question (2019). Research, based on the question: How does the utilization of a math journal impact the problem-solving skills of middle school self-contained special education students when addressing math word problems?, utilized the case study method to assess the effects of this practice on the students' ability to solve word problems. In line with Efron and Ravid's thoughts, the purpose of the case study is for the researcher to look deeply into a chosen subject, examining its intricacies, behaviors, and the underlying motivations for those behaviors. Using qualitative data to indicate what, if any, influence the writing process has on students' outcomes will be a large component of this project. Reflexivity, encompassing the consciousness or awareness of the researcher's own experiences with these students, was a crucial factor in upholding the objectivity of this research project. Qualitative research emphasizes the idea that the researcher's thoughts and feelings can impact

the research. (2019). However, there is also the need for a quantitative approach to collect data, evaluate any changes in outcomes, and characterize the nature of these changes.

Research Setting

This section presents the setting for this research study. This study is designed to answer the research question: How does the utilization of a math journal impact the problem-solving skills of middle school self-contained special education students when addressing math word problems? The mixed method study was conducted in a public school in a suburb located in Northern New Jersey. The population of this town is 24,382 residents. Residents of the town include a population of: 97.1% individuals who are Caucasian, 7.8% individuals who are Hispanic or Latino, 3.5% of individuals who are of two or more races, 1.8% of individuals who are Asian, 1.3% of individuals who are Black or African American, and 0.2% of individuals who are Native American, and 0.1% of individuals who are Pacific Islander. Median household income of this town is \$107,359. In this town, 3.3% of the population lives at or below the poverty line.

The school district is comprised of five elementary schools, a middle school, a high school, and a school for students with emotional and behavioral needs. These schools service students from preschool through twelfth grade. Enrollment in this school district is 3,028 students, with a student-teacher ratio of 13:1. This district is well known for its award-winning marching band program. Some other notable programs are a new pilot's licensing class, National Honor Society, a preschool practicum program, Activity Nights, the Gay/Straight Alliance, and DECA (Distributive Education Clubs of America).

The school represented in this research study is the middle school. The middle school has 777 students, and 65 teachers as well as many paraprofessionals. This school is composed of

sixth through eighth grade students. In general, each grade level has two general education teachers for each of the core content subjects. This school also offers special education services, Unified Athletics, STEM classes, ELL services, academic support services, counseling services, occupational and physical therapies, a variety of after school clubs, and speech services. The population of students includes 81% of students who are Caucasian, 12% of students who are Hispanic, 2% of students who are Black or African American, 2% of students who are Asian, and 1% of students who are of two or more races. Of the 777 students, 519 of the students are in seventh and eighth grade, which are the grade levels of the students in my study.

This school building has art rooms, music rooms, a media center, gymnasium, auditorium, and cafeteria. Students travel from one room to the next for each class throughout the day. There are rooms for the principal, assistant principal, counselors, child study team, and speech therapists. There are outdoor classrooms, gardens, and a breezeway, which enables students to pass from either side of the building in an enclosed outdoor space. Physical and occupational therapists utilize classrooms that are empty at various points throughout the day.

The classroom in which the research was conducted is a self-contained special education class. Research took place during the daily math period. There is a projector with a document camera that can be utilized with a desktop. Each student is provided with a Chromebook for instructional purposes. There are whiteboards and anchor charts available for mathematical reference, as well as a variety of manipulatives available for student use. The materials utilized for instruction are provided by the researcher, based on state standards, grade level, and student capability.

Research Participants

This section presents information on the participants in this research study. This study is designed to answer the research question: How does the utilization of a math journal impact the problem-solving skills of middle school self-contained special education students when addressing math word problems? The research for this study was conducted by the teacher-researcher with seventh and eighth grade special education students in a self-contained classroom. The researcher is in her third year of teaching this population of students at this school. The researcher obtained an undergraduate degree from William Paterson University with a degree as a Teacher of the Handicapped. The researcher is currently pursuing a Master of Education in Writing from William Paterson University.

Participants of this study consist of ten seventh and eighth grade students in the researcher's fourth period mathematics class. Since this class is a self-contained special education class, all the participants have an Individualized Education Plan (IEP). The disabilities present within this self-contained special education class are: Autism, ADHD, Communication Impairment, and Specific Learning Disabilities in Reading and/or Math. The researcher's familiarity with the participants' individual learning needs and the details of their IEPs contributed deeper understanding of their mathematical development within the context of this study.

Of the ten student participants, there were two female students and eight male students of varying ability levels. The students were evenly split with four males and one female in seventh grade, and four males and one female in eighth grade. The research was conducted during the daily "Do Now" element, which takes place at the beginning of the 46 minute math period. Of

the ten student participants in this study, nine of these students have received instruction in mathematics with the researcher in the prior school year.

Data Sources

This section presents the data sources for this research study. This study is designed to answer the research question: How does the utilization of a math journal impact the problem-solving skills of middle school self-contained special education students when addressing math word problems? Throughout this research, data was collected and analyzed from a variety of sources. These sources include: daily math word problems on a graphic organizer sheet, a Friday student reflection sheet, a rubric for the assessment of student work, and a journal of anecdotal records kept by the researcher.

Daily Math Word Problems (See Appendix)

Students were given a math word problem on a graphic organizer, to guide them through the steps of writing through the problem. These papers were kept in each student's individual math journal. This quantitative data was used to measure progress and validity, aimed at measuring the ability to solve word problems using writing. By utilizing this data, the researcher was able to quantitatively gauge the impact of written expression on the students' ability to comprehend, interpret, and effectively solve mathematical word problems. This evaluation not only facilitated the measurement of progress over time but also contributed to the validation of the hypothesis and the effectiveness of the chosen instructional method.

Friday Student Reflection Sheet (See Appendix)

At the end of each week, students were given a reflection paper, where students were encouraged to reflect on their problem solving of the week, with the option to use sentence starters provided,

or their own thoughts. Additionally, students were able to evaluate their perception of their own progress that week using a rating scale of 1-10 provided at the bottom of the form.

