# EFFECT OF DIRECT INSTRUCTION APPROACH ON MATHEMATICS SKILLS' ACQUISITION AMONG LEARNERS WITH AUTISM IN PUBLIC PRIMARY SCHOOLS WITHIN KAKAMEGA COUNTY, KENYA

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## DECLARATION AND APPROVAL

### Declaration by the Candidate

This project is my original work and has not been, presented for a degree in any other university or for any other award.

Signature: ..... Date:5TH November,2024

**Doreen Khayesi Muchalwa**

**MEDSNE/51859/2016**

### Approval by Supervisors

We confirm that the candidate under our supervision carried out this research project.

Signature: ..... Date: 5TH November,2024

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## DEDICATION

I dedicate this work wholeheartedly to my entire family, who provided me with tremendous moral support, encouragement, and timesaving assistance to succeed in my study.

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## ABSTRACT

Education for Sustainable Development is transformative, providing fresh insights into the world, yet learners with autism encounter persistent hurdles in grasping mathematical concepts, prompting notable apprehensions regarding their academic performance, potentially due to their struggle in attaining the desired goals for acquiring mathematical skills. The purpose of the study was to establish the effect of direct instruction approach on Mathematic skills' acquisition among LWA in public primary schools within Kakamega County, Kenya. The study specific objectives were: Establish the effect of addition by regrouping instruction approach on Mathematic skills' acquisition among Learners with Autism in public primary schools within Kakamega County; assess the effect of addition using counters instruction approach on Mathematics skills' acquisition among Learners with Autism in public primary schools within Kakamega County; determine the effect of addition by breaking apart instruction approach on Mathematic skills' acquisition among Learners with Autism in public primary schools within Kakamega County; and ascertain the effect of addition by counting on instruction approach on Mathematic skills' acquisition among Learners with Autism in public primary schools within Kakamega County. The study drew upon Piaget's Theory of cognitive development and adopted a quasi-experimental design with a non-equivalent control group pre-test post-test approach within a mixed methods framework. Targeting 1853 individuals, including 733 learners with autism and 1120 mathematics teachers, the sample size comprised 318 participants, with 126 learners with autism and 192 mathematics teachers. Employing cluster sampling divided the county into twelve groups, while a stratified random sampling technique created strata of learners with autism and mathematics teachers, with simple random sampling used to select mathematics teachers. Research instruments included the Learners Mathematics Achievement Test, observation guide, and questionnaire, validated by experts from the faculty of education, with a pilot test yielding a Cronbach coefficient of above 0.7. Quantitative data underwent analysis using descriptive and inferential statistics, presented in tables, while observation guide analysis contributed to triangulation. The study uncovered a significant effect of various instructional approaches, including addition by regrouping, using counters, breaking apart, and counting on, on the acquisition of mathematical skills among learners with autism. Conclusively, addition by regrouping ($t=3.092$; P-value=.002; $df=124$), using counters ($t=4.693$; P-value=.000; $df=124$), breaking apart ($t=3.421$; P-value=.001; $df=124$), and counting on instruction approach ($t=4.166$; P-value=.000; $df=124$) were found to positively affect mathematical skills acquisition in this group. The study advocates for further exploration into the mediating effect of the relationship between direct instruction approach and mathematical skills acquisition among learners with autism.

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## LIST OF ABBREVIATIONS AND ACRONYMS

**ASD** : Autism Spectrum Disorder

**DI** : Direct Instruction

**EGMA** : Early Grade Mathematics Assessment

**ESD** : Education for Sustainable Development

**MSA** : Mathematical Skills Acquisition

**NRP** : National Reading Panel

**SDGs** Sustainable Development Goals

# CHAPTER ONE

# INTRODUCTION

## 1.0 Introduction

This chapter delve into giving the, background of the study, purpose of the study significance of the study, scope of this study, limitations and delimitations, assumptions in addition to operational definition of key terms.

## 1.1 Background to the Study

Education for Sustainable Development (ESD) is transformative, offering new perspectives on the world (Grund & Brock, 2020). The integration of mathematics for sustainable education has been significant to the Sustainable Development Goals (SDGs) (Rico, *et al.*, 2021). Despite global momentum, mathematics remains challenging for many learners, especially those with autism (Cox & Jimenez, 2020). These limitations arise from the challenge of meeting the mathematical needs of learners with autism, primarily due to the scarce use of direct instruction approach (Root, Cox, & McConomy, 2022). However, while most developed nations have effectively addressed the challenges of learners with autism, Sub-Saharan Africa faces a significant gap in this regard (Pervin, Ahmed, & Hagmayer, 2022). Thus, subscribing to the direct instruction approach to overcome the constraints of learning mathematics among students diagnosed with autism (Polo-Blanco & González López, 2021). This suggests that direct instruction approach is crucial for addressing the challenges faced by learners with autism in learning mathematics.

Mathematical skills acquisition among learners with autism is the process of improving their understanding and application of mathematical concepts (Cox & Jimenez, 2020).

These learners are affected by autism spectrum disorder (ASD), which presents developmental disability significantly affecting verbal and non-verbal communication and social interaction, that adversely affects their educational experience (Molosiwa, 2023). Effective acquisition of mathematical skills among learners with autism requires specific strategies (Siregar, *et al.*, 2020), such as employing the direct instruction approach to overcome learning constraints in mathematics (Frampton, Munk, Shillingsburg, & Shillingsburg, 2021). This indicates that addressing adverse learning challenges of learners with autism in acquiring mathematical skills necessitates tailored strategies, like the direct instruction approach.

The direct instruction approach systematically guided practice of mathematical concepts to learners, aiming to enhance their comprehension and skill development (Hornby & Greaves, 2022). In teaching mathematics to learners with autism, effective direct instruction involves interventions like addition by regrouping, using counters, breaking apart, and counting on instruction approach (Stockard, Wood, Coughlin, & Khoury, 2020). The link between direct instruction approach and Mathematic skills' acquisition is based on Piaget' Theory of cognitive development that aid in comprehending the cognitive processes of learning math across developmental stages (Du, Liang, Guo, & Xiao, 2024). This infers that employing the direct instruction approach in teaching mathematics to learners with autism improve their mathematic concepts.

Globally, learners with autism frequently encounter substantial challenges and struggle within educational settings (Tonizzi & Usai, 2023). In the United Kingdom, mathematics holds a pivotal role in education. However, the achievement levels of learners with autism remain persistently low, raising concerns among educators and researchers. For instance,

only 33% of learners aged five to seven years old with Special Educational Needs (SEN) in England achieved the expected level in mathematics, in contrast to 84% for learners without SEN (Packer, 2021). Moreover, in Malaysia, learners with autism face notable challenges in mathematics, prompting specialists to implement specific mathematical instructional strategies to improve their comprehension (Siregar, *et al.*, 2020). Similarly, acquiring mathematical skills among learners with autism is a priority in Indonesia, highlighting the need for further research to develop effective teaching strategies that provide autistic learners with a high-quality education (Sabaruddin, Mansor, Rusmar, & Husna, 2020). This highlights the critical need for tailored and effective instructional strategies in mathematics to enhance problem-solving skills and overall learning outcomes for learners with autism, emphasizing further research and implementation to provide a high-quality education for these students.

In Nigeria, some students with autism may have difficulty acquiring mathematical knowledge. However, effective teaching strategies are the use of right instructional techniques and materials to enable pupils learn what is expected of them. In Rwanda, numerous teachers find it challenging to instruct learners with autism spectrum disorder (ASD) within inclusive classrooms, primarily due to their distinct needs and difficulties, leading specialists to introduce tailored mathematical instructional strategies (Ntalindwa, *et al.*, 2022). This implies that that tailored mathematical instructional strategies are essential for effectively teaching students with autism spectrum disorder (ASD) in inclusive classrooms, addressing their distinct needs and difficulties, and enabling them to acquire mathematical knowledge successfully.

In Kenya, mathematics is mandatory at both primary and secondary levels; however, the persistent poor performance in national examinations is a major concern for educators, parents, curriculum developers, and the public, indicating the potential for improvement among learners with disabilities like autism through effective interventions, enabling them to transition from low to high achievers in mathematics (Njoroge, 2022). Moreover, A consortium of experts from the Ministry of Education and its stakeholders collaborated with the Triangle Institute to develop and implement the PRIMR program for Class 1 and 2 in January 2017, following three years of research. Teachers in all public primary and special schools received training in 2017 (Onsare, Mutai, & Milimu, 2022). In Kakamega County, over three consecutive years, enrollment figures for learners with ASD have shown a consistent decline, with poor performance observed in mathematics during examinations.

**Table 1: Number of learners enrolled and dropped out**

| Year | No. Enrolled | No. Dropped Out | Mathematics Mean Scores |
|---|---|---|---|
| 2019 | 20 | 15 | 10.6 |
| 2020 | 12 | 9 | 11.1 |
| 2021 | 19 | 10 | 9.2 |
| 2022 | 15 | 6 | 10.2 |

**Source:** County Director of Education, Kakamega (2022)

Consequently, to enable learners with autism to reach their full potential, there is a pressing need to enhance instructional approaches for acquiring mathematics skills. Therefore, this study aimed to investigate the impact of the direct instruction approach on mathematical

skills acquisition among learners with autism in public primary schools within Kakamega County, Kenya.

### 1.2 Statement of the problem

The essence of acquiring mathematical skills among learners with autism is to provide them with the tools they need to comprehend and apply mathematical concepts for improved academic performance (Cox & Jimenez, 2020). Consequently, for learners with autism to effectively acquire mathematical skills, employing the direct instruction approach is essential (Siregar, *et al.*, 2020). In Kenya, learners with autism consistently face challenges in understanding mathematical concepts, raising significant concerns about their performance. Potentially, this stems from their inability to achieve their intended goals for mathematical skills acquisition. In Kakamega County, there has been a consistent decrease in enrollment of learners with ASD over the past three years, coinciding with poor performance in mathematics exams.

Despite global efforts by governments through Ministries of Education to promote mathematical skills acquisition via policies and strategic plans, challenges persist. Additionally, empirical studies often lack triangulation and use research designs that are incapable of determining causation. In this context, the current study adopted a quasi-experimental research design to determine how the direct instruction approaches of addition by regrouping, using counters, addition by breaking apart, and addition by counting on predict the acquisition of mathematical skills among LWA in public primary schools within Kakamega County, Kenya.

### 1.3 Purpose of the Study

The purpose of the study was to establish the effect of direct instruction approach on Mathematic skills' acquisition among LWA in public primary schools within Kakamega County, Kenya.

### 1.4 Research objectives

This study was channeled by the following research objectives:

i. To establish the effect of addition by regrouping instruction approach on Mathematic skills' acquisition among LWA in public primary schools within Kakamega County
ii. To assess the effect of addition using counters instruction approach on Mathematics skills' acquisition among LWA in public primary schools within Kakamega County
iii. To determine the effect of addition by breaking apart instruction approach on Mathematic skills' acquisition among LWA in public primary schools within Kakamega County
iv. To ascertain the effect of addition by counting on instruction approach on Mathematic skills' acquisition among LWA in public primary schools within Kakamega County

### 1.5 Research Hypotheses

These four null hypotheses were formulated from the aforementioned research objectives, which were tested statistically at 95% confidence level;

**H01:** There is no statistically significant effect of addition by regrouping instruction approach on Mathematic skills' acquisition among LWA in public primary schools

within Kakamega County.

**$H0_2$:** There is no statistically significant effect of addition by using counters instruction approach on Mathematic skills' acquisition among LWA in public primary schools within Kakamega County.

**$H0_3$:** There is no statistically significant effect of addition by breaking apart instruction approach on Mathematic skills' acquisition among LWA in public primary schools within Kakamega County.

**$H0_4$:** There is no statistically significant effect of addition by counting on instruction approach on Mathematic skills' acquisition among LWA in public primary schools within Kakamega County.

### 1.6 Significance of the Study

The research paper's findings will be important to various parties for implementing future policies. First, the Ministry of Education will use the findings to raise awareness about the Direct Instruction Approach (DIA) and its impact on mathematics performance among learners with autism. Second, major stakeholders will address the challenges faced by teachers of learners with autism (LWA) in teaching mathematics. Finally, teachers will develop potential solutions to these challenges.

### 1.7 Scope of the study

The study covered the effects of direct instruction approaches on mathematics skills acquisition among LWA in public primary schools in Kakamega County. The research adopted quasi experimental research design to account for the effect of DI approaches on mathematics skills acquisition among learners with autism.

The study unit of analysis involved mathematics teachers and learners directly and it was carried out in Kakamega County in public primary schools between July and October,2023.

### 1.8 Limitations of the Study

The researcher faced some limitations: some respondents could not provide written information due to motor impairments, making it challenging to interact freely while collecting data. However, this did not hinder the study, as the researcher employed mathematics teachers as research assistants to collect the data.

### 1.9 Delimitations of the Study

This study was delimited to 800 learners with autism and 200 mathematics teachers as the target population. The study concentrated on regrouping instruction approach, addition using counters instruction approach, addition by breaking apart instruction approach and addition by counting on instruction approach on Mathematic skills' acquisition.

### 1.10 Assumptions of the Study

It was assumed that learners with autism had inadequate mathematics skills, teachers used conventional approaches for teaching them, and schools in Kakamega County lacked sufficient infrastructure for educating these learners. The researcher believed these assumptions might have influenced the research methodology and interpretation of the findings.

## 1.11 Operational Definition of Key Terms

**Addition by breaking apart** : This is a strategy that breaks apart numbers according to their place value when adding.

**Addition by counting on** : A strategy that enables children to count in a sequential manner formally.

**Addition by using counters** : A strategy that children use objects that are tangible and real when putting numbers together.

**Autism** : It is a disorder that affects the social, behavior and communication skills of a child.

**Direct Instruction** :. It is a strategy that breaks learning into smaller steps that a learner can easily understand.

**Mathematics skills** : These are abilities to count accurately and make mathematical ideas “real” by using words, pictures, symbols and objects.

**Regrouping:** : This is a strategy of grouping numbers according to their place value when adding

# CHAPTER TWO

# LITERATURE REVIEW

## 2.0 Introduction

This chapter gives a brief summary on the studies relating to the effect of DI on mathematics skill acquisition, theoretical literature and conceptual framework in addition to gaps in the literature review.

## 2.1 Empirical Literature

This section provides literature centered upon specific objectives of the research.