Researcher Journal

The researcher monitored students during their activities, noted observations on interactions or questions, and recorded these interactions in her journal, in order to document the entire process. By doing so, the researcher had the ability to reflect on the data collected on each day and compare it with notes and observations that were documented both during the research and following the study. Some of the criteria included motivation, confidence, reflection, and student dialogue.

Rubric (Appendix)

In order to ensure that the assessment of the word problems was unbiased and objective, the researcher utilized a rubric to assess the work of each student in their daily math journal. The rubric is designed to evaluate both the accuracy of the students' solutions and their problem-solving approaches. This approach allowed the researcher to analyze the data in a comprehensive and impartial manner, facilitating a thorough understanding of the students' progress over time.

Data Collection and Analysis Procedures

This section presents the data collection and analysis procedures conducted in this research study. The data collection for the study designed to answer the research question: How does the utilization of a math journal impact the problem-solving skills of middle school self-contained special education students when addressing math word problems?, took place over the course of a three week period. Three data sources were analyzed. These sources include: daily math word problems on a graphic organizer sheet with a rubric for the assessment of student work, a Friday student reflection sheet, and a journal of anecdotal records kept by the researcher.

The first data source is the daily math word problems. These math word problems are drafted on a graphic organizer, which guides the student through the process of writing to solve the problem. These daily problems were kept in the student's math journal, as a running record and offered students the ability to look back at their work from prior classes. These problems will be analyzed quantitatively, utilizing the rubric to ensure uniformity in assessment. The researcher analyzed mathematical understanding, problem solving, organization, and effort with the rubric, assigning a numerical score ranging from one through four (lowest score to highest score) in each of four areas, for a maximum score of sixteen. The researcher used descriptive statistics, which involved summarizing and describing the main features of the data through measures such as mean, median, mode, standard deviation, or range. Descriptive statistics provide a concise summary of the data, enabling the researcher to understand the central tendencies and variability within the data. The second data source is the Friday student reflection form. This qualitative data offered students the opportunity to reflect on the work they completed that week. This reflection form offered sentence starters as a scaffold, but students were also encouraged to use their own original ideas to write about. Furthermore, this form offered a rating scale, for students to self-evaluate their sentiments related to their problem-solving skills. This data was analyzed to identify common themes, sentiments, issues or feedback that may emerge from the students' reflections.

The third data source is the journal of anecdotal records. This journal contains qualitative data. In this journal, the researcher took copious notes on the activities of the students each day. The researcher noted how well they worked, any comments they made, and conversations of interest that occurred as we reviewed the problems. The researcher also noted how well the students worked, whether any intervention required, or were there any extraneous events

happening that may have impacted the outcome that day. When needed, the researcher took notes on the content of the mathematics journals. Any information that would not be evident in the math journal itself but is relevant to this research were noted in this journal.

The researcher used this data to identify common themes, topics, or issues that are noted among the students. This enabled the researcher to organize these themes and analyze any patterns or trends. Information gleaned from this analysis was used to extract meaningful insights and consider how they relate to the research question: How does the utilization of a math journal impact the problem-solving skills of middle school self-contained special education students when addressing math word problems? An anecdotal journal was an important tool for contextualizing the data; understanding the context in which the data was collected was useful for providing a deeper understanding of the data. Triangulating the data from this journal with the other data sources enhanced the credibility and reliability of the data.

Validity and Reliability

This section presents the validity and reliability of this study. This study was designed to answer the research question, “How does the utilization of a math journal impact the problem-solving skills of middle school self-contained special education students when addressing math word problems?”. The data in this study was reliable since multiple data sources that were both qualitative and quantitative will be collected to measure the effects of instruction. Three data sources were utilized to find and compare emerging themes and patterns to answer the research question. Students in this study were aware that they were participating in a three-week long research study but were unaware as to what specifically the researcher was examining. The research setting was natural in that it took place in their typical classroom setting during the

typical classroom time, and instruction was provided by the researcher who is their usual teacher for this class.

The data collected for this study was valid. Validity was ensured using multiple data points. This process, known as “triangulation” (2019) allowed the researcher to utilize more than one data source. Triangulation is employed to enhance the validity and reliability of the findings by verifying the results obtained from different angles. By utilizing multiple sources of data, the researcher can cross-check the information and identify any discrepancies or inconsistencies, thereby strengthening the credibility of the study. This approach to qualitative data ensures the trustworthiness of this research.

Limitations

This section presents the limitations for this research study. This study was designed to answer the research question, “How does the utilization of a math journal impact the problem-solving skills of middle school self-contained special education students when addressing math word problems?”. One limitation to this study is the duration. Since the research took place over a three-week period, it may impact the extent of the findings and the potential for long term impact. It is possible that a longer research duration would produce a more in-depth finding.

Another limitation to this research is the fact that it will be targeted to a specific group of students (self-contained special education). The focused approach allows an in-depth understanding of the impact of this research on this specific population. However, this may limit the study’s ability to generalize its findings to other populations of students.

Finally, a limitation of this study may be the relatively small participant group. Ten students participated in this study. The limited number of participants may restrict the study's ability to draw comprehensive or statistically significant conclusions, as the sample size might

not be representative of the overall population of middle school self-contained special education students. Additionally, it should be recognized that the findings of this study may have limited applicability beyond this specified population and duration.

CHAPTER IV

Findings

Introduction

This chapter presents the findings that were identified from the analysis of the data gathered from the sources listed in Chapter 3. The findings were based on the analysis of the following data sources: daily math word problems on a graphic organizer sheet, a Friday student reflection sheet, a rubric for the assessment of student work, and a journal of anecdotal records kept by the researcher. Recurrent themes and patterns emerged through triangulation and coding of the data. The findings present the answer to the research question: How does the utilization of a math journal impact the problem-solving skills of middle school self-contained special education students when addressing math word problems?

The data analysis resulted in the identification of three significant themes: Engagement and Enjoyment, Shifts in Attitude and Confidence, and Impact of Writing in Problem Solving Skills.