## 2.2 Overview of Direct Instructional Approach

Direct instruction (DI) is an evidence-based educational approach known for its effectiveness across various student populations, with emerging evidence suggesting its efficacy for individuals with autism spectrum disorder (ASD) (Frampton, Shillingsburg, & Simeone, 2020). The Direct Instruction strategy relies on the behavioral approach in which instructions are given explicitly and sequentially when a skill is to be learned, or instructional models are presented without any distractions. This strategy is focused on procedures followed by teachers and the curriculum and identify specifically and explicitly what skills need to be learned step-by-step, instead of leaving students to their own experience. This, of course, improves and accelerates learning in students. The implementation of the Ethnos science-based Direct Instruction Learning Model enhances students' critical thinking skills by linking classroom learning with their everyday experiences, such as through activities like folk music, thereby fostering active engagement in the learning process (Risdianto, Dinissjah, Nirwana, & Kristiawan, 2020).

As an instruction strategy, Direct Instruction typically focuses on accomplishing instructional targets by providing training on skills that are closely related to the targets. Further, it requires well-planned, neat, and organized lessons. Training provided usually revolves around small modules where teacher directs the instructional process depending on the skills acquired, providing a set of procedures that fit with instructional targets and arrange the environment accordingly. The main goal of this strategy is to reach with students to the mastery level before learning a new skill in teaching mathematics to learners with autism, effective direct instruction involves interventions like addition by regrouping, using counters, breaking apart, and counting on instruction approaches (Bouck, Long, & O'Reilly, 2024).

The addition by regrouping instruction approach for learners with autism entails instructing them on adding numbers by regrouping or carrying over the tens place when the sum of digits in a column exceeds nine. This method utilizes strategies like matching, understanding place values, and pairing to aid learners with autism in comprehending and executing addition with larger numbers more effectively (Sari & Jaguthsing, 2021). The addition by using counters instruction approach for learners with autism utilizes physical counters like beads or blocks to represent and manipulate numbers during addition tasks. This method employs numbering, counting, sorting, grouping, and pattern-making to help learners visualize and understand addition concepts more concretely, facilitating their comprehension and application of mathematical principles (Moomaw, 2024).

The addition by breaking apart instruction approach for learners with autism entails breaking numbers into smaller, more manageable parts and then adding them together. This method utilizes sorting, grouping, pairing, and number recognition to help learners with

autism understand addition by simplifying complex calculations into smaller steps, facilitating their comprehension and problem-solving in mathematics (Elfakki, Sghaier, & Alotaibi, 2023). The teaching of math skills remains a basic part of the elementary school math curriculum. Outcome research has shown that students with learning disabilities often use slow counting strategies (e.g. finger counting) to solve basic mathematical problems. These strategies typically result in a general lack of speed in computing math problems, which can dramatically diminish the student's performance of mathematical functions commensurate with peers and the requirements of many math related tasks. The addition by counting on instruction approach for learners with autism begins with one number and then incrementally adding the other number to it. This method utilizes counting, concrete objects, pattern ordering, and sequencing to aid learners in developing their counting skills and comprehending addition by visually and sequentially adding numbers, thereby enhancing their understanding of mathematical concepts (Suprihatin, Yufitriani, & Mulyeni, 2023).

### 2.2.1 Addition by Re-Grouping Instructional Approach and Learners' MSA

The addition by regrouping instructional approach is a teaching method designed to help learners understand and master addition concepts by breaking down numbers into their components and rearranging them to simplify calculations. In this approach, learners are taught strategies to regroup or carry over values when adding multi-digit numbers, enabling them to perform addition operations efficiently. By emphasizing the concept of place value and the significance of each digit's position in a number, learners with autism spectrum disorder (ASD) can grasp the mechanics of addition more effectively. Through guided practice and reinforcement, learners develop proficiency in regrouping numbers and

applying these strategies to solve addition problems accurately and confidently. This instructional approach fosters a deeper understanding of addition principles and empowers learners to tackle increasingly complex mathematical tasks with greater ease and proficiency (Wang, Wang, Raymond, & Wang, 2023).

Goñi-Cervera and Jacinto (2024) conducted a study on enhancing inconsistent language problem-solving in an autistic student through a modified schema-based instruction. The study revealed that the use of a matching strategy to helps learners with autism solve mathematical problems, thus enhance the mathematical problem-solving abilities. However, the studies reliance on a single-case analysis and lack of a control group limited the generalizability and robustness of the findings. Powell, Akther, Yoon and Roberts (2023) The study evaluated the impact of Addition and Subtraction Practice in a Word-Problem Intervention on Addition and Subtraction outcomes, indicating that learning addition and subtraction computation frequently involves using objects or drawings to aid students in comprehending place value, such as hundreds, tens, and ones, and how to regroup between different place values.

Shurr, Bouck, Bassette and Park (2021) conducted a study on virtual Versus Concrete: A Comparison of Mathematics Manipulatives for Three Elementary Students with Autism. The study indicated that utilizing place value helps learners with autism enhance their acquisition of mathematics skills. The relevance of this literature to a current study lies in its exploration of different instructional approaches, particularly virtual manipulatives, which may offer valuable insights into enhancing mathematical skill acquisition, including the regrouping technique, for elementary students with autism spectrum disorder (ASD).

The studies reliance on a small sample size and lack of long-term follow-up assessments limited the generalizability and robustness of the findings.

Folostina and Michel (2022) examined teaching mathematics to children with autism: Pedagogical strategies. The study revealed that understanding number value help the autistic children to learn basic mathematic. The relevance of this literature to a study on addition by regrouping lies in its recognition of the challenges children with autism face in learning mathematics, offering methodological solutions that informed the current study. However, the study lacked empirical evidence to support its claims and for not providing specific, detailed methodologies that can be practically implemented to improve mathematical abilities in children with autism.

Jitendra and Hoff (2018) examined the impact of the DI method on word problem-solving abilities among individuals. Three students, aged between eight and ten, were enrolled in classes three and four at a private primary school for pupils with learning impairments. Miller, Kaffar, and Mercer (2019) taught addition with regrouping to students struggling with learning, using an instructional technique that involved a concrete representation of an abstract linear arrangement with physical objects. The lesson incorporated two mathematical techniques, RENAME and FAST RENAME, as well as a sequence that concretely represented abstract concepts. The results revealed that students with disabilities improved their ability to solve word problems and addition problems with regrouping.

### 2.2.2 Addition by Counters Instructional Approach and Learners' MSA

The addition by using counters instructional approach is a pedagogical method aimed at facilitating learners' grasp of mathematical addition by employing tangible objects, such as

counters or manipulatives, to represent numerical quantities. In this approach, learners with autism spectrum disorder (ASD) manipulate physical counters to model addition operations, allowing them to concretely visualize the mathematical process. By physically manipulating counters, learners can engage their senses and enhance their understanding of addition concepts, such as combining quantities and counting to find the total. This hands-on approach provides learners with a concrete representation of abstract mathematical ideas, making addition more accessible and comprehensible. Through repeated engagement with counters, learners develop a deeper conceptual understanding of addition and build foundational mathematical skills in a supportive and interactive learning environment tailored to their individual needs (Young, Reed, Rosenberg, & Kook, 2023).

Ingelin, Intepe-Tingir and Hammons (2023) explored increasing the Number Sense Understanding of Preschool Students With ASD. The study indicated that increasing the number sense helped learners enhances their acquisition of mathematics skills. This literature is relevant to a study on using counters as it demonstrates the effectiveness of combining constructivist approaches and systematic instruction to enhance number sense skills in preschool children with ASD, suggesting similar strategies could be beneficial for using counters in teaching mathematics. However, the literature lacks detail on the specific adaptations made to the Number Talks approach and does not address the long-term sustainability of the observed improvements in number sense skills among preschool children with ASD.

Folostina and Michel (2022) examined teaching mathematics to children with autism: Pedagogical strategies. The study revealed that counters improve children's ability to retain

mathematical concept due to commensurate time they spend time doing activities that are related to number and the number system with the counters. The relevance of this literature to a study on addition by regrouping lies in its recognition of the challenges children with autism face in learning mathematics, offering methodological solutions that informed the current study. However, the study lacked empirical evidence to support its claims and for not providing specific, detailed methodologies that can be practically implemented to improve mathematical abilities in children with autism.

Burris, (2019) finds counters a good aid in teaching number recognition since they change abstract concepts to become concrete. The majority of the studies indicate that mathematics achievement increases when counters as manipulative instructional resources are well utilized in learning (Joyce, 2019). Many researchers say that counters help retain mathematical concepts including number recognition for a long span. Silver (2019) that counters help retain mathematical concepts including number recognition for a long span. Jimenez and Besaw (2020) pattern making increase early numeracy outcomes thus enhance their acquisition of mathematics skills.

Hungary, Jenny (2019), in assessment of a math lesson presentation of concept six as a numeral to learners, used six sets of objects, he identified a set of things that were tangible in order to ascertain the value of six being used by the teacher. This was successful because it produced a favorable result when learners took a test to determine the sum of six. Kids were allowed to use tools like beads and threads to experiment and figure things out on their own. Fiona, (2021), stated that counters improve children's ability to retain mathematical concept due to commensurate time they spend time doing activities that are related to number and the number system with the counters. Counters in preschool help in

the counting process which is hierarchical in nature. In counting the lower numbers are simple whereas the understanding of the later number is a bit challenging.

### 2.2.3. Addition by Breaking Apart Instructional Approach and Learners' MSA

The addition by breaking apart instructional approach is a teaching method designed to facilitate learners' understanding of mathematical addition by decomposing numbers into smaller, more manageable parts. In this approach, learners are encouraged to break down larger numbers into simpler components, such as place value units or friendly numbers, before adding them together. By deconstructing the numbers, learners with autism spectrum disorder (ASD) can approach addition problems in a step-by-step manner, focusing on smaller increments rather than tackling the entire sum at once. This method allows learners to visualize the addition process more clearly and reinforces their comprehension of addition principles. Through repeated practice and reinforcement, learners develop fluency in addition skills while gaining confidence in their mathematical abilities. The addition by breaking apart instructional approach promotes a deeper conceptual understanding of addition and supports the individualized learning needs of learners with ASD by providing a structured and systematic approach to mathematical problem-solving (Rivadeneira & Inga, 2023).

Bresser, Carve and Holtzman (2018) The study focused on mathematics skills and problem-solving concepts through the breaking apart instruction approach, providing two activity options for students to practice throughout the day. One option targeted kindergarten and grade one learners, while the other was designed for grade two students, aiming to enhance numerical reasoning, equation writing, and understanding the relationship between addition and multiplication. Introducing learners with ASDs to

addition by breaking apart can help them recognize numbers with their place value. Alabdulaziz (2024) assessed whether using video modeling (VM), concrete manipulatives, a self-monitoring checklist, and practice for comprehension check impacted the extent to which five primary school students with autism spectrum disorder (ASD) could accurately solve problems involving fractions. The sample of the study was purely comprised of five students owing to the challenges associated with eliciting approval to extend the study to a larger sample. A single-case multiple probes between participants experimental approach in its quasi-experimental design was employed to evaluate whether a significant association could be identified between these variables. The results revealed that from baseline to intervention, all five students solved simple proper fraction problems with greater accuracy and four were able to apply this ability to solve problems involving whole proper fractions.

In a study by Saha (2018) investigating mathematics academic achievement, attitudes, and cognitive styles, significant differences were observed between males and females across the three variables. The independent group of boys outperformed the dependent group in mathematics achievement, similar to the results observed for girls. This suggests that implementing the direct instruction approach in teaching learners with ASDs could potentially improve their performance in mathematics. Goñi-Cervera, Polo-Blanco, Bruno and Fernández-Cobos (2024) that pairing using blocks assist students improve their mathematics skills performance. Xavier and Annaraja's (2019) study on the effectiveness of multiple intelligence-based teaching among standard VI learners demonstrated notable disparities between the gain scores of learners and their performance in multiple intelligences across control and experimental groups. The findings indicated a significant positive score of 10% in the control group and 26.67% in the experimental group. However,

no significant difference was observed between the control and experimental groups in terms of their multiple intelligence profiles. Polo-Blanco, Suárez-Pinilla, Goñi-Cervera, Suárez Pinilla and Payá, (2024) that utilizing grouping helps learners with autism heighten their mathematical problem-solving performance.

Saileela, (2019) examined the relationship between self-regulation, efficacy, and attitudes toward mathematics and academic achievement among higher secondary pupils. The goal was to compare these factors in relation to performance on mathematical achievement tests. The researcher administered a random sample of 1000 questions to first-year higher secondary students. The results showed that boys' mathematics achievement was significantly higher than that of girls. Kumas and Yıldırım (2024) assessed the effectiveness of a program aimed at improving the early numeracy skills of students with moderate intellectual disability. The persistence of the acquired skills and the program's impact on learning were monitored. Feedback from the students and their mothers was also gathered. Using a multiple-probe design across subjects, the results were visually presented through graphical analysis. Three male students aged 8–9 years participated. After obtaining high-reliability findings from reliability analyses, results showed the program effectively increased students' number skills with a high effect size. These skills persisted post-intervention, and both students and mothers expressed positive views of the intervention.

### 2.2.4 Addition by Counting Instructional Approach and Learners' MSA

The addition by counting instructional approach is a pedagogical method aimed at teaching learners' mathematical addition skills through systematic counting procedures. In this approach, learners are guided to add numbers by physically counting objects, such as

counters or other tangible items, to represent each numerical value involved in the addition process. Through this method, learners with autism spectrum disorder (ASD) are provided with concrete, hands-on experiences to grasp the concept of addition. The approach typically involves breaking down the addition process into smaller, manageable steps, allowing learners to visually and kinesthetically engage with the mathematical operations. By incorporating tactile and visual elements, the addition by counting instructional approach caters to the diverse learning needs of individuals with ASD, fostering a deeper understanding of mathematical concepts and promoting skill acquisition in addition operations (Powell, *et al.*, 2023).

One of the fundamental mathematical concepts' children have learned for generations is counting, which they practice both formally and informally through interactions with others in their environment. A learner is taught that each item has a unique name and is counted only once during the counting process. The learner also grasps the order principle, which states that the sequence of number names remains consistent when counting a set of objects. In English, this sequence is one, two, three, four, five, six, seven, eight, nine, ten (Gelman & Gallistel, 2019). Alghamdi (2024) conducted a study on evidence-based practices: using the touch points strategy to teach single-digit addition to students with ASD. The researchers conducted single-subject research using a reversal design (A-B-A-B) to determine the intervention's effect on three students with ASD as the main data source. Additionally, an interview with the math teacher of these participants was conducted to gather more in-depth data, which helped explore the effectiveness and challenges of using the touch-point strategy in teaching math addition facts to Saudi students with ASD. Significant improvements in computation and acquisition rate were

noted among all participants when the strategy was used to solve single-digit addition problems. Two major themes emerged from the analysis of the interview data: the need for resources to teach the strategy and challenges in implementing the touch-point strategy across the whole class, given the individual needs of each student. The study revealed that that adding two numbers by counting the dots on both numbers helped learners enhances their acquisition of mathematics skills.