Engagement and Enjoyment

Throughout the three-week research period, during their typical math class instruction time, students were asked to complete a daily math journal word problem formatted on a graphic organizer, to guide them through solving the problem. The researcher took comprehensive notes on any notable events that occurred during this time, as well as on the conversations during this period of the class. At the conclusion of a five day instructional window, students were instructed to complete a reflection form. During the course of instruction, students demonstrated the following pattern: engagement and enjoyment. This pattern is defined by students' engagement in completing all the components of the journal entry, engagement in classroom

discussions about the problem and thoughts expressed on the reflection form. For example, On the Day 5 reflection form, Student 4 stated, “These journals are helpful because they give you more information unlike a regular paper worksheet.” On the final reflection form, Student 4 stated, “I like using the journal because it shows you the problem so you can get a better description of what to do.”. The researcher noted in the researcher journal (11/4/23) that this student was eager to share his description of his problem-solving process daily. Student 2 was also eager to share her problem-solving strategies daily, with the researcher noting in the journal (11/1/23) that Student 2 enjoyed sharing that her error was purely a computational error, and that she knew there were two steps to that problem. The researcher also documented that the need for students to share their individual thought process increased daily, with 75% of the class wanting to share their own thoughts on one or more of the components of their math journal and their thought process, regardless of whether they solved it correctly on the last three days of this study.

Throughout the process, the researcher documented in her journal an increase in the amount/quality of discussion around the math problems over the course of the research period. The researcher noted that the time it took to complete and review these journal problems increased from approximately 5 minutes on Day 1 to approximately 15 minutes on Day 15, due to the level of student participation and engagement.

For example, on Day 4, Student 4 requested we create an anchor chart, to be posted in the class where we could add mathematical words that provided “clues” as we encountered them. As a class, we decided to color code these words to make them easily identifiable by operation. The researcher notes that students became more engaged in finding these words in the problem on subsequent days. The researcher noted (11/15/23) students using the problem solving word chart to solve a problem which was not part of the math journal research.

Student 8 experienced a higher level of success solving word problems than he would typically. He was very engaged in the process, with detailed descriptions of his thought process in the “How did you solve the problem?” section of his journal forms. Student 8’s Reflection Form 2 indicates his enjoyment of the process of reviewing the problem. He states, “I liked when we go over it because I feel like neveres when we don’t go over the work I feel like I can’t leve if we don’t and it fun I like doing it.”

In another example, the researcher noted on 10/26/23 that Student 5 put minimal effort into the journal on Day 1. However, he began to put more effort in as the days progressed. When the researcher asked him why he began putting more effort in, she noted on 11/2/23 Student 5 responded, “Everyone is getting them right and talking a lot and I couldn’t answer because I didn’t work.”

Shifts in Attitude and Confidence

As a result of the use of a math journal to utilize writing as a means to solve math word problems, students demonstrated the following pattern: shifts in attitude and confidence. Analysis of the data contained in the self-reflection scale, which students completed three times throughout the three week research period, indicated an overall rise in students’ confidence in problem solving skills. This pattern is marked by a positive shift in attitude towards viewing the resolution of word problems as a favorable experience. Moreover, most students demonstrated an enhanced level of confidence not only throughout the instructional sessions but also on the self-reflection scale. On the self-reflection scale, students rated their perception of their mathematical problem-solving skills on a scale with one being the lowest score (least confident) and ten being the highest score (most confident). Additionally, the researcher’s notes taken during the instructional time also provide evidence that throughout the

instructional period, students exhibited a discernible pattern characterized by changes in both attitude and confidence.