When counting, children initially use direct modeling strategies, such as using fingers and other objects to represent the problem. As they master these modeling strategies, they progress to more efficient and abstract counting methods. The learner understands the answer to "how many?" by grasping the cardinal principle, realizing that the total number of items is represented by the last number counted (Carpenier *et al.*,2018). Goñi-Cervera, Polo-Blanco, Tregón and Bruno (2024) assessed the effectiveness of concrete-representational-abstract sequence (CRA) in teaching children with autism spectrum disorder (ASD) the acquisition of the cardinal principle. The research followed a single-subject, multiple-probe across-participants design. The results showed a functional relationship between CRA sequence and the acquisition of the cardinal principle by the three participants. The acquired skills were maintained up to 16 wk after the completion of the intervention. Moreover, children were able to generalize the skills to situations other than the instructional context. Social validity data collected from the children's families and teachers indicated that both groups had a positive perception of the teaching experience. It further revealed that concrete-representational-abstract sequence (CRA) in teaching children with autism spectrum disorder (ASD) heighten their acquisition.

TaMunn (2018) conducted a study on children's beliefs about counting and found that preschoolers had little to no understanding of the adult purpose of counting. Interestingly, Munn's research revealed that children believed in counting simply because they knew it involved naming number words in the correct order. Rosli, *et al.*, (2023) that skills acquired by mathematics ordering of patterns enhance Mathematics Abilities on Children with Autism Spectrum Disorder (ASD) of mathematics skills. Readers have likely heard friends or relatives boasting that their child could count at just three years old. While counting is the foundation of early arithmetic concepts, the downside is that a student might be introduced to more challenging concepts before fully understanding what counting entails. By having practitioners understand the basic concepts of counting, the challenges kids could encounter on their way to mastering the skill might be avoided (Dolman, 2019).

Kaya and Yildiz (2023) determine the effectiveness of the concrete-representational-abstract (CRA) sequence presented by the explicit instruction in teaching the skills of basic addition and subtraction, building tens-and-ones to a student with special needs in a general education classroom. A multiple probe across skills single case research design was used to evaluate the CRA sequence. The research was carried out with a seven-year-old female student diagnosed with autism spectrum disorder (ASD). It was determined that the participant gained the math skills taught with the CRA sequence, and these skills were displayed two, three, and four weeks after the intervention ended. In addition, it was observed that the student was able to generalize these skills to another environment and person. Social validity findings show that the mother has positive opinions about teaching math skills with CRA sequence.

## 2.3 Theoretical Framework

This study was guided by two theories, that is the Piaget' theory of cognitive development and Armstrong's Theory of Mind (ToM).

**Theory of Cognitive Development**

Piaget's (1967) theory of cognitive development examines the learning sequences that kids adhere to. As per Piaget, children undergo through four phases of cognitive development. The pre-operational period, often known as the second stage, lasts for two to seven years. At this level, the child learns at a time main attributes of a situation. He/she may not make numerous comparisons and may not conserve quantity. The child learns how to classify since he/she is capable of making global comparisons. The learner discriminates shapes and colors visually. The child compares objects and number representation at a later stage. Matching is a fundamental ability that must be mastered, starting with smaller things and progressing to matching of various objects and groupings of objects. The learner develops numerous skills leading to higher level of mathematics performance at the end of this stage. The concrete operating stage, which lasts for 7 to 11 years, is the last. Children start to challenge impressions and pick up on logical thinking at this point. Kids start to influence their surroundings, primarily through mental images. Children develop flexibility and reversibility of mind at this age, along with an awareness of conservation.

## 2.4 Conceptual Framework

Is the correlation relating to the independent linked alongside dependent variables within a table.

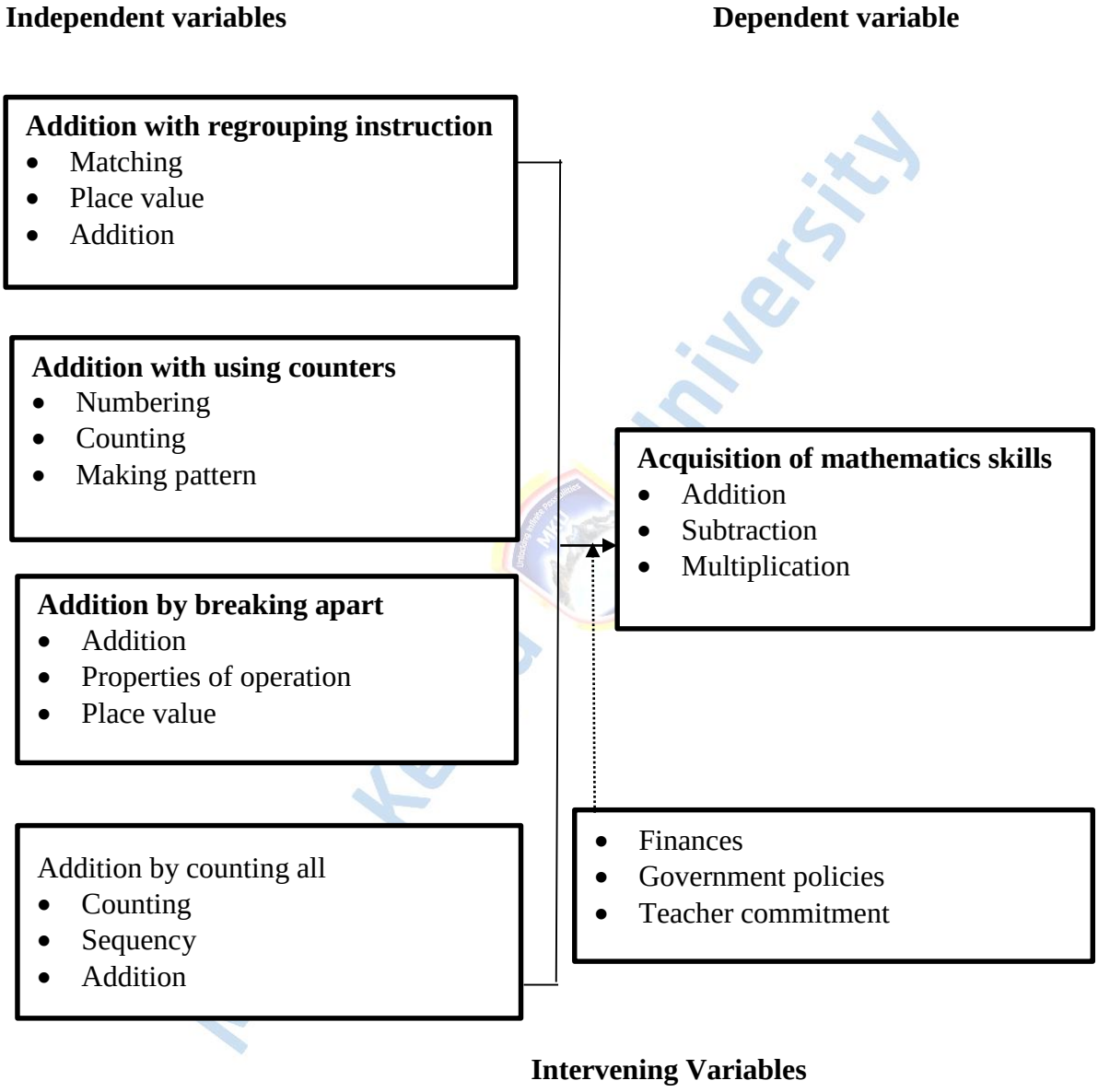



**Figure 1: Conceptual framework**
**Source: Researcher (2022).**

The study established the effect of the Direct Teaching Method on students with autism in Kakamega Central Sub-County public schools, with the primary objectives being to assess the effects of addition with regrouping, using counters, breaking apart, and counting on instruction approaches on mathematics performance among learners with autism. Additional factors influencing success included institutional leadership, finances, teamwork, peer groups, government policies, and teacher commitment.

## 2.5 Research Gap

The literature review highlighted a lack of attention given to learners with ASDs compared to typically developing children, prompting continued interest across various research fields. While legal frameworks support inclusion for students with autism, significant gaps remained, including those addressed by this study. Notably, existing research on teaching methods for students with learning disabilities often prioritized language, reading, and writing over mathematics, indicating a need for interventions to address foundational math skills.

## 2.5 Recap of Literature Review

The National Association of Math Teachers conducted numerous studies on teaching core arithmetic concepts to struggling students, aiming to enhance memory retention and overall performance in math classes by fostering a deeper understanding of numerical relationships. However, most research focused on learners with learning disabilities or typically developing and preschool children, overlooking those with autism. Given the limited literature on this topic, especially regarding the impact of Direct Instruction (DI) on mathematics skills acquisition among learners with autism, this study fills a critical gap by examining the effectiveness of DI on learners with ASDs in Kakamega County and beyond.

# CHAPTER THREE

# RESEARCH DESIGN AND METHODOLOGY

## 3.0 Introduction

This chapter gives highlights on the research design and methodology, where the study will be carried out, target population, sampling procedures, data collection procedures, analysis and presentation, reliability besides research instruments as well ethical considerations.

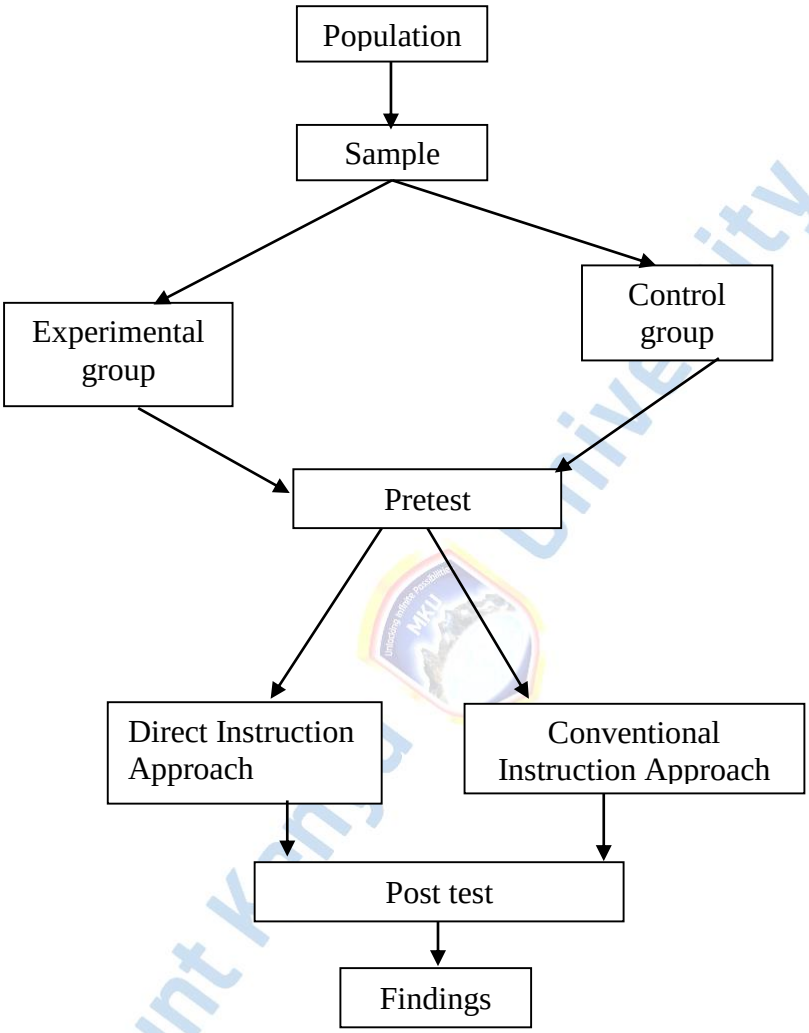
## 3.1 Research Methodology

The researcher employed a mixed-methods approach, gathering both qualitative and quantitative data. For this investigation, questionnaires and observation schedules served as the primary data collection instruments. The numerical data obtained was then analyzed using statistical methods.

## 3.2 Research Design

The study employed a quasi-experimental research design, which effectively addressed time and logistical constraints often associated with numerous true experimental designs. The results derived from this design corroborated the findings of the case studies. A quasi-experimental approach minimizes the time and resources required by conducting thorough prescreening, eliminating the need for randomization. However, this research design can lead to non-equivalent test groups, potentially limiting the generalizability of the findings to a broader population due to the absence of random assignments (Campbel & Stanley, 2015). This design employed pretest and posttest assessments to evaluate the results, comprising both oral and practical components. These assessments evaluated four activities essential for mastering mathematical skills related to addition: addition by

regrouping, addition by counting on, addition using counters, and addition by breaking apart.




**Source:** Adapted and modified from Shadish, Cook and Campbell**, (2002)**

**Figure 2: Model of the quasi experiment**

As depicted in Figure 2, this research design involved dividing the sample into two treatment groups: experimental and control. Both groups underwent pretesting, after which the experimental group received intervention while the control group remained unchanged.

The intervention consisted of four activities aimed at enhancing mathematics skills acquisition related to addition.

### 3.3 Location of the Study

This study was conducted in Kakamega County in western Kenya. Kakamega is bordered by Vihiga County to the south, Siaya County to the west, Bungoma and Trans Nzoia Counties to the north, and Nandi and Uasin Gishu Counties to the east. The county covers an area of 3,033.8 square kilometers and has a population of 1,660,651 people. It is divided into twelve sub-counties and has a total of 1,406 schools, including 1,012 primary schools and 394 secondary schools. Approximately 800 learners with autism reside in the county.

### 3.4 Target Population

A target population is the specific group of individuals or entities that a researcher aims to study and draw conclusions from (Mugenda & Mugenda, 2003). The study targeted 1853 individuals comprised of 733 learners with autism and 1120 mathematics teachers.

**Table 2: Target Population**

| Sub counties | No. of learners with Autism | Mathematics Teachers |
|---|---|---|
| Butere | 65 | 90 |
| Kakamega Central | 64 | 327 |
| Kakamega South | 77 | 102 |
| Kakamega East | 67 | 62 |
| Kakamega North | 60 | 55 |
| Mumias | 51 | 70 |
| Matete | 69 | 30 |

| | | |
|---|---|---|
| Lugari | 15 | 168 |
| Likuyani | 55 | 89 |
| Matungu | 73 | 47 |
| Khwisero | 68 | 45 |
| Navakholo | 69 | 35 |
| **Total** | **733** | **1120** |

**Source: County Director of Education, Kakamega(2022)**

### 3.5 Sample Size and Sampling Procedures

A sample is a carefully selected subset of a target population that represents all the main traits of the population (Orodho, 2002). A formula by Fisher (1963, as cited by Kothari, 2004) was employed in calculating the size of the sample as follows:

$n = z^2pq/d^2$

$$n = \frac{(1.96^2)\ (0.5)\ (0.5)}{(0.05)^2}$$

$n = 384$

Where:

n = the desired sample size

z = the standard normal deviation at the required C.I = 1.96

p = proportion in the target population is estimated to have characteristics of interest = 0.5

q=1-p=0.5, d=the level of statistical significance set = 0.05.