Figure 1

Student Self Reflection Scores

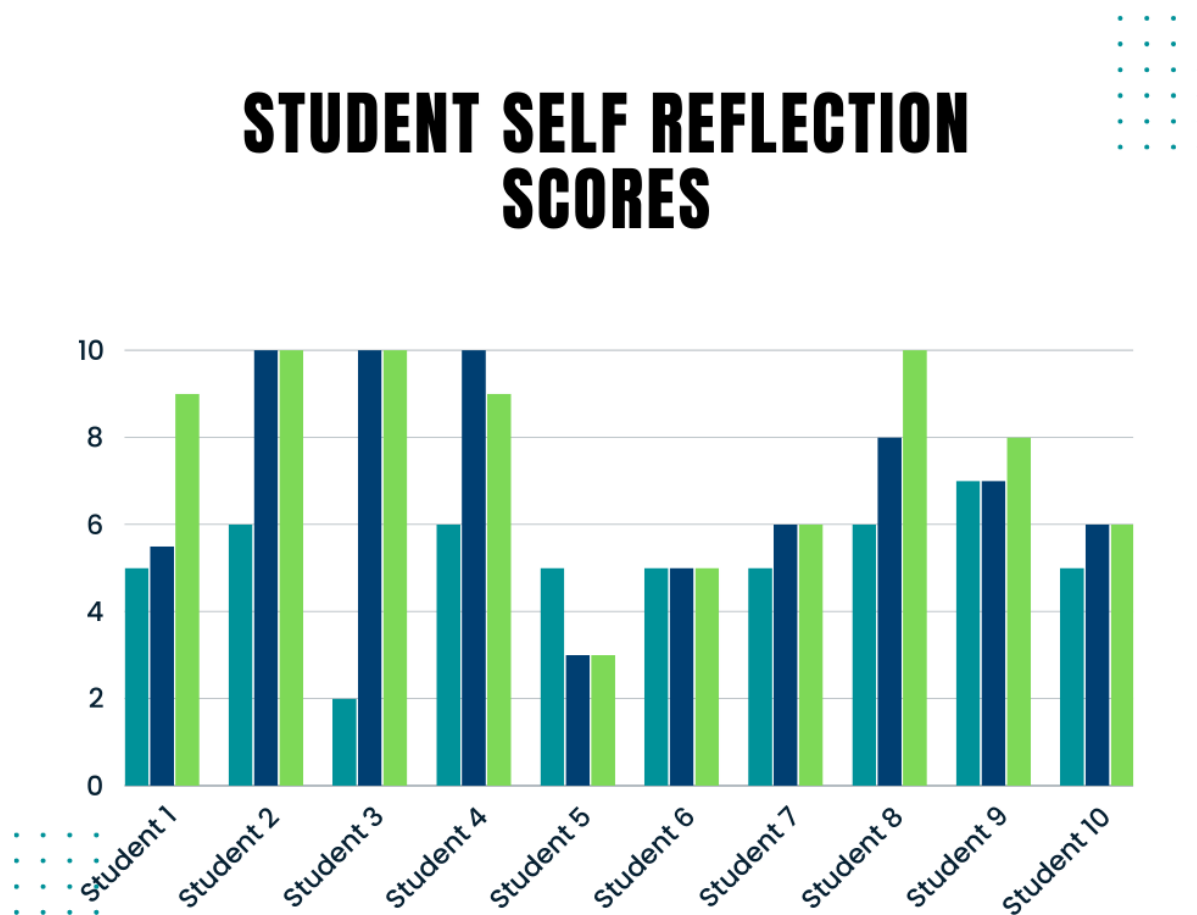


Figure 1 illustrates the change in students' reflections on their problem-solving abilities. This data was collected on Day 5, Day 10, and Day 15. The self-reflection scores provide a quantitative measure, enhancing the comprehensive understanding of students' shift in attitude and confidence throughout the three-week research period.

As indicated in the graph, 80% of students scored their problem-solving abilities higher by the end of this research. 10% of the students felt less confident in their feelings about their problem-solving abilities, and 10% of the students felt no change in their problem-solving skills. These scores demonstrate the shift in attitude and confidence over the course of the research period.

Table 1

Reflection Form Data

| Student | Relevant Comments Made by Student and Self-Assessment Score #1 | Relevant Comments Made by Student and Self-Assessment Score #2 | Relevant Comments Made by Student and Self-Assessment Score #3 |
|---------|--|---|--|
| 1 | Likes the process but not sure why there is the drawing part. Self-assessment: 5 | Dislikes the drawing, does not feel it is helpful. Writing component about problem solving is more helpful to him. Self-assessment: 5.5 | Feels the drawing is not helpful. Writing component was more helpful. Self-assessment: 9 |
| 2 | Feels she needs more help with subtracting. Self-assessment: 6 | Likes finding clues in the problem to determine what operation to choose. Self-assessment: 10 | Likes this process. Feels confident with math skills. Feels she has shown improvement. Self-assessment: 10 |
| 3 | Did not understand the prompt and tried to answer all of the sentence starters. Indicated he needs more help multiplying decimals. (Unrelated to the problem.) Self-assessment: 2 | Gave a detailed description about what areas of mathematical operations he feels he needs more help with. Feels the journal is helpful because it helps him to be less confused. Self-assessment: 10 | Indicates using a math journal is helpful. Can look back at the problem and not be confused. Self-assessment: 10 |
| 4 | Likes the journal because it has more information and is easier to read and solve. | Likes when we go over the problem together. | Likes the journal format. |

| | | | |
|----|--|---|---|
| | Self-assessment: 6 | The journals provide more information than a typical problem. | Feels it offers a better description of how to proceed. |
| | | Self-assessment: 10 | Self-assessment: 9 |
| 5 | Needs more help. Self-assessment: 5 | Needs more help with word problems. Self-assessment: 3 | Is very good at what we are working on during our math period. (Outside of research.) Self-assessment: 3 |
| 6 | Needs more help in choosing the operation. Self-assessment: 5 | Needs more help with mathematical operations. Self-assessment: 5 | Needs more help knowing when to double add and subtract or anything to do with doubling. Self-assessment: 5 |
| 7 | Feels he is very good at drawing pictures. Writing about your thinking helps him think more. Self-Assessment: 5 | Needs more help on explaining his problem solving in writing, feels he is not good at that. Self-assessment: 6 | Has trouble explaining during the writing about problem solving. Self-assessment: 6 |
| 8 | Likes going over the work, helps him to feel less nervous. Says it is fun and he likes doing it. Self-assessment: 6 | Likes when we go over the problem. Self-assessment: 8 | Notes he is getting better at solving correctly. Enjoys getting the problems correct. Self-assessment: 10 |
| 9 | Feels he is very good at math. Uses his hand to help him count. Self-assessment: 7 | Likes it and feels he is really good at some of it. Self-assessment: 7 | The steps of dividing are too hard. Self-assessment: 8 |
| 10 | Feels it helps because it offers more room to write. Self-assessment: 5 | Feels it offers more room to write. Enjoys it. | Improved his work so he liked the journal. Self-assessment: 6 |

Self-assessment: 6

Table 1 shows relevant comments made on the reflection form by each student over the course of the three week research period, as well as the self-reflection score. The comments reflect students' individual insights and experiences during the research, offering a qualitative perspective on their learning journey.

Specifically, on Day 5, in the Reflection Form, Student 7 expressed, "I am really good at draw a picture because it help me get The answer. I like How the ask me How to solve The problem becaus it makes me think moor." This student rated himself an 8 on his feelings regarding his problem-solving skills on that day, as compared to a 10 on Day 15.

On Day 15, Student 7 articulated that he struggles with explaining how to solve the problem stating, "I still need help with How to solve the problem heve trumbull ecksplan." This student rated his feelings about his problem solving skills as a 10, although he had the lowest mean rubric score. This was up from a 6 on Day 10.

Another example of a shift in confidence; on Day 15, Student 3 indicated on his reflection form that, "Using a math journal is helpful because I can look back the the proble so I won't get confused.". He rated his problem-solving skills a 2 on Day 5, and a 10 on Day 15, despite having the lowest rubric mean score of the focus group.

Student 5 showed a decline from Day 5 to Day 15 in his self-reflection. On Day 15 he wrote, "I am really good at the mph stuff.", referring to the instruction he was receiving on unit rate that was taking place during the portion of the math period that followed the math journals. Student 6 showed no change in her self-reflection throughout the fifteen day period. Her explanation was not clear on the form, stating: "I need more help with knowing when to double add and subtract or anything that has to do with doubling.". When pressed, the

researcher noted in her journal that Student 6 stated, “I don’t understand when it is add, multiply, or subtract.”.

On Day 15, Student 8 reported, “I liked when I get it right so I now I been getting batter.”. He rated his problem-solving skills a 10 on Day 15, as opposed to an 8 on Day 10.

The researcher noted that on Day 1 this project was met with some complaining and resistance from 50% of the students, which she documented waned over the course of the data collection. By Day 8 the researcher noted that 60% of students were asking to do the math journal. The researcher noted a daily increase in classroom conversation and desire of students to put forth information and share their thinking, regardless of whether they had the correct answer.

Impact of Writing in Problem Solving Skills

Throughout the three week study, students were provided daily with a math word problem on a graphic organizer (Appendix), to guide them through the steps of writing through the problem. This organizer was assessed daily by the researcher, using the rubric (Appendix). Students were instructed on the use of this format at the onset of this study. One student read the problem aloud for the class daily, prior to completing the assignment independently. Once all the students completed the work, we reviewed each step of the problem as outlined in the graphic organizer, culminating with the section “How did you solve the problem?”, that each student completed in their own written words. During the course of instruction, students demonstrated the following pattern: an impact of writing on problem solving skills. This pattern is defined by identifying the impact of writing in problem solving skills both by the students and the researcher.

As we reviewed each step of the problem, students would indicate their own choices in completing the section; agreeing or disagreeing with each other respectfully. This led to deeper discussions about words contained within the problem as to why they made the choices that they did. Student 4 requested that we begin an anchor chart, listing the words that we encountered that influenced their choice in terms of choosing the correct operation(s) to solve the problem. At the onset of the research, many students completed the written component in the literal sense, describing the operation that they chose. However, as the research progressed, many began to articulate the thoughts that went into making the choices for operation that they did.

Figure 2

Student 9's Work Sample


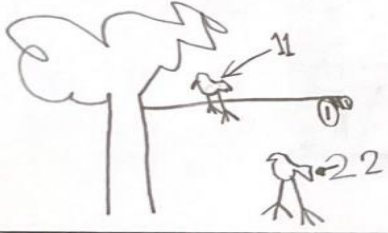
|  | |
|---|--|
| Problem of the Day | |
| 11 birds were sitting in a tree. Some more fly up to the tree. Then there were 29 birds in the tree total. How many more birds flew up to the tree? | |
| What is the problem asking? How many more birds flew up to the tree? | |
| Draw a picture  | Write a number sentence $\begin{array}{r} 29 \\ - 11 \\ \hline 18 \end{array}$ |
| Your answer 18 birds more | How did you solve the problem: I got rid of 11 birds. There use to be 29. So I can figer out how many more went up the tree. |

Figure 2 is an example from Student 9's journal. Student 9 utilized the components of this journal to correctly solve the problem, and articulated well what his thought process was. Student 9 did an excellent job explaining his thought process in the last section, which the researcher notes is a difficult thing for Student 9 to do verbally. Although this student did not

circle words in the word problem that were helpful, he put great effort into the drawing and writing portion of his journal daily. On Reflection Form 2, Student 9 referred to problem solving as “easy here”, which the researcher noted that when she asked Student 9 for clarification, he stated it to mean that it is “easier for him on this paper”, which indicated he meant in the math journal format.

When completing a reflection form, Student 1, who had a perfect score of 16 on the rubric for all 15 days, stated, “...the draw did not help me and the How did you solve the problem help me more.”, indicating that the portion of the journal that required drawing was not helpful to him, but that the portion of the journal requiring the explanation of his thought process helped him to think more critically about the problem. This student rated his own problem-solving abilities a 5.5 (he wrote that in) on Day 10, and a 9 on Day 15. This increase indicates a higher level of confidence in his problem-solving skills.

Student 7 indicates that the “How did you solve the problem” (written) section of the journal encouraged him to think more. This student (Student 7) had 50% of the problems solved correctly. However, this student scored “Proficient” on the Rubric Score, based on his organization of the problem and effort put forth in problem solving.

Students were assessed daily for fifteen days. The daily assessments conducted over the fifteen day period provided a detailed and dynamic understanding of the students' progress, contributing valuable insights into their development and facilitating the identification of patterns or trends over time.

Table 2*Mean Rubric Score Day 8/Day 15*

| Student | Mean Rubric Score Day 8 | Mean Rubric Score Day 15 | Change |
|---------|-------------------------|--------------------------|-----------|
| 1 | 16 | 16 | No change |
| 2 | 9.875 | 9.73 | Decrease |
| 3 | 8.625 | 9.33 | Increase |
| 4 | 15.375 | 15.43 | Increase |
| 5 | 10.875 | 11.33 | Increase |
| 6 | 11.125 | 10.73 | Decrease |
| 7 | 12 | 12.57 | Increase |
| 8 | 12.375 | 14.53 | Increase |
| 9 | 13.375 | 14 | Increase |
| 10 | 9.714 | 11.43 | Increase |

Note. Rubric Scoring Key: Exemplary (14-16), Proficient (12-13), Basic (8-11), Limited (<8).

Table 2 shows the results of the rubric scoring for the data collection period. The results indicate that 70% of the students showed an increase in their rubric score from the midway data analysis to the final data analysis. Further, of that 70%, 40% of the students fell into the “Exemplary” scoring range. These results demonstrate that most participants’ scores increased, with a minority showing no change/decrease. This data supports the effectiveness of the use of a math journal to guide students through the problem-solving process.