Since the target population is less than 10,000, the following formula will be used to determine the actual sample size:

$$nf = \frac{n}{1+n/N}$$

$$nf = \frac{384}{1+384/1853}$$

$$= 318$$

Sampling is the technique used to select a representative group of subjects from a defined population (Orodho, 2002). This study employed a cluster sampling technique to divide the county into twelve groups, referred to as clusters (Sub-Counties). After forming the twelve clusters, a stratified random sampling technique was used to create strata consisting of learners with autism and mathematics teachers. Within each stratum, simple random sampling was then used to select mathematics teachers, who are considered to be well-informed about the direct instruction approach and the acquisition of mathematics skills among learners with autism in public primary schools. As shown in Table 2, Learners with Autism are denoted as LWA, and Mathematics teachers are denoted as MT.

**Table 3: Sampling Frame**

| **Sub counties** | **Category** | **Target Population** | **Proportional Allocation $n_i=(N_i/N) *n$** | **Sample size (n)** |
|---|---|---|---|---|
| Butere | LWA | 65 | (65/733) *126 | 11 |
| | MT | 90 | (90/1120) *192 | 15 |
| Kakamega Central | LWA | 64 | (64/733) *126 | 11 |
| | MT | 327 | (327/1120) *192 | 56 |
| Kakamega South | LWA | 77 | (77/733) *126 | 13 |
| | MT | 102 | (102/1120) *192 | 17 |
| Kakamega East | LWA | 67 | (67/733) *126 | 12 |

| | | | | |
|---|---|---|---|---|
| Kakamega North | MT | 62 | (62/1120) *192 | 11 |
| | LWA | 60 | (60/733) *126 | 10 |
| Mumias | MT | 55 | (55/1120) *192 | 9 |
| | LWA | 51 | (51/733) *126 | 9 |
| Matete | MT | 70 | (70/1120) *192 | 12 |
| | LWA | 69 | (69/733) *126 | 12 |
| Lugari | MT | 30 | (30/1120) *192 | 5 |
| | LWA | 15 | (15/733) *126 | 3 |
| Likuyani | MT | 168 | (168/1120) *192 | 29 |
| | LWA | 55 | (55/733) *126 | 9 |
| Matungu | MT | 89 | (89/1120) *192 | 15 |
| | LWA | 73 | (73/733) *126 | 13 |
| Khwisero | MT | 47 | (47/1120) *192 | 9 |
| | LWA | 68 | (68/733) *126 | 12 |
| Navakholo | MT | 45 | (45/1120) *192 | 8 |
| | LWA | 69 | (69/733) *126 | 12 |
| | MT | 35 | (35/1120) *192 | 6 |
| **Total** | **LWA** | **733** | (733/1853) *318 | **126** |
| | **MT** | **1120** | (1120/1853) *318 | **192** |

**Source (Researcher, 2022)**

### 3.6 Data collection Instruments

A research instrument encompasses any tool, technique, or device utilized for data collection in a research endeavor, such as surveys, questionnaires, tests, or observations. Commonly employed instruments include questionnaires, interview schedules, and observation forms (Orodho, 2004). In this study, the Learners Mathematics Achievement Test (LMAT) was employed to assess the mathematics skills of learners with autism. It was administered to learners from one control and one experimental group as a pre-test immediately preceding the experiment, and then to both groups again as a post-test following the experiment. An observation guide was utilized by the researcher during the experiment to monitor learners' activities as they engaged in collaborative tasks. Additionally, a mathematics teacher's questionnaire was distributed to elicit their perspectives on the use of direct instruction approach.

### 3.7 Piloting of Research Instruments

Piloting research instruments involves testing and refining research tools on a small scale before conducting the actual study to ensure their effectiveness and reliability (Orodho, 2002). Two schools in Bungoma County participated, although they were not included in the actual data collection process. The study's findings were utilized to assess the reliability and validity of the research tools. The study assessed both accuracies along with dependability of the data collection methods.

#### 3.7.1 Validity of Research Instrument

The validity of a test is a crucial aspect of a research instrument, encompassing various types such as construct, content, and criterion validity (Wiersma, 2000). Validation of the instruments involved supervisors and professionals from the Education department of the university. Tests were conducted based on the standards set by the Kenya National

Examination Council, utilizing pre-set examinations from past papers of the Kenya Certificate of Primary School Examination.

### 3.7.2 Reliability of Research Instruments

This refers to the ability of a tool to consistently produce the same results when subjected to repeated trials or conditions (Orodho, 2009). The reliability of the questionnaires was assessed using a test-retest method, where they were administered and then re-administered after a two-week interval. The results obtained are presented in Table 3.

**Table 4: Reliability test**

**Reliability Statistics**

| | Cronbach's Alpha | No. of Items |
|---|---|---|
| Addition by regrouping | .784 | 4 |
| Addition by breaking apart | .786 | 4 |
| Addition by using counters | .882 | 4 |
| Addition by counting on | .874 | 4 |

**Source (Researcher, 2024)**

As depicted in Table 3, addition by regrouping comprised four items with a Cronbach alpha coefficient of 0.784, addition by breaking apart included four items with a Cronbach alpha coefficient of 0.786, addition by using counters consisted of four items with a Cronbach alpha coefficient of 0.882, and addition by counting on had four items with a Cronbach alpha coefficient of 0.874. Typically, an acceptable alpha should be 0.70 or higher (Gliem & Gliem, 2003). Since the Cronbach alpha coefficients exceeded this minimum threshold, the items were deemed reliable.

### 3.8 Data Collection Procedures

The researcher obtained authorization from The National Council of Science and Technology and Innovation (NACOSTI) and secured clearance from the County director at the Ministry of Education Kakamega County office. Additionally, permission was sought from the Head Teachers of the selected schools. After obtaining authorization, the identified primary schools were visited to familiarize with the mathematics teachers. Two experienced teachers were assigned to each experimental and control group. The researcher sought guidelines on training materials from the Kenya Institute of Curriculum Development (K.I.C.D) and provided one week of training to the two teachers in each experimental group on employing the direct instruction approach prior to the treatment initiation. Control group teachers were instructed to follow the regular teaching methods outlined in the Kenyan Primary school curriculum. Both selected teachers had similar experiences in teaching mathematical skills. Mathematics lessons were conducted according to the school timetable. Before treatment initiation, a pre-test was administered to both experimental (N1) and control (N2) groups. Treatment commenced with the experimental groups (N1) receiving the intervention. At the study's conclusion, Learners Mathematics Achievement Test was administered as a post-test to both groups. Mathematics teachers were provided with a questionnaire to assess their views on the use of the direct instruction approach, and the researcher also observed learners' activities.

### 3.9 Data Analysis Methods

As conclusion is crucial, data must be analyzed after being collected, organized, examined, and entered into the SPSS program (Kate Williams, 2022). The study utilized Statistical Package for the Social Sciences (SPSS) Version 27 for data analysis. Data collected from

the study underwent analysis employing descriptive statistics such as mean scores and standard deviations, as well as inferential statistics including t-tests conducted on the Learners Mathematics Achievement Test (LMAT). The results were organized in tables, comparing outcomes between the experimental and control groups to determine the impact of the direct instruction approach on mathematics skills acquisition among learners with autism in public primary schools within Kakamega County, Kenya. Significance testing was conducted at a significance level of 0.05. Quantitative data was presented using tables, while qualitative data was conveyed through reporting and narration.

### 3.10 Ethical Consideration

Prior to conducting the research, the respondents' permission was requested. They were not required to write their names or provide other forms of identification, ensuring their identities remained confidential. The data was kept secure, and the respondents' rights to privacy and protection were upheld. Participants had the right to withdraw voluntarily from the study at any time. Additionally, the assessments were brief and not distressing.

# CHAPTER FOUR

# RESULTS AND DISCUSSION

## 4.0 Introduction

This chapter presents the results of data analysis. The study established the effect of direct instruction approach on Mathematic skills' acquisition among LWA in public primary schools within Kakamega County, Kenya. The chapter is divided into various sections namely response rate, the demographic information of the participants and the study objectives specifically: Establish the effect of addition by regrouping instruction approach on Mathematic skills' acquisition among LWA in public primary schools; assess the effect of addition using counters instruction approach on Mathematics skills' acquisition among LWA in public primary schools; determine the effect of addition by breaking apart instruction approach on Mathematic skills' acquisition among LWA in public primary schools; and ascertain the effect of addition by counting on instruction approach on Mathematic skills' acquisition among LWA in public primary schools within Kakamega County. The chapter opens with the response rate and then demographic information of the participants.

## 4.1 Questionnaire Response Rate

Out of the 192 questionnaires distributed to the respondents, 178 were returned for analysis, representing a response rate of 92.7%. According to Mugenda and Mugenda (1999), a response rate of 70% and above is considered adequate, thus the achieved rate of 92.7% was acceptable for data analysis. Table 5 illustrates the response rate.

**Table 5: Response rate**

| Questionnaire | Frequency | Percentage |
|---|---|---|
| Administered | 192 | 100.0 |
| Returned | 178 | 92.7 |

**Source (Researcher, 2024)**

### 4.2 Demographic Characteristics of the Respondents

Among the demographic information sought were; gender, academic qualification, number of years taught in the present schools and the professional qualification. These variables were considered to have an effect on the relationship between direct instruction approach on Mathematic skills' acquisition among LWA in public primary schools. The results of data analysis are presented in Table 6.

**Table 6: Demographic Information**

| Indicator | Response Categories | Frequencies | Percentages |
|---|---|---|---|
| **Gender** | Male | 108 | 60.7 |
| | Female | 70 | 39.3 |
| | **Total** | **178** | **100** |
| **Academic** | Teachers Training College | 116 | 65.2 |
| **Qualification** | University | 62 | 34.8 |
| | **Total** | **178** | **100** |
| **Period Taught at the** | 0-2 years | 48 | 27.0 |
| **School** | 3-4 years | 38 | 21.3 |
| | 5-6 years | 63 | 35.4 |

| | | | |
|---|---|---|---|
| | 7 years and above | 29 | 16.3 |
| | **Total** | **178** | **100** |
| **Professional** | P1 | 88 | 49.4 |
| **Qualification** | Diploma in Education | 28 | 15.7 |
| | Bachelor of Education | 53 | 29.8 |
| | Post Graduate Degree in Education | 9 | 5.1 |
| | **Total** | **178** | **100** |

**Source (Researcher, 2024)**

Table 6 shows that the majority 108(60.7%) of the respondents were males, while 70(39.3%) were female. This indicates that the principle of the two-thirds gender rule for employment was adhered to. Moreover, majority 116(65.2%) of the respondents had college (Teacher's training) level of education, while 62(34.8%) had university level. This implies that most of the respondents possess a college-level education, which is a requirement for teaching in primary schools. On period taught in the schools, 63(35.4%) had taught in that school for a period of 5-6 years, 48(27%) 0-2 years, 38(21.3%) 3-4 years, 29(16.3%) 7 years and above. This suggests that respondents, having taught at the school for several years, possess a deeper understanding of the school's culture, pupils need, and educational challenges, allowing them to offer more informed and insightful feedback. Lastly, on the professional qualification, 88(49.4%) of the respondents had P1 qualification, 53(29.8%) Bachelor of Education and 9(5.1%) had Post Graduate Degree in Education. This implies that most of the respondents hold a P1 professional qualification, which is required for teaching in primary schools.

### 4.3 Effect of addition by regrouping instruction approach on Mathematical Skills' acquisition among LWA in public primary schools

The preferred inferential statistic for analyzing data from the Learners Mathematics Achievement Test (LMAT) was the independent sample t-test, along with mean and standard deviation calculations from LMAT. Additionally, descriptive statistics, including frequency and percentages, were utilized from the mathematics teachers' questionnaire to gauge the level of agreement on a five-point Likert scale. This approach helped ascertain the effect of addition by regrouping instruction on mathematics skills acquisition among learners with autism (LWA) in public primary schools, initiating with descriptive statistics of the variable addition by regrouping instruction approach.

#### 4.3.1. Descriptive statistics for effect of addition by regrouping instruction approach on mathematical Skills'

The mean and standard deviation derived from the Learners Mathematics Achievement Test (LMAT) were established and summarized in Tables 7 and 8. Additionally, frequency and percentage ratings of mathematics teachers' perceptions for each questionnaire item were established and summarized in Table 9. The analysis commenced with the mean and standard deviation of the variable representing the effect of addition by regrouping instruction approach (Table 7).

**Table 7: Descriptive statistics for addition by regrouping instruction approach pre-test**

| | Treatments | N | Mean | Std. Deviation |
|---|---|---|---|---|
| Addition by regrouping instruction approach pretest | Experimental group | 63 | 37.14 | 9.901 |
| | Control group | 63 | 36.08 | 9.550 |

**Source (Researcher, 2024)**

The results in Table 7 show that the pre-test mean scores of LMAT for the experimental group (M = 37.14, SD = 9.901) were higher than those for the control group (M = 36.08, SD = 9.550). A t-test was conducted to establish if this difference was statistically significant. Additionally, a mean gain analysis of pre- and post-test scores, shown in Table 8, was performed to assess the effect of the addition by regrouping instruction approach on mathematics skills acquisition.

**Table 8: Descriptive statistic for mean gain analysis on addition by regrouping instruction approach**

| SCALE | Experimental group | Control group |
|---|---|---|
| Post-test means | 41.70 | 38.13 |
| Pre-test mean | 37.14 | 36.08 |
| Mean Gain | 4.56 | 2.05 |

**Source (Researcher, 2024)**

Table 8 presents the mean gain analysis for the Experimental and Control groups. The results indicate that the Experimental group had a higher mean gain (4.56) from the addition by regrouping instruction approach compared to the Control group (2.05). This

difference likely resulted from the treatment provided to the Experimental group. Furthermore, these descriptive statistics from the Learners Mathematics Achievement Test (LMAT) were followed by an analysis of questionnaire data to establish the mathematics teachers' perceptions on the effect of addition by regrouping instruction on mathematics skills acquisition among learners with autism (LWA) in public primary schools. This was analysed and presented in Table 9.