Table 3

Problem Solving Quantitative Data

Key: C = Correct Answer I = Incorrect answer A = Absent

| Student Number/ Classification | Day 1 | Day 2 | Day 3 | Day 4 | Day 5 | Day 6 | Day 7 | Day 8 | Day 9 | Day 10 | Day 11 | Day 12 | Day 13 | Day 14 | Day 15 | Total Correct by pupil |
|-----------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|--------|--------|--------|--------|--------|------------------------|
| 1/SLD | C | C | A | C | C | C | C | C | C | C | C | C | C | C | C | 15/15 |
| 2/CI | I | I | C | I | I | C | I | I | I | I | C | I | I | I | C | 4/15 |
| 3/Autism | I | C | I | I | I | I | I | I | I | I | C | I | I | I | I | 2/15 |
| 4/ADHD | I | C | C | C | C | C | C | C | C | C | I | C | C | C | C | 14/15 |
| 5/SLD | I | C | I | I | C | I | I | C | I | C | I | C | I | C | C | 7/15 |
| 6/Autism | C | C | I | I | I | I | I | C | I | I | C | I | I | I | I | 3/15 |
| 7/ADHD | I | I | C | C | I | C | I | C | C | I | C | I | A | I | C | 7/14 |
| 8/CI | C | C | C | C | I | C | C | C | C | C | C | C | I | C | C | 12/15 |
| 9/Autism | C | I | I | C | C | C | C | C | C | C | C | C | C | C | C | 13/15 |
| 10/CI | C | I | A | I | I | I | C | I | C | I | C | I | A | C | C | 6/13 |
| Total Correct per Class | 5/10 | 6/10 | 4/8 | 5/10 | 3/9 | 5/9 | 4/9 | 7/10 | 6/10 | 5/10 | 8/10 | 5/10 | 3/8 | 6/10 | 8/10 | |

Table 3 illustrates the individual students who answered the daily problem correctly, as well as the corresponding fraction of the class that achieved the correct response. It also indicates the total number of problems each student solved correctly over the course of fifteen days. The results are inconsistent and show no consistent pattern of progression over the course of the data

collection period for most students. The lack of a discernible pattern in the results suggests that there may be underlying variables or factors influencing the outcomes.

Both Table 2 and Table 3 are related to the data collection period and involve student performance in problem-solving. Both Table 2 and Table 3 present data related to student performance. While Table 2 focuses on rubric scores, demonstrating the percentage increase, and the distribution of students falling into the "Exemplary" range, Table 3 illustrates individual student responses to daily problems, class fractions achieving correct responses, and the total number of correct responses over fifteen days. Although the data from Table 3 is inconclusive, it is not a clear representation of the success of the math journal as a tool since it simply shows whether the problem was solved correctly. Table 2 highlights a positive trend, indicating that most students experienced an increase in their rubric scores, supporting the effectiveness of using a math journal.

The data contained in Table 2, as well as the researcher journal and self-reflection forms, support the hypothesis of the research. By utilizing this data, the researcher was able to gauge the impact of written expression on the students' ability to comprehend, interpret, and effectively solve mathematical word problems. This evaluation not only facilitated the measurement of progress over time but also contributed to the overall validation of the hypothesis and the effectiveness of the chosen instructional method.

Summary

The findings outlined in this chapter identified patterns that resulted from the use of a math journal for solving word problems. The instruction and tools resulted in higher levels of enjoyment and engagement in solving mathematical word problems. Students demonstrated a higher confidence level in their problem-solving abilities. Additionally, most achieved a higher

median score on their math journals as a result of the instruction and tools used. There was variability in the total number of correctly solved problems among individual students throughout the fifteen day period. This suggests the presence of underlying variables or factors influencing outcomes, contributing to the overall ambiguity of the collected data. This data conflicts with the other data collected as a result of this study. Through the instruction implemented in this research, students' mathematical problem-solving abilities improved, as well as classroom engagement and discussion regarding these problems. Finally, there was a perceptible shift in attitude and confidence as a result of the instruction implemented in this study.

CHAPTER V

Conclusions, Discussions, and Recommendations

Introduction

The purpose of this study was to determine how the utilization of a math journal impacts the problem-solving skills of middle school self-contained special education students when addressing math word problems. This chapter discusses the conclusions drawn based on the data analysis presented in the previous chapter. The conclusions drawn answer the research question: How does the utilization of a math journal impact the problem-solving skills of middle school self-contained special education students when addressing math word problems?. From the data analysis, the following conclusions were made: (1) Use of a math journal increases engagement and enjoyment of the students in solving mathematical word problems. (2) Attitude and confidence levels of students increased using a math journal to solve word problems. (3) Problem solving in mathematical word problems was positively impacted by the use of math journals and writing. Evidence from the present study as well as in existing research supports these conclusions.

Conclusion I

Use of a math journal increases engagement and enjoyment of the students in solving mathematical word problems.

Discussion

From the data analysis, students demonstrated an increased level of engagement and enjoyment while solving math word problems using a math journal. The data showed that students demonstrated an increase in the amount and quality of discussion around the math problems. Research findings indicated an increase in the number of students who were excited

to share their thinking regarding components of the math journal over the duration of the study. On the final self-reflection form, 60% of students indicated they enjoyed solving mathematical word problems using the math journal. In this study, it was noted that as the level of engagement increased, the enjoyment level of mathematical word problem solving in this class increased as well. The data supports that this can be attributed to the students' excitement of having a new strategy that they were finding increased success levels with, and as their perceived success levels increased, so did their level of engagement and enjoyment. This idea was supported by Siskawati et al. (2023), who noted that there was a deeper understanding about mathematical problem solving, contributing to deeper, more engaging mathematical conversation.

The data analysis of other studies also documented an increased level of engagement and enjoyment among students using a math journal to solve mathematical word problems with writing. Guce (2018) noted that students were more willing to engage in mathematical activities following instruction in using writing in mathematical problem solving. In the current study, the researcher noted similar findings. Both Guce (2018) and Siskawati et al. (2023) noted in their research that students shared that they felt the ability to develop a closer relationship with their teachers as a result of sharing their thoughts in their journals. The researcher did not receive this specific feedback from the students in this study. The discrepancy in this finding between the present study and the findings of Guce (2018) and Siskawati et al. (2023) regarding students expressing a closer relationship with teachers using a writing journal in mathematics may be explained by a variety of contributing factors. For example, the unique dynamics between teachers and students in each study may contribute to varying results. The teaching style, level of encouragement for open communication, and the overall classroom atmosphere can impact students' willingness to share thoughts and feelings in their journals. Another variable could be

the methodologies or techniques employed, such as data collection methods, survey instruments, or interview protocols. Any of these factors can contribute to disparities in the findings. The way in which the researchers gathered and interpreted the data may have influenced the results. For the purposes of this study, the researcher feels that due to the small class size and the fact that she has had these students for multiple years and works with them multiple periods per day, the class lends itself to the freedom to express oneself freely and would not be as influenced by the ability to write in a journal to the researcher.

The findings of all the studies indicated above align with Vygotsky's Zone of Proximal Development Theory (ZPD). For children to exceed their learning potential, they would require a scaffold or support from a teacher or peer that can lead them to develop the ability to achieve independence in tasks beyond their ability level. The engagement of the students in conversation around each problem is a scaffold which enables students to benefit from the information shared by their peers and the teacher, thereby increasing their ability level and level of independence.

Conclusion II

Attitude and confidence levels of students increased using a math journal to solve word problems.

Discussion

The data analysis of the students' self-assessment of their problem solving abilities showed that 80% of students scored their problem solving abilities higher by the end of this research. 10% of the students felt less confident in their feelings about their problem solving abilities, and 10% of the students felt no change in their problem solving skills. The majority of students scored their problem solving abilities higher at the end of the research period, demonstrating a positive shift in attitude and confidence in problem solving abilities. The

researcher's documentation in her journal during the instructional sessions serves as supporting evidence, indicating a noticeable upward trend among students' attitudes towards mathematical problem solving. This trend is marked by observable shifts in both attitude and confidence throughout the instructional period.

Other studies that report on the use of writing to influence shifts in attitude and confidence in mathematical problem solving include Kaur and Prendergast (2022), Zeleny (2013), and Guce (2018). In all three studies, the findings supported the impactfulness of writing on mathematical word problem solving in shifting students' attitudes and confidence levels. It was also found that students were more willing to engage in mathematical activities due to their increased confidence levels. In the current study, similar findings indicated that as students' attitudes shifted towards a more positive view of writing in mathematical problem solving, their confidence to speak about their thoughts grew as well. Most students in the current study also rated their problem solving skills better at the conclusion of the research period. The data shows that in most cases, this was true regardless of whether the student was successful in solving the problem correctly the majority of the time.

The positive change in students' problem-solving attitudes aligns with Vygotsky's ZPD theory, which underscores the impact of social interaction, collaborative learning, and instructional support on cognitive development. The documented shifts in attitude and confidence reflect the dynamic nature of the ZPD and highlight the role of scaffolding and cultural influence in the learning process.

Conclusion III

Problem solving of mathematical word problems was positively impacted by the use of writing in math journals.

Discussion

Based on analysis of the data, 70% of students showed an increase in their mean rubric score from the mid-way data collection point to the final day of data collection. The rubric created for this study provided a more comprehensive and nuanced assessment of students' problem-solving efforts, moving beyond a sole focus on the correctness of the answer and included a focus on effort. Use of the rubric created for assessment of the journal entries in this study ensured uniformity of assessment and encouraged a growth mindset by placing value in the process of problem-solving, and recognized students' score improvement as their process and effort improved.

As the study progressed, students demonstrated an awareness of the role of writing in mathematical problem solving. For example, one student asked that as a class we create an anchor chart of the language used in word problems that helped them choose the correct operation. This became a part of our daily routine. Furthermore, students enthusiastically participated in sharing their individual approaches to completing the written section, engaging in respectful agreements or disagreements with their peers. This type of interaction facilitated deeper discussions regarding the language used in the problem, prompting students to articulate the rationale behind their choices when selecting a particular mathematical operation. On the self-reflection form, students indicated that writing out their problem solving strategy encouraged them to think more about the problem.

However, the quantitative data based solely on whether the word problem was solved correctly or incorrectly was inconclusive, with no consistent pattern of results over the course of the research period. This may be in part due to underlying factors or variables that influence the outcomes such as the difficulty of the word problem, or variables within the classroom setting on

a given day. Those variables may include: the impact of the complexity of a problem, internal or external stimuli, or the level of concentration exhibited by the student. Nevertheless, the qualitative data suggests there is an overall feeling that the use of writing in mathematical problem solving had a positive impact on mathematical word problem solving skills. The findings of the current study are strikingly similar to the research findings of Zeleny (2013). Zeleny's study on journal writing in mathematics was the only study where the results of the research were mixed. The quantitative research reflected minimal impact of writing on mathematical problem solving. However, the qualitative research indicated a positive impact. In Zeleny's study (2013), during interviews, students discussed how writing had become an important component of their mathematical problem solving process, as did the students in the current study.

Other studies also reported on the impact of writing in mathematical word problem solving. Hebert et al., (2019), Taban and Cadorna (2019), Gallagher-Immenschuh (2020), and Siskawati et al. (2023) all found that the use of writing in mathematical word problem solving was impactful. A comparison among all the studies listed was the impactfulness of writing in mathematical problem solving, regardless of age or learning ability. The current study was in agreement, noting no distinction between ability levels and positive feelings about writing in mathematical problem solving. Siskawati et al. (2023) also noted that examining students' writing regarding what they do/do not understand about the problem enabled educators to identify and correct errors in mathematical understanding and promote effective problem solving in students. This researcher also found this to be the case in the present study, noting that she had a deeper understanding of the thought processes of some students as a result of their writing, particularly for a student who struggles with verbal communication.

Powell et al. (2021) also supported this finding, reporting that the teachers in their research felt mathematical writing was helpful for students' understanding of mathematical concepts. Their research showed the importance of mathematical writing as a tool to enable students to understand mathematical concepts, explain procedures, and complete word problems. The evidence from the current study supports these findings, with the majority of students indicating that writing had become an important tool in mathematical problem solving.