**Table 9: Descriptive statistics for effect of addition by regrouping instruction on mathematic skills acquisition among Learners with Autism in Public primary schools**

| **Statements** | | **SD** | **D** | **U** | **A** | **SA** | **MEAN** |
|---|---|---|---|---|---|---|---|
| The use of matching helps learners with autism enhances their acquisition of mathematics skills. | F | 25 | 15 | 13 | 51 | 74 | **3.48** |
| | **%** | **14.0** | **8.4** | **7.3** | **28.7** | **41.6** | |
| Utilizing place value helps learners with autism heighten their acquisition of mathematics skills. | F | 13 | 28 | 18 | 56 | 63 | **3.43** |
| | **%** | **7.3** | **15.7** | **10.1** | **31.5** | **35.4** | |
| Pairing helps learners with autism improve their acquisition of mathematics skills | F | 2 | 8 | 32 | 54 | 82 | **3.69** |
| | **%** | **1.1** | **4.5** | **18.0** | **30.3** | **46.1** | |
| Understanding number value helps learners with autism enhance their acquisition of mathematics skills. | F | 4 | 17 | 6 | 72 | 79 | **4.11** |
| | **%** | **2.2** | **9.6** | **3.4** | **40.4** | **44.4** | |

**Source (Researcher, 2024)**

Table 9 shows that 74 (41.6%) of the respondents strongly agreed that the use of matching helped learners with autism enhanced their acquisition of mathematics skills, 51 (28.7%) agreed, 25 (14.0%) strongly disagreed, 15 (8.4%) disagreed, and 13 (7.3%) were undecided. The study findings indicated that respondents somehow agreed (Mean = 3.48) that the use of matching helped learners with autism enhanced their acquisition of mathematics skills. This implies that use of matching by learners with autism enhance their acquisition of mathematics skills. This concurs with the findings of Goñi-Cervera and Jacinto (2024) that the use of a matching strategy to helps learners with autism solve mathematical problems, thus enhance the mathematical problem-solving abilities.

Similarly, 63 (35.4%) of the respondents strongly agreed that utilizing place value helped learners with autism heightened their acquisition of mathematics skills, 56 (31.5%) agreed, 28 (15.7%) disagreed, 18 (10.1%) were undecided, and 13 (7.3%) strongly disagreed. The study found that respondents somehow agreed (Mean = 3.43) that utilizing place value helped learners with autism heightened their acquisition of mathematics skills. This indicates that utilizing place value helps learners with autism to heighten their acquisition of mathematics skills. This supports the findings of Shurr, Bouck, Bassette and Park (2021) that utilizing place value helps learners with autism enhance their acquisition of mathematics skills.

Additionally, 82 (46.1%) of the respondents strongly agreed that pairing helped learners with autism improved their acquisition of mathematics skills, 54 (30.3%) agreed, 32 (18.0%) were undecided, 8 (4.5%) disagreed, and 2 (1.1%) strongly disagreed. The study findings indicated that respondents tended to agree (Mean = 3.69) that pairing helped learners with autism improved their acquisition of mathematics skills. This suggests that

pairing helps learners with autism improve their acquisition of mathematics skills. This supports the finding of Jitendra and Hoff (2018) that addition with regrouping through pairing aided disabled students improved in their capacity to answer word problems and addition problems.

Lastly, 79(44.4%) of the respondents strongly agreed with the statement that understanding number value helped learners with autism enhanced their acquisition of mathematics skills, 72(40.4%) agreed, 17(9.6%) disagreed, 6(3.4%) were undecided and 4(2.2%) strongly disagreed. It emerged from the study that the respondents agreed (Mean=4.11) that understanding number value helped learners with autism enhanced their acquisition of mathematics skills. This implies that understanding number value helps learners with autism enhance their acquisition of mathematics skills. This concurs with the findings of Folostina and Michel (2022) that understanding number value help the autistic children to learn basic mathematic. This descriptive statistics analysis of objective one was followed by an independent sample t test to determine the effect of the addition by regrouping instruction approach on mathematical skills acquisition. This was analyzed under the following sub-section.

### 4.3.2. Independent sample t test for the effect of effect of addition by grouping instruction approach on Mathematical Skills'

The independent sample t-test at a significance level of $p \leq 0.05$, illustrating the statistically significant effect of the addition by regrouping instruction approach on mathematical skills acquisition, is summarized in Table 10.

**Table 10: Independent sample t test of the Pre-test Mean Scores on LMAT for addition by regrouping instruction approach pre-test**

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
| | | | | | | | | | Lower | Upper |
| Addition by regrouping instruction approach pretest | Equal variances assumed | .402 | .527 | .614 | 124 | .541 | 1.063 | 1.733 | -2.367 | 4.494 |
| | Equal variances not assumed | | | .614 | 123.839 | .541 | 1.063 | 1.733 | -2.367 | 4.494 |

**Source (Researcher, 2024)**

The results in Table 10 indicate that the difference between the mean scores on the LMAT for the addition by regrouping instruction approach in the experimental and control groups was not statistically significant at the 0.05 level, as the p-value was greater than 0.05. This demonstrates that the groups were similar and therefore suitable for the study. Consequently, the independent sample t-test at a significance level of $p \leq 0.05$ did not show a statistically significant effect of the addition by regrouping instruction approach on mathematical skills acquisition as analyzed in the pre and post-test means and summarized in Table 11. This analysis aimed to test the following hypothesis:

**$H0_1$:** There is no statistically significant effect of addition by regrouping instruction approach on Mathematic skills' acquisition among LWA in public primary schools within Kakamega County.

**$H1_1$:** There is statistically significant effect of addition by regrouping instruction approach on Mathematic skills' acquisition among LWA in public primary schools within Kakamega County.

**Table 11: LMAT t test for post and pre-test mean gain analysis on addition by regrouping instruction approach**

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
| | | | | | | | | | Lower | Upper |
| Addition by regrouping instruction approach | Equal variances assumed | 3.525 | .063 | 3.092 | 124 | .002 | 2.50794 | .81121 | .90232 | 4.11356 |
| | Equal variances not assumed | | | 3.092 | 111.184 | .003 | 2.50794 | .81121 | .90049 | 4.11538 |

**Source (Researcher, 2024)**

Table 11 shows that shows that the calculated t-value was 3.092 with a degree of freedom of 124. Since the p-value is less than 0.05, it indicates that the difference between the mean gain scores on the LMAT for the addition by regrouping instruction approach in the experimental group and the control group was statistically significant at the 0.05 level. As a result, the null hypothesis that "there is no statistically significant effect of addition by regrouping instruction approach on Mathematic skills' acquisition among LWA in public primary schools within Kakamega County" was rejected. This was supported by an observation noting that, "*Compared to the pretest, during the post-test, most learners with autism (76%) had classification skills and were able to group flashcards according to their shapes like triangles and squares"*. This implies that there is a statistically significant effect of addition by regrouping instruction approach on Mathematic skills' acquisition among LWA in public primary schools. This is in line with the findings of Miller, Kaffar, and Mercer (2019) that disabled students improved in their capacity to answer word problems and addition problems with regrouping.

### 4.4 Effect of addition by using counters instruction approach on Mathematical Skills' acquisition among LWA in public primary schools

The preferred inferential statistic for analyzing data from the Learners Mathematics Achievement Test (LMAT) was the independent sample t-test, accompanied by mean and standard deviation calculations from LMAT. Furthermore, descriptive statistics, such as frequency and percentages, were extracted from the mathematics teachers' questionnaire to measure the level of agreement on a five-point Likert scale. This methodology aided in assessing the effect of the addition using counters instruction approach on mathematics skills acquisition among learners with autism (LWA) in public primary schools,

commencing with descriptive statistics of the variable representing the addition using counters instruction approach.

### 4.4.1. Descriptive statistics for effect of addition by using counters instruction approach on mathematical Skills'

The mean and standard deviation derived from the Learners Mathematics Achievement Test (LMAT) were assessed and summarized in Tables 12 and 13. Moreover, frequency and percentage ratings of mathematics teachers' perceptions for each questionnaire item were assessed and summarized in Table 14. The analysis began with the mean and standard deviation of the variable representing the effect of addition by using counters instruction approach (Table 12).

**Table 12: Descriptive statistics for addition by using counters instruction approach pre-test**

| | Treatments | N | Mean | Std. Deviation |
|---|---|---|---|---|
| Addition by using counters instruction approach pretest | Experimental group | 63 | 38.57 | 8.765 |
| | Control group | 63 | 38.27 | 9.521 |

**Source (Researcher, 2024)**

The results in Table 12 show that the pre-test mean scores of LMAT for the experimental group (M = 38.57, SD = 8.765) were higher than those for the control group (M = 38.27, SD = 9.521). A t-test was conducted to assess if this difference was statistically significant. Furthermore, a mean gain analysis of pre- and post-test scores, shown in Table 13, was performed to assess the effect of the addition by using counters instruction approach on mathematics skills acquisition.

**Table 13: Descriptive statistic for mean gain analysis on addition by using counters instruction approach**

| SCALE | Experimental group | Control group |
|---|---|---|
| Post-test means | 47.11 | 41.14 |
| Pre-test mean | 38.57 | 38.27 |
| Mean Gain | 8.54 | 2.87 |

**Source (Researcher, 2024)**

Table 13 presents the mean gain analysis for the Experimental and Control groups. The results indicate that the Experimental group had a higher mean gain (8.54) from the addition by using counters instruction approach compared to the Control group (2.87). This difference likely resulted from the treatment provided to the Experimental group. Furthermore, these descriptive statistics from the Learners Mathematics Achievement Test (LMAT) were followed by an analysis of questionnaire data to assess the mathematics teachers' perceptions on the effect of addition by using counters instruction on mathematics skills acquisition among learners with autism (LWA) in public primary schools. This was analysed and presented in Table 14.

**Table 14: Descriptive statistics for effect of addition by using counters instruction on mathematic skills acquisition among Learners with Autism in Public primary schools**

| Statements | | SD | D | U | A | SA | MEAN |
|---|---|---|---|---|---|---|---|
| The use of numbering helped learners with autism enhances their acquisition of mathematics skills. | F | 32 | 13 | 10 | 57 | 66 | **3.37** |
| | **%** | **18.0** | **7.3** | **5.6** | **32.0** | **37.1** | |
| Utilizing counting helps learners with autism heighten their acquisition of mathematics skills. | F | 6 | 24 | 6 | 54 | 88 | **4.04** |
| | **%** | **3.4** | **13.5** | **3.4** | **30.3** | **49.4** | |
| Sorting and grouping help learners with autism improve their acquisition of mathematics skills | F | 4 | 6 | 21 | 53 | 94 | **3.98** |
| | **%** | **2.2** | **3.4** | **11.8** | **29.8** | **52.8** | |
| Understanding pattern making helps learners with autism enhance their acquisition of mathematics skills. | F | 6 | 17 | 7 | 68 | 80 | **4.05** |
| | **%** | **3.4** | **9.6** | **3.9** | **38.2** | **44.9** | |

**Source (Researcher, 2024)**

Table 14 shows that 66 (37.1%) of the respondents strongly agreed that the use of numbering by learners with autism enhanced their acquisition of mathematics skills, 57 (32.0%) agreed, 32 (18.0%) strongly disagreed, 13 (7.3%) disagreed, and 10 (5.6%) were undecided. The study findings indicated that respondents somehow agreed (Mean = 3.37) that use of numbering by learners with autism enhanced their acquisition of mathematics skills. This implies that use of numbering by learners with autism enhance their acquisition of mathematics skills. This supports the findings of Ingelin, Intepe-Tingir and Hammons

(2023) that increasing the number sense helped learners enhances their acquisition of mathematics skills.

Similarly, 88 (49.4%) of the respondents strongly agreed that utilizing counting helped learners with autism heightened their acquisition of mathematics skills, 54 (30.3%) agreed, 24 (13.5%) disagreed, 6 (3.4%) were undecided, and another 6 (3.4%) strongly disagreed. The study found that respondents agreed (Mean = 4.40) that utilizing counting helped learners with autism heightened their acquisition of mathematics skills. This indicates that utilizing counting helps learners with autism heighten their acquisition of mathematics skills. This concurs with the findings of Silver (2019) that counters help retain mathematical concepts including number recognition for a long span.

Additionally, 94 (52.8%) of the respondents strongly agreed that sorting and grouping helped learners with autism improved their acquisition of mathematics skills, 53 (29.8%) agreed, 21 (11.8%) were undecided, 6 (3.4%) disagreed, and 4 (2.2%) strongly disagreed. The study findings indicated that respondents tended to agree (Mean = 3.98) that sorting and grouping helped learners with autism improved their acquisition of mathematics skills. This suggests that sorting and grouping help learners with autism improve their acquisition of mathematics skills. This concurs with the findings of Folostina and Michel (2022) and Hungary, Jenny (2019) that grouping activity starts from forming pairs of objects that gives children the possibility to improve their ordering abilities, thus improve their acquisition of mathematics skills.

Lastly, 80 (44.9%) of the respondents strongly agreed with the statement that understanding pattern making helped learners with autism enhanced their acquisition of

mathematics skills, 69 (38.2%) agreed, 17 (9.6%) disagreed, 6 (3.4%) were undecided and 7 (3.9%) strongly disagreed. It emerged from the study that the respondents agreed (Mean=4.05) that understanding pattern making helped learners with autism enhanced their acquisition of mathematics skills. This implies that understanding pattern making help learners with autism enhance their acquisition of mathematics skills. This is in line with the findings of Hungary, Jenny (2019) and Jimenez and Besaw (2020) pattern making increase early numeracy outcomes thus enhance their acquisition of mathematics skills. This descriptive statistics analysis of objective two was followed by an independent sample t test to assess the effect of the addition by using counters instruction approach on mathematical skills acquisition. This was analyzed under the following sub-section.

### 4.4.2. Independent sample t test for the effect of effect of addition by using counters instruction approach on Mathematical Skills'

The independent sample t-test at a significance level of $p \leq 0.05$, illustrating the statistically significant effect of the addition by using counters instruction approach on mathematical skills acquisition, is summarized in Table 15.

**Table 15: Independent sample t test of the Pre-test Mean Scores on LMAT for addition by using counters instruction approach pre-test**

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
| | | | | | | | | | Lower | Upper |
| Addition by using counters instruction approach pretest | Equal variances assumed | 1.036 | .311 | .185 | 124 | .854 | .302 | 1.630 | -2.926 | 3.529 |
| | Equal variances not assumed | | | .185 | 123.161 | .854 | .302 | 1.630 | -2.926 | 3.529 |

**Source (Researcher, 2024)**

The results in Table 15 indicate that the difference between the mean scores on the LMAT for the addition by using counters instruction approach in the experimental and control groups was not statistically significant at the 0.05 level, as the p-value was greater than 0.05. This demonstrates that the groups were similar and therefore suitable for the study. Consequently, the independent sample t-test at a significance level of $p \leq 0.05$ did not show a statistically significant effect of the addition by using counters instruction approach on mathematical skills acquisition as analyzed in the pre and post-test means and summarized in Table 16. This analysis aimed to test the following hypothesis:

**$H0_2$:** There is no statistically significant effect of addition by using counters instruction approach on Mathematic skills' acquisition among LWA in public primary schools within Kakamega County.