The findings of all of the above studies align with Vygotsky's Zone of Proximal Development Theory (ZPD). Vygotsky proposed that for students to learn outside of their independent level and exceed their learning potential, they would require a scaffold or support from a teacher or peer. Scaffolds exist to support students in moving to their ZPD, which is outside of their independent level. In this case, the writing format and structure of the math journal acts as a scaffold to support students in developing skills to have a deeper understanding of the skills needed to solve mathematical word problems.

Recommendations for Further Research

Based on the findings of this study of how the utilization of a math journal impacts the problem solving skills of middle school self-contained special education students when addressing math word problems, there are several recommendations for further research. First, this study was targeted to a very specific group. A study that can continue with this concept may extend the research to explore the effectiveness of math journals across different grade levels and learning abilities. It could be beneficial to investigate whether the impact on engagement, enjoyment, attitude, and confidence varies among students in elementary, middle, and high school. Additionally, analyzing the outcomes for students with varying learning abilities to

identify if the use of math journals is equally beneficial for all students or if adjustments are needed for specific groups.

Since there are very few mixed method studies on the process of writing in mathematics, further investigation is needed. It could prove beneficial to conduct a study to investigate the specific writing strategies employed by students in mathematical problem solving. Research to explore what components of writing are specifically effective in this process and examine the relationship between specific writing strategies and problem solving outcomes. This could be useful in developing a theory as to how and why writing impacts mathematical ability. This research could provide a better understanding of the role of writing in facilitating deeper comprehension and effective problem solving skills.

Finally, this study was limited in duration. Further research should be conducted for a longer period of time and could implement follow-up assessments at regular intervals after the intervention to track any changes in students' perceptions and performance over an extended period. This analysis could provide insights into the long-term benefits and potential challenges associated with integrating math journals into the curriculum and assess the sustained impact of using math journals on students' engagement, enjoyment, attitude, and confidence in solving mathematical word problems over an extended period of time. Furthermore, further analysis can provide insight as to the effect, if any, on standardized testing scores.

Recommendations for Teachers

Based on the findings of this study, several recommendations can be made for teachers to utilize to implement or improve upon their use of writing as a tool in mathematical problem solving. For example, given the positive impact observed on students' engagement, enjoyment, attitude, and confidence in mathematical problem solving, teachers are encouraged to consider

incorporating math journals as a regular tool in classroom practices, providing students with opportunities to reflect on and write about their problem-solving strategies, fostering a deeper understanding of mathematical concepts.

The study suggests that increased engagement was linked to the quality and quantity of discussions. Teachers can foster an environment that encourages open discussions around the content of math journals. Encourage students to share their thoughts, strategies, and findings with their peers, promoting collaborative learning, while also informing future instruction.

Finally, teachers can guide students in understanding which components of writing are specifically impactful in this context. This may involve exploring various writing techniques and formats that align with mathematical problem-solving processes. Students can be encouraged to utilize the techniques and formats that they find are most suited for their individual learning styles.

Recommendations for Administrators

Administration may consider the benefits of providing professional development opportunities for teachers to enhance their understanding of incorporating writing in mathematical problem-solving activities. Equipping teachers with strategies to effectively integrate math journals into the curriculum and maximize their benefits may prove to be beneficial. In addition, administrators may consider forming committees of the teaching faculty to explore the potential impact of math journals on standardized testing scores. While the current study did not address this aspect conclusively, further research could investigate any correlation between the use of math journals and standardized test performance. Finally, administrators should encourage collaboration among teachers for sharing best practices related to the use of math journals. This type of collaborative approach can lead to a richer understanding of the

impact on students and facilitate continuous improvement in teaching practices in this area of instruction.

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Appendices

Appendix A. Daily Math Word Problem Journal Sheet

Problem of the Day

Problem itself goes here

What is the problem asking?

| | |
|-----------------------|--|
| Draw a picture | Write a number sentence |
| Your answer | How did you solve the problem: ----- ----- ----- ----- ----- |

Fri-Yay Flashback

Happy Fri-YAY! Think back over what you worked on in your math journal this week. Use this sheet to express your thoughts and feelings about math, your work, or what you've learned. Be honest and try your best to answer the questions.

Some thoughts to get you started may be: **(You may have different ideas!)**

I liked/disliked when...

I need more help with...

I am really good at...

I knew my answer was right when...

Using a math journal is helpful/not helpful because...

On a scale of 1-10, rate your feelings about your problem solving skills::

1 2 3 4 5 6 7 8 9 10

Appendix C. Daily Math Journal Rubric

Math Journal Rubric

| Criteria | 4 (Exemplary) | 3 (Proficient) | 2 (Basic) | 1 (Limited) |
|-----------------------------------|--|--|---|---|
| Mathematical Understanding | Student demonstrates a deep understanding of the mathematical concepts involved and consistently applies them correctly. | Student shows a good understanding of the mathematical concepts and generally applies them correctly. | Student displays some understanding of the mathematical concepts but may make occasional errors. | Student struggles to understand or apply mathematical concepts correctly. |
| Problem Solving | Student consistently solves problems using appropriate strategies, showing clear and logical steps. | Student effectively solves problems using appropriate strategies, with some minor errors or omissions in the solution process. | Student attempts to solve problems but may make significant errors or lack clarity in their solution process. | Student has difficulty solving problems and often provides incomplete or incorrect solutions. |
| Organization | Student organizes their journal entries neatly and logically, making it easy to follow their work. | Student organizes their journal entries in a somewhat organized manner but may have some disorganized or cluttered sections. | Student's journal entries lack clear organization, making it difficult to follow their work. | Student's journal entries are disorganized and chaotic, making it nearly impossible to understand their work. |
| Effort | Student consistently puts forth a high level of effort, and their journal is exceptionally neat and well-presented. | Student occasionally adds creative elements or extra effort to their journal entries. | Student rarely adds creative elements or extra effort to their journal entries. | Student does not demonstrate any creativity or extra effort in their journal. |

| | | | | |
|------------------------------|---------|---------|--------|-------------|
| Overall Score (Out of 16) | (14-16) | (11-13) | (8-12) | Less than 8 |
|------------------------------|---------|---------|--------|-------------|