**$H1_2$:** There is statistically significant effect of addition by using counters instruction approach on Mathematic skills' acquisition among LWA in public primary schools within Kakamega County.

**Table 16: LMAT t test for post and pre-test mean gain analysis on addition by using counters instruction approach**

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
| | | | | | | | | | Lower | Upper |
| Addition by using counters instruction approach | Equal variances assumed | 18.027 | .000 | 4.693 | 124 | .000 | 5.66667 | 1.20744 | 3.27680 | 8.05654 |
| | Equal variances not assumed | | | 4.693 | 89.316 | .000 | 5.66667 | 1.20744 | 3.26762 | 8.06571 |

**Source (Researcher, 2024)**

Table 16 shows that shows that the calculated t-value was 4.693 with a degree of freedom of 124. Since the p-value is less than 0.05, it indicates that the difference between the mean gain scores on the LMAT for the addition by using counters instruction approach in the experimental group and the control group was statistically significant at the 0.05 level. As a result, the null hypothesis that "there is no statistically significant effect of addition by using counters instruction approach on Mathematic skills' acquisition among LWA in public primary schools within Kakamega County" was rejected. This was supported by an observation noting that, "*Compared to the pretest, during the post-test, most learners with autism (85%) had number value skills and were able to break numbers into tens, like 12=10+2".* This implies that there is a statistically significant effect of addition by using counters instruction approach on Mathematic skills' acquisition among LWA in public primary schools. This supports the findings of Fiona, (2021) that counters improve children's ability to retain mathematical concept due to commensurate time they spend time doing activities that are related to number and the number system with the counters.

### 4.5 Effect of addition by breaking apart instruction approach on Mathematical Skills' acquisition among LWA in public primary schools

The preferred inferential statistic for analyzing data from the Learners Mathematics Achievement Test (LMAT) was the independent sample t-test, accompanied by mean and standard deviation calculations from LMAT. Moreover, descriptive statistics, such as frequency and percentages, were extracted from the mathematics teachers' questionnaire to measure the level of agreement on a five-point Likert scale. This methodology aided in determining the effect of addition by breaking apart instruction approach on Mathematic

skills' acquisition among LWA in public primary schools, beginning with descriptive statistics of the variable representing the addition breaking apart instruction approach.

### 4.5.1. Descriptive statistics for effect of addition by breaking apart instruction approach on mathematical Skills'

The mean and standard deviation derived from the Learners Mathematics Achievement Test (LMAT) were determined and summarized in Tables 17 and 18. Moreover, frequency and percentage ratings of mathematics teachers' perceptions for each questionnaire item were determined and summarized in Table 19. The analysis began with the mean and standard deviation of the variable representing the effect of addition by breaking apart instruction approach (Table 17).

**Table 17: Descriptive statistics for addition by breaking apart instruction approach pre-test**

| | Treatments | N | Mean | Std. Deviation |
|---|---|---|---|---|
| Addition by breaking apart instruction approach pretest | Experimental group | 63 | 39.92 | 9.470 |
| | Control group | 63 | 36.81 | 8.743 |

**Source (Researcher, 2024)**

The results in Table 17 show that the pre-test mean scores of LMAT for the experimental group (M = 39.92, SD = 9.470) were higher than those for the control group (M = 36.81, SD = 8.743). A t-test was conducted to determine if this difference was statistically significant. Furthermore, a mean gain analysis of pre- and post-test scores, shown in Table 18, was performed to determine the effect of the addition by breaking apart instruction approach on mathematics skills acquisition.

**Table 18: Descriptive statistic for mean gain analysis on addition by breaking apart instruction approach**

| SCALE | Experimental group | Control group |
|---|---|---|
| Post-test means | 43.87 | 38.22 |
| Pre-test mean | 39.92 | 36.81 |
| Mean Gain | 3.95 | 1.41 |

**Source (Researcher, 2024)**

Table 18 presents the mean gain analysis for the Experimental and Control groups. The results indicate that the Experimental group had a higher mean gain (3.95) from the addition by breaking apart instruction approach compared to the Control group (1.41). This difference likely resulted from the treatment provided to the Experimental group. Furthermore, these descriptive statistics from the Learners Mathematics Achievement Test (LMAT) were followed by an analysis of questionnaire data to determine the mathematics teachers' perceptions on the effect of addition by breaking apart instruction on mathematics skills acquisition among learners with autism (LWA) in public primary schools. This was analysed and presented in Table 19.

**Table 19: Descriptive statistics for effect of addition by breaking apart instruction on mathematic skills acquisition among Learners with Autism in Public primary schools**

| Statements | | SD | D | U | A | SA | MEAN |
|---|---|---|---|---|---|---|---|
| The use of sorting helped learners with autism enhances their acquisition of mathematics skills. | F | 15 | 11 | 15 | 62 | 74 | **3.68** |
| | **%** | **8.5** | **6.2** | **8.5** | **35.0** | **41.8** | |
| Utilizing grouping helps learners with autism heighten their acquisition of mathematics skills. | F | 3 | 30 | 10 | 72 | 63 | **3.81** |
| | **%** | **1.7** | **16.9** | **5.6** | **40.4** | **35.4** | |
| Pairing helps learners with autism improve their acquisition of mathematics skills | F | 6 | 4 | 36 | 48 | 84 | **3.57** |
| | **%** | **3.4** | **2.2** | **20.2** | **27.0** | **47.2** | |
| Understanding number recognition helps learners with autism enhance their acquisition of mathematics skills. | F | 3 | 21 | 10 | 54 | 90 | **4.06** |
| | **%** | **1.7** | **11.8** | **5.6** | **30.3** | **50.6** | |

**Source (Researcher, 2024)**

Table 19 shows that 74 (41.8%) of the respondents strongly agreed that the use of sorting helped learners with autism enhanced their acquisition of mathematics skills, 62 (35.0%) agreed, 15 (8.5%) strongly disagreed, another 15 (8.5%) were undecided, and 11 (6.2%) disagreed. The study findings indicated that respondents tended to agree (Mean = 3.68) that the use of sorting helped learners with autism enhanced their acquisition of mathematics skills. This implies that the use of sorting by learners with autism enhance

their acquisition of mathematics skills. This concurs with the finding of Kumas and Yıldırım (2024) that early numeracy skills and included training in counting and sorting helped learners improve their mathematic skills.

Similarly, 72 (40.4%) of the respondents agreed that utilizing grouping helped learners with autism heightened their acquisition of mathematics skills, 63 (35.4%) strongly agreed, 30 (16.9%) disagreed, 10 (5.6%) were undecided, and 3 (1.7%) strongly disagreed. The study found that respondents tended to agree (Mean = 3.81) that utilizing grouping helped learners with autism heightened their acquisition of mathematics skills. This indicates that utilizing grouping help learners with autism heighten their acquisition of mathematics skills. This supports the findings of Polo-Blanco, Suárez-Pinilla, Goñi-Cervera, Suárez-Pinilla and Payá, (2024) that utilizing grouping helps learners with autism heighten their mathematical problem-solving performance.

Additionally, 84 (47.2%) of the respondents strongly agreed that pairing helped learners with autism improved their acquisition of mathematics skills, 48 (27.0%) agreed, 36 (20.2%) were undecided, 6 (3.4%) strongly disagreed, and 4 (2.2%) disagreed. The study findings indicated that respondents tended to agree (Mean = 3.57) that pairing helped learners with autism improved their acquisition of mathematics skills. This suggests that pairing help learners with autism improve their acquisition of mathematics skills. This is in line with the findings of Goñi-Cervera, Polo-Blanco, Bruno and Fernández-Cobos (2024) that pairing using blocks assist students improve their mathematics skills performance.

Lastly, 90 (50.6%) of the respondents strongly agreed with the statement that understanding number recognition helped learners with autism enhanced their acquisition of mathematics skills, 54 (30.3%) agreed, 21 (11.8%) disagreed, 10 (5.6%) were undecided and 3 (1.7%) strongly disagreed. It emerged from the study that the respondents agreed (Mean=4.06) that understanding number recognition helped learners with autism enhanced their acquisition of mathematics skills. This implies that understanding number recognition help learners with autism enhance their acquisition of mathematics skills. This supports the findings of Alabdulaziz (2024) that knowledge of number recognition helps learners with enhance their understanding of mathematics skills. This descriptive statistics analysis of objective three was followed by an independent sample t test to determine the effect of the addition by breaking apart instruction approach on mathematical skills acquisition. This was analyzed under the following sub-section.

### 4.5.2. Independent sample t test for the effect of effect of addition by breaking apart instruction approach on Mathematical Skills'

The independent sample t-test at a significance level of $p \leq 0.05$, illustrating the statistically significant effect of the addition by breaking apart instruction approach on mathematical skills acquisition, is summarized in Table 20.

**Table 20: Independent sample t test of the Pre-test Mean Scores on LMAT for addition by breaking apart instruction approach pre-test**

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
| | | | | | | | | | Lower | Upper |
| Addition by breaking apart instruction approach pretest | Equal variances assumed | .253 | .616 | 1.916 | 124 | .058 | 3.111 | 1.624 | -.103 | 6.325 |
| | Equal variances not assumed | | | 1.916 | 123.217 | .058 | 3.111 | 1.624 | -.103 | 6.325 |

**Source (Researcher, 2024)**

The results in Table 20 indicate that the difference between the mean scores on the LMAT for the addition by breaking apart instruction approach in the experimental and control groups was not statistically significant at the 0.05 level, as the p-value was greater than 0.05. This demonstrates that the groups were similar and therefore suitable for the study. Consequently, the independent sample t-test at a significance level of $p \leq 0.05$ did not show a statistically significant effect of the addition by breaking apart instruction approach on mathematical skills acquisition as analyzed in the pre and post-test means and summarized in Table 21. This analysis aimed to test the following hypothesis:

**$H0_3$:** There is no statistically significant effect of addition by breaking apart instruction approach on Mathematic skills' acquisition among LWA in public primary schools within Kakamega County.

**$H1_3$:** There is statistically significant effect of addition by breaking apart instruction approach on Mathematic skills' acquisition among LWA in public primary schools within Kakamega County.

**Table 21: LMAT t test for post and pre-test mean gain analysis on addition by breaking apart instruction approach**

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
| | | | | | | | | | Lower | Upper |
| Addition by breaking apart instruction approach | Equal variances assumed | 1.056 | .306 | 3.421 | 124 | .001 | 2.53968 | .74228 | 1.07050 | 4.00886 |
| | Equal variances not assumed | | | 3.421 | 116.920 | .001 | 2.53968 | .74228 | 1.06963 | 4.00974 |

**Source (Researcher, 2024)**

Table 21 shows that shows that the calculated t-value was 3.421 with a degree of freedom of 124. Since the p-value is less than 0.05, it indicates that the difference between the mean gain scores on the LMAT for the addition by breaking apart instruction approach in the experimental group and the control group was statistically significant at the 0.05 level. As a result, the null hypothesis that "there is no statistically significant effect of addition by breaking apart instruction approach on Mathematic skills' acquisition among LWA in public primary schools within Kakamega County" was rejected. This was supported by an observation noting that, "*Compared to the pretest, during the post-test, most learners with autism (78%) had pairing skills and were able to match counters by their numbers, like 00=2".* This implies that there is a statistically significant effect of addition by breaking apart instruction approach on Mathematic skills' acquisition among LWA in public primary schools. This is in line with the findings of Bresser, Carve and Holtzman (2018) that on mathematics skills and problem-solving concepts activities to help students practice them throughout the day by breaking apart instruction approach, offered two options of activities focusing learners on breaking apart numbers.

### 4.6 Effect of addition by counting on instruction approach on Mathematical Skills' acquisition among LWA in public primary schools

The preferred inferential statistic for analyzing data from the Learners Mathematics Achievement Test (LMAT) was the independent sample t-test, accompanied by mean and standard deviation calculations from LMAT. Moreover, descriptive statistics, such as frequency and percentages, were extracted from the mathematics teachers' questionnaire to measure the level of agreement on a five-point Likert scale. This methodology aided in ascertaining the effect of addition by counting on instruction approach on Mathematic

skills' acquisition among LWA in public primary schools, opening with descriptive statistics of the variable representing the addition counting on instruction approach.

### 4.6.1. Descriptive statistics for effect of addition by counting on instruction approach on mathematical Skills'

The mean and standard deviation derived from the Learners Mathematics Achievement Test (LMAT) were ascertained and summarized in Tables 22 and 23. Moreover, frequency and percentage ratings of mathematics teachers' perceptions for each questionnaire item were ascertained and summarized in Table 24. The analysis began with the mean and standard deviation of the variable representing the effect of addition by counting on instruction approach (Table 22).

**Table 22: Descriptive statistics for addition by counting on instruction approach pre-test**

| | Treatments | N | Mean | Std. Deviation |
|---|---|---|---|---|
| Addition by counting on instruction approach pretest | Experimental group | 63 | 38.62 | 9.511 |
| | Control group | 63 | 34.79 | 9.511 |

**Source (Researcher, 2024)**

The results in Table 22 show that the pre-test mean scores of LMAT for the experimental group (M = 38.62, SD = 9.511) were higher than those for the control group (M = 34.79, SD = 9.511). A t-test was conducted to ascertain if this difference was statistically significant. Furthermore, a mean gain analysis of pre- and post-test scores, shown in Table

23, was performed to ascertain the effect of the addition by counting on instruction approach on mathematics skills acquisition.

**Table 23: Descriptive statistic for mean gain analysis on addition by counting on instruction approach**

| SCALE | Experimental group | Control group |
|---|---|---|
| Post-test means | 43.59 | 36.11 |
| Pre-test mean | 38.62 | 34.79 |
| Mean Gain | 4.97 | 1.32 |

**Source (Researcher, 2024)**

Table 23 presents the mean gain analysis for the Experimental and Control groups. The results indicate that the Experimental group had a higher mean gain (4.97) from the addition by counting on instruction approach compared to the Control group (1.32). This difference likely resulted from the treatment provided to the Experimental group. Additionally, these descriptive statistics from the Learners Mathematics Achievement Test (LMAT) were followed by an analysis of questionnaire data to ascertain the mathematics teachers' perceptions on the effect of addition by counting on instruction on mathematics skills acquisition among learners with autism (LWA) in public primary schools. This was analysed and presented in Table 24.

**Table 24: Descriptive statistics for effect of addition by counting on instruction on mathematic skills acquisition among Learners with Autism in Public primary schools**

| Statements | | SD | D | U | A | SA | MEAN |
|---|---|---|---|---|---|---|---|
| Counting of numbers helped learners with autism enhances their acquisition of mathematics skills. | F | 28 | 17 | 10 | 43 | 80 | **3.49** |
| | **%** | **15.7** | **9.6** | **5.6** | **24.2** | **44.9** | |
| Utilizing counting of concrete objects helps learners with autism heighten their acquisition of mathematics skills. | F | 8 | 24 | 14 | 62 | 70 | **3.71** |
| | **%** | **4.5** | **13.5** | **7.9** | **34.8** | **39.3** | |
| Ordering of patterns helps learners with autism improve their acquisition of mathematics skills | F | 2 | 7 | 19 | 51 | 99 | **4.09** |
| | **%** | **1.1** | **3.9** | **10.7** | **28.7** | **55.6** | |
| Understanding sequencing helps learners with autism enhance their acquisition of mathematics skills. | F | 15 | 17 | 6 | 68 | 72 | **3.83** |
| | **%** | **8.4** | **9.6** | **3.4** | **38.2** | **40.4** | |

**Source (Researcher, 2024)**

Table 24 shows that 80 (44.9%) of the respondents strongly agreed that counting of numbers helped learners with autism enhanced their acquisition of mathematics skills, 43 (24.2%) agreed, 28 (15.7%) strongly disagreed, 17 (9.6%) disagreed, and 10 (5.6%) were undecided. The study findings indicated that respondents somehow agreed (Mean = 3.49) that counting of numbers by learners with autism enhanced their acquisition of mathematics skills. This implies that counting of numbers by learners with autism enhance

their acquisition of mathematics skills. This supports the findings of Alghamdi (2024) that adding two numbers by counting the dots on both numbers helped learners enhances their acquisition of mathematics skills.

Similarly, 70 (39.3%) of the respondents strongly agreed that utilizing counting of concrete objects helped learners with autism heightened their acquisition of mathematics skills, 62 (34.8%) agreed, 24 (13.5%) disagreed, 14 (7.9%) were undecided, and 8 (4.5%) strongly disagreed. The study found that respondents tended to agree (Mean = 3.71) that counting of concrete objects helped learners with autism heightened their acquisition of mathematics skills. This indicates that counting of concrete objects help learners with autism heighten their acquisition of mathematics skills. This is in line with the findings of Goñi-Cervera, Polo-Blanco, Tregón and Bruno (2024) that concrete-representational-abstract sequence (CRA) in teaching children with autism spectrum disorder (ASD) heighten their acquisition of mathematics skills.

Additionally, 99 (55.6%) of the respondents strongly agreed that ordering of patterns helped learners with autism improved their acquisition of mathematics skills, 51 (28.7%) agreed, 19 (10.7%) were undecided, 7 (3.9%) disagreed, and 2 (1.1%) strongly disagreed. The study findings indicated that respondents agreed (Mean = 4.09) that ordering of patterns helped learners with autism improved their acquisition of mathematics skills. This suggests that ordering of patterns helps learners with autism improve their acquisition of mathematics skills. This concurs with the findings of Rosli, *et al*., (2023) that skills acquired by mathematics ordering of patterns enhance Mathematics Abilities on Children with Autism Spectrum Disorder (ASD).

Lastly, 72 (40.4%) of the respondents strongly agreed with the statement that understanding sequencing helped learners with autism enhanced their acquisition of mathematics skills, 68 (38.2%) agreed, 17 (9.6%) disagreed, 15 (8.4%) strongly disagreed and 6 (3.4%) were undecided. It emerged from the study that the respondents tended to agree (Mean=3.83) that understanding sequencing helped learners with autism enhanced their acquisition of mathematics skills. This implies that understanding sequencing help learners with autism enhance their acquisition of mathematics skills. This supports the findings of Kaya and Yildiz (2023) that CRA sequence supports conceptual understanding of mathematics skills by learners with autism. This descriptive statistics analysis of objective four was followed by an independent sample t test to ascertain the effect of the addition by counting on instruction approach on mathematical skills acquisition. This was analyzed under the following sub-section.

### 4.6.2. Independent sample t test for the effect of effect of addition by counting on instruction approach on Mathematical Skills'

The independent sample t-test at a significance level of $p \leq 0.05$, illustrating the statistically significant effect of the addition by counting on instruction approach on mathematical skills acquisition, is summarized in Table 25.

**Table 25: Independent sample t test of the Pre-test Mean Scores on LMAT for addition by counting on instruction approach pre-test**

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
| | | | | | | | | | Lower | Upper |
| Addition by counting on instruction approach pretest | Equal variances assumed | .001 | .971 | 2.257 | 124 | .026 | 3.825 | 1.695 | .471 | 7.180 |
| | Equal variances not assumed | | | 2.257 | 124.000 | .026 | 3.825 | 1.695 | .471 | 7.180 |

**Source (Researcher, 2024)**

The results in Table 25 indicate that the difference between the mean scores on the LMAT for the addition by counting on instruction approach in the experimental and control groups was not statistically significant at the 0.05 level, as the p-value was greater than 0.05. This demonstrates that the groups were similar and thus suitable for the study. Consequently, the independent sample t-test at a significance level of $p \leq 0.05$ did not show a statistically significant effect of the addition by counting on instruction approach on mathematical skills acquisition as analyzed in the pre and post-test means and summarized in Table 26. This analysis aimed to test the following hypothesis:

**$H0_4$:** There is no statistically significant effect of addition by counting on instruction approach on Mathematic skills' acquisition among LWA in public primary schools within Kakamega County.

**$H1_4$:** There is statistically significant effect of addition by counting on instruction approach on Mathematic skills' acquisition among LWA in public primary schools within Kakamega County.

**Table 26: LMAT t test for post and pre-test mean gain analysis on addition by counting on instruction approach**

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
| | | | | | | | | | Lower | Upper |
| Addition by counting on instruction approach | Equal variances assumed | 10.647 | .001 | 4.166 | 124 | .000 | 3.65079 | .87632 | 1.91630 | 5.38528 |
| | Equal variances not assumed | | | 4.166 | 93.202 | .000 | 3.65079 | .87632 | 1.91064 | 5.39095 |

**Source (Researcher, 2024)**

Table 26 shows that shows that the calculated t-value was 4.166 with a degree of freedom of 124. Since the p-value is less than 0.05, it indicates that the difference between the mean gain scores on the LMAT for the addition by counting on instruction approach in the experimental group and the control group was statistically significant at the 0.05 level. As a result, the null hypothesis that "there is no statistically significant effect of addition by counting on instruction approach on Mathematic skills' acquisition among LWA in public primary schools within Kakamega County" was rejected. This was supported by an observation noting that, "*Compared to the pretest, during the post-test, most learners with autism (92%) had color recognition skills and were able to count numbers 1 to 20".* This implies that there is a statistically significant effect of addition by counting on instruction approach on Mathematic skills' acquisition among LWA in public primary schools. This supports the findings of Dolman (2019) that by having practitioners understand the basic concepts of counting, the challenges kids could encounter on their way to mastering the skill might be avoided. In addition to DI, counting strategy children can use number facts with derived facts.

# CHAPTER FIVE

# SUMMARY, CONCLUSION AND RECOMMENDATION

## 5.1 Introduction

This chapter presents the summary, conclusion and recommendation of the study. The chapter therefore, opens with the summary of the findings.

## 5.2 Summary of the findings

The summary is divided as per the study objectives, specifically; Establish the effect of addition by regrouping instruction approach on Mathematic skills' acquisition; assess the effect of addition using counters instruction approach on Mathematics skills' acquisition; determine the effect of addition by breaking apart instruction approach on Mathematic skills' acquisition; and ascertain the effect of addition by counting on instruction approach on Mathematic skills' acquisition among LWA in public primary schools within Kakamega County.

### 5.2.1 Effect of addition by regrouping instruction approach on Mathematical Skills' acquisition among LWA in public primary schools

In the pre-test, the experimental group's LMAT mean scores surpassed those of the control group. During the mean gain analysis, the experimental group exhibited a higher mean gain through the addition by regrouping instruction approach than the control group. Consequently, from the questionnaire, the findings suggested that respondents somewhat agreed that utilizing matching and place value assisted learners with autism in enhancing their acquisition of mathematics skills. Lastly, the study uncovered that respondents tended to agree that pairing, and agreed that understanding number value,

respectively, aided learners with autism in enhancing their acquisition of mathematics skills.

In inferential statistics, the independent sample t-test conducted for the pre-test of the addition by regrouping instruction approach indicated that the difference in mean scores on LMAT between the experimental and control groups was not statistically significant at $\alpha = 0.05$. This suggests that the groups were comparable and thus appropriate for the study. Subsequently, to test the hypothesis, the independent sample t-test conducted for the mean gain analysis of the addition by regrouping instruction approach revealed that the difference in mean gain scores on LMAT between the experimental and control groups was statistically significant at the 0.05 level.

### 5.2.2 Effect of addition by using counters instruction approach on Mathematical Skills' acquisition among LWA in public primary schools

During the pre-test, the experimental group's LMAT mean scores exceeded those of the control group. In the subsequent mean gain analysis, the experimental group demonstrated a greater mean gain through the addition by using counters instruction approach compared to the control group. Subsequently, from the questionnaire, the study findings indicated that respondents somehow agreed that use of numbering helped learners with autism enhanced their acquisition of mathematics skills. Additionally, the study revealed that respondents agreed that utilizing counting and understanding pattern making helped learners with autism heightened their acquisition of mathematics skills. Lastly, study findings indicated that respondents tended to agree that sorting and grouping helped learners with autism improved their acquisition of mathematics skills. In inferential statistics, the independent sample t-test conducted for the pre-test of the addition by using counters instruction approach indicated that the difference in mean

scores on LMAT between the experimental and control groups was not statistically significant at $\alpha = 0.05$. This implies that the groups were similar and therefore suitable for the study. Subsequently, to test the hypothesis, the independent sample t-test conducted for the mean gain analysis of the addition by using counters instruction approach revealed that the difference in mean gain scores on LMAT between the experimental and control groups was statistically significant at the 0.05 level.

### 5.2.3 Effect of addition by breaking apart instruction approach on Mathematical Skills' acquisition among LWA in public primary schools

In the pre-test, the experimental group's LMAT mean scores surpassed those of the control group. During the mean gain analysis, the experimental group exhibited a higher mean gain through the addition by breaking apart instruction approach than the control group. Consequently, from the questionnaire, the study findings indicated that respondents tended to agree that the use of sorting, utilizing grouping and pairing helped learners with autism enhanced their acquisition of mathematics skills. Lastly, it emerged from the study that the respondents agreed that understanding number recognition helped learners with autism enhanced their acquisition of mathematics skills.

In inferential statistics, the independent sample t-test conducted for the pre-test of the addition by breaking apart instruction approach indicated that the difference in mean scores on LMAT between the experimental and control groups was not statistically significant at $\alpha = 0.05$. This suggests that the groups were comparable and thus appropriate for the study. Subsequently, to test the hypothesis, the independent sample t-test conducted for the mean gain analysis of the addition by breaking apart instruction

approach revealed that the difference in mean gain scores on LMAT between the experimental and control groups was statistically significant at the 0.05 level.

### 5.2.4 Effect of addition by counting on instruction approach on Mathematical Skills' acquisition among LWA in public primary schools

During the pre-test, the experimental group's LMAT mean scores exceeded those of the control group. In the subsequent mean gain analysis, the experimental group demonstrated a greater mean gain through the addition by counting on instruction approach compared to the control group. Subsequently, from the questionnaire, the study findings indicated that respondents somehow agreed and agreed that counting of numbers and ordering of patterns, respectively helped learners with autism enhanced their acquisition of mathematics skills. Lastly, the study found that respondents tended to agree that counting of concrete objects and understanding sequencing helped learners with autism heightened their acquisition of mathematics skills.

In inferential statistics, the independent sample t-test conducted for the pre-test of the addition by counting on instruction approach indicated that the difference in mean scores on LMAT between the experimental and control groups was not statistically significant at $\alpha = 0.05$. This implies that the groups were similar and therefore suitable for the study. Subsequently, to test the hypothesis, the independent sample t-test conducted for the mean gain analysis of the addition by counting on instruction approach revealed that the difference in mean gain scores on LMAT between the experimental and control groups was statistically significant at the 0.05 level.

## 5.3 Conclusion

The researcher concludes that the direct instruction approach has a statistically significant effect on mathematical skills acquisition among learners with autism (LWA)

in public primary schools within Kakamega County, Kenya. Particularly, addition by regrouping, using counters, breaking apart and counting on instruction approach, enhance mathematical skills acquisition among learners with autism.

The addition by regrouping instruction approach demonstrates a statistically significant positive effect on mathematical skills acquisition. Specifically, understanding number value adequately enhances mathematical skills acquisition, pairing tend to boost mathematical skills acquisition, while, the use of matching and place value somewhat enhances mathematical skills acquisition

The utilization of counters instruction approach reveals a statistically significant positive effect on the acquisition of mathematical skills. Precisely, employing counting and understanding pattern making elevate their acquisition of mathematics skills, sorting and grouping tend to enhance their acquisition of mathematics skills, while the use of numbering somehow contributes to enhancing the acquisition of mathematics skills among learners with autism.

The addition by breaking apart instruction approach exhibits a statistically significant positive effect on the acquisition of mathematical skills. Specifically, understanding number recognition contribute to improving their acquisition of mathematics skills, while, employing sorting, utilizing grouping, and pairing tend to assist learners with autism in enhancing their acquisition of mathematics skills.

The addition by counting on instruction approach demonstrates a statistically significant positive effect on the acquisition of mathematical skills. Specifically, ordering patterns appears to contribute to improving their acquisition of mathematics skills, counting concrete objects and understanding sequencing tend to enhance their

acquisition of mathematics skills, while, counting numbers somehow assist learners with autism in enhancing their acquisition of mathematics skills.

### 5.4 Recommendations

The study suggests the following recommendation to enhance learners' Mathematic Skills acquisition;

Teachers to consider direct instruction approach as one of the new methods that can help to improve learners Mathematic Skills.

The government, policy makers, school management and QASO should encourage and ensure implementation of direct instruction approach as this is the best method to ensure students improvement in Mathematic Skills acquisition.

The curriculum developers should consider direct instruction approach as one of the important teaching methods which can help in acquisition of knowledge in Mathematic Skills.

### 5.5 Suggestions for further studies

The researcher suggests the following for further areas of research;

The study was limited to four variables; addition by regrouping instruction approach, addition by using counters instruction approach, addition by breaking apart instruction approach and addition by counting on instruction approach, thus, a further study should be conducted to assess the effect of other direct instruction approach on Mathematic skills.

To gain an ample understanding on this subject, future research should be narrowed down to the effect of each indicator (addition by regrouping instruction approach,

addition by using counters instruction approach, addition by breaking apart instruction approach and addition by counting on instruction approach) on Mathematic skills acquisition.

Lastly, the mediating effect of the relationship between the direct instruction approach and learners' Mathematic skills acquisition should be determined.

## REFERENCES


Alabdulaziz, M. (2024). The effects of using video-based instruction in solving fraction computations of students with autism spectrum disorder. *International Journal of Instruction, 17*(1), 437-460.

Alghamdi, A. S. (2024). Evidence-based practices: using the touch points strategy to teach single-digit addition to students with ASD. *Humanities and Social Sciences Communications, 11*(1), 1-10.

Bouck, E. C., Long, H., & O'Reilly, C. (2024). Learning to make change via virtual money manipulative, system of least prompts, and modeling online. *Focus on Autism and Other Developmental Disabilities*, 10883576241230924.

Cox, S. K., & Jimenez, B. A. (2020). Mathematical interventions for students with autism spectrum disorder: Recommendations for practitioners. *Research in Developmental Disabilities, 105*, 103744.

Du, J., Liang, Y., Guo, D., & Xiao, Y. (2024). The relationship between theory of mind and moral sensitivity among Chinese preschool children: the mediating role of empathy. *BMC psychology, 12*(1), 112.

Elfakki, A. O., Sghaier, S., & Alotaibi, A. A. (2023). An efficient system based on experimental laboratory in 3D virtual environment for students with learning disabilities. *Electronics, 12*(4), 989.

Folostina, R., & Michel, T. (2022). Teaching Mathematics to Children With Autism: Pedagogical Strategies. *In Interventions for Improving Adaptive Behaviors in Children With Autism Spectrum Disorders*, 66-89.

Folostina, R., & Michel, T. (2022). Teaching Mathematics to Children With Autism: Pedagogical Strategies. . *In Interventions for Improving Adaptive Behaviors in Children With Autism Spectrum Disorders*, 66-89.

Frampton, S. E., Munk, G. T., Shillingsburg, L. A., & Shillingsburg, M. A. (2021). A systematic review and quality appraisal of applications of direct instruction with children with Autism Spectrum Disorder. *Perspectives on Behavior Science, 44*, 245-266.

Frampton, S. E., Shillingsburg, M. A., & Simeone, P. J. (2020). Feasibility and preliminary efficacy of direct instruction for individuals with autism utilizing speech-generating devices. *Behavior Analysis in Practice, 13*, 648-658.

Goñi-Cervera, J., & Jacinto, H. (2024). Enhancing inconsistent language problem-solving in an autistic student through a modified schema-based instruction. *Education, 3*(13), 1-15.

Goñi-Cervera, J., Polo-Blanco, I., Bruno, A., & Fernández-Cobos, R. (2024). Effects of Modified Schema-Based Instruction to Teach Students With Autism to Solve

Additive Compare Problems. *The Journal of Special Education*, 00224669241252422.

Goñi-Cervera, J., Polo-Blanco, I., Tregón, N., & Bruno, A. (2024). The concrete-representational-abstract sequence for the acquisition of the cardinal principle in preschool children with autism. *International Journal of Developmental Disabilities*, 1-11.

Grund, J., & Brock, A. (2020). Education for sustainable development in Germany: Not just desired but also effective for transformative action. *Sustainability*, *12*(7), 2838.

Hornby, G., & Greaves, D. (2022). Direct instruction. In *Essential Evidence-Based Teaching Strategies: Ensuring Optimal Academic Achievement for Students* (pp. 45-62). Cham: Springer International Publishing.

Ingelin, B. L., Intepe-Tingir, S., & Hammons, N. C. (2023). Increasing the number sense understanding of preschool students with ASD. *Topics in Early Childhood Special Education, 43*(2), 116-128.

Jimenez, B. A., & Besaw, J. (2020). Building early numeracy through virtual manipulatives for students with intellectual disability and autism. *Education and Training in Autism and Developmental Disabilities, 55*(1), 28-44.

Kaya, S., & Yildiz, N. G. (2023). Using the concrete–representational–abstract sequence to teach math skills to a student with autism spectrum disorder in a general education classroom. *International Journal of Developmental Disabilities*, 1-12.

Kumas, O., & Yıldırım, A. E. (2024). Development of early numeracy skills in children with moderate intellectual disability. *Journal of Intellectual Disabilities*, 17446295241228897.

Molosiwa, S. M. (2023). lassroom Assessment of Learners with Autism-Implications for Educators. *Autism*.

Moomaw, S. (2024). *eaching STEM in the early years: Activities for integrating science, technology, engineering, and mathematics.* . Redleaf Press.

Njoroge, G. (2022). Demystifying Mathematics: handling learning difficulties in Mathematics among low achievers in Kenyan schools. *Journal of Language, Technology & Entrepreureship in Africa, 13*(1).

Ntalindwa, T., Nduwingoma, M., Uworwabayeho, A., Nyirahabimana, P., Karangwa, E., Rashid Soron, T., & Hansson, H. (2022). Adapting the use of digital content to improve the learning of numeracy among children with autism spectrum disorder in Rwanda: Thematic content analysis study. *JMIR Serious Games, 10*(2), e28276.

Onsare, L. M., Mutai, P., & Milimu, L. N. (2022). Effects of Mainstreaming Learners with Autism on Their Educational Experience in Public Primary Schools in

Nyamache Sub County, Kisii County, Kenya. *International Journal of Social Science And Human Research, 5*(11), 4924-4946.

Packer, R. (2021). *All Change!: Best practice for educational transitions.* Critical Publishing.

Pervin, M., Ahmed, H. U., & Hagmayer, Y. (2022). Effectiveness of interventions for children and adolescents with autism spectrum disorder in high-income vs. lower middle-income countries: An overview of systematic reviews and research papers from LMIC. *Frontiers in Psychiatry*, *13*, 834783.

Polo-Blanco, I., & González López, E. M. (2021). Teaching addition strategies to students with learning difficulties. *Autism & Developmental Language Impairments*, *6*, 23969415211045324.

Polo-Blanco, I., Suárez-Pinilla, P., Goñi-Cervera, J., Suárez-Pinilla, M., & Payá, B. (2024). Comparison of mathematics problem-solving abilities in autistic and non-autistic children: the influence of cognitive profile. *Journal of Autism and Developmental Disorders*, *54*(1), 353-365.

Powell, S., Akther, S., Yoon, N., & Roberts, G. (2023). The Effect of Addition and Subtraction Practice within a Word-Problem Intervention on Addition and Subtraction Outcomes. *Learning Disabilities Research & Practice*, 1-17.

Rico, A., Agirre-Basurko, E., Ruiz-González, A., Palacios-Agundez, I., & Zuazagoitia, D. (2021). Integrating mathematics and science teaching in the context of education for sustainable development: Design and pilot implementation of a teaching-learning sequence about air quality with pre-service primary teachers. *Sustainability*, *13*(8), 4500.

Risdianto, E., Dinissjah, M. J., Nirwana, M. K., & Kristiawan, M. (2020). The effect of Ethno science-based direct instruction learning model in physics learning on students' critical thinking skill. *Universal Journal of Educational Research, 8*(2), 611-615.

Root, J. R., Cox, S. K., & McConomy, M. A. (2022). Teacher-implemented modified schema-based instruction with middle-grade students with autism and intellectual disability. *Research and Practice for Persons with Severe Disabilities*, *47*(1), 40-56.

Rosli, Z., Shahbodin, F., Yuwono, J., Gunarhadi, G., Yusuf, M., & Supratiwi, M. (2023). The Proposed Conceptual Framework to Enhance Mathematics Abilities on Children with Autism Spectrum Disorder (ASD) Through the Application of Virtual Reality Technology. *Journal of Namibian Studies: History Politics Culture*, *34*, 1507-1520.

Sabaruddin, S., Mansor, R., Rusmar, I., & Husna, F. (2020). Student with special needs and mathematics learning: A case study of an autistic student. *Journal of Research and Advances in Mathematics Education*, 317-330.

Sari, P., & Jaguthsing, D. (2021). Counting up'strategy as an alternative to solve subtraction problems with regrouping. In *AIP Conference Proceedings* (Vol. 2331). AIP Publishing.

Shurr, J., Bouck, E. C., Bassette, L., & Park, J. (2021). Virtual versus concrete: A comparison of mathematics manipulatives for three elementary students with autism. *Focus on Autism and Other Developmental Disabilities, 36*(2), 71-82.

Siregar, N. C., Rosli, R., Maat, S. M., Alias, A., Toran, H., Mottan, K., & Nor, S. M. (2020). The Impacts of Mathematics Instructional Strategy on Students with Autism: A Systematic Literature Review. *European Journal of Educational Research, 9*(2), 729-741.

Stockard, J., Wood, T. W., Coughlin, C., & Khoury, C. R. (2020). All students can succeed: A half century of research on the effectiveness of Direct Instruction.

Suprihatin, S., Yufitriani, Y., & Mulyeni, T. (2023). Developing the Ability to Add Integer through Live Worksheets among Grade II Pupils with Autism in Mathematics Learning. *Indonesian Journal of Community and Special Needs Education, 4*(2), 95-102.

Tonizzi, I., & Usai, M. (2023). Math abilities in autism spectrum disorder: A meta-analysis . *Research in Developmental Disabilities*.

## APPENDICES

### Appendix I: Consent Form

My name is **Doreen Khayesi Muchalwa** a post graduate student at Mount Kenya University pursuing a Master of Education degree in Special Needs Education on **'Effect of Direct Instruction Approach on Mathematics Skills Among Learners with Autism in Public Primary Schools in Kakamega County, Kenya.'** Please share the details that will help the study's research aims. To maintain secrecy, we will utilize code numbers rather than names. There is no risk to the research subjects, and the information gathered will not be, disclosed.

While I request your help, I respectfully seek your approval on the supplementary document.

I understand the goal of this study, thus I am ready to sign up right now, even if I end up changing my mind later.

Subject (coded)

Signature…… Date……

Principal investigator

Name: **Doreen Khayesi Muchalwa**

Signature……

For complains or clarification, please contact.

Chairperson,

MKU IREC,

P.O. BOX 342-01000,

**THIKA**

**Appendix II: Teacher`s Mathematics Questionnaire (TMQ)**

This study aims to look at how teachers use the Direct Instructional Approach as a teaching method to help students with autism. The researcher will be grateful for your honest response to this questionnaire. I want to say thank you.

**SECTION I: Demographic Information**

1. Please write your name.……
2. Name of your school.……..
3. Gender: Male ( ) Female ( )
4. What is your academic qualification?
5. Teachers Training College ( ) University ( )
6. For how long have you taught in your present school?

   0-2 years ( ) 3-4 years ( )

   5-6 years ( ) 7 years and above ( )
7. What is your professional qualification/

   P1 ( ) Diploma in Education ( )

   Bachelor of Education ( ) Post Graduate Degree in Education ( )

**SECTION II: Study Objectives**

**SECTION A:**

Please rank the following statement on Likert scale ranging from strongly disagree toward strongly agree. Where; **1= Strongly Disagree 2= Disagree 3= Undecided 4= Agree 5= Strongly Agree.**

| **Statement** | | | | | |
|---|---|---|---|---|---|
| The use of matching helps learners with autism enhances their acquisition of mathematics skills. | **1** | **2** | **3** | **4** | **5** |
| Utilizing place value helps learners with autism heighten their acquisition of mathematics skills. | **1** | **2** | **3** | **4** | **5** |
| Pairing helps learners with autism improve their acquisition of mathematics skills | **1** | **2** | **3** | **4** | **5** |
| Understanding number value helps learners with autism enhance their acquisition of mathematics skills. | **1** | **2** | **3** | **4** | **5** |

**SECTION B:**

Please rank the following statement on Likert scale ranging from strongly disagree toward strongly agree. Where; **1= Strongly Disagree 2= Disagree 3= Undecided 4= Agree 5= Strongly Agree.**

| **Statement** | | | | | |
|---|---|---|---|---|---|
| The use of numbering helps learners with autism enhances their acquisition of mathematics skills. | **1** | **2** | **3** | **4** | **5** |
| Utilizing counting helps learners with autism heighten their acquisition of mathematics skills. | **1** | **2** | **3** | **4** | **5** |
| Sorting and grouping help learners with autism improve their acquisition of mathematics skills | **1** | **2** | **3** | **4** | **5** |
| Understanding pattern making helps learners with autism enhance their acquisition of mathematics skills. | **1** | **2** | **3** | **4** | **5** |

**SECTION C:**

Please rank the following statement on Likert scale ranging from strongly disagree toward strongly agree. Where; **1= Strongly Disagree 2= Disagree 3= Undecided 4= Agree 5= Strongly Agree.**

| **Statement** | | | | | |
|---|---|---|---|---|---|
| The use of sorting helps learners with autism enhances their acquisition of mathematics skills. | **1** | **2** | **3** | **4** | **5** |
| Utilizing grouping helps learners with autism heighten their acquisition of mathematics skills. | **1** | **2** | **3** | **4** | **5** |
| Pairing helps learners with autism improve their acquisition of mathematics skills | **1** | **2** | **3** | **4** | **5** |
| Understanding number recognition helps learners with autism enhance their acquisition of mathematics skills. | **1** | **2** | **3** | **4** | **5** |

**SECTION C:**

Please rank the following statement on Likert scale ranging from strongly disagree toward strongly agree. Where; **1= Strongly Disagree 2= Disagree 3= Undecided 4= Agree 5= Strongly Agree.**

| **Statement** | | | | | |
|---|---|---|---|---|---|
| Counting of numbers helps learners with autism enhances their acquisition of mathematics skills. | **1** | **2** | **3** | **4** | **5** |
| Utilizing counting of concrete objects helps learners with autism heighten their acquisition of mathematics skills. | **1** | **2** | **3** | **4** | **5** |
| Ordering of patterns helps learners with autism improve their acquisition of mathematics skills | **1** | **2** | **3** | **4** | **5** |
| Understanding sequencing helps learners with autism enhance their acquisition of mathematics skills. | **1** | **2** | **3** | **4** | **5** |

**Appendix III: Learners Mathematics Observation Checklist**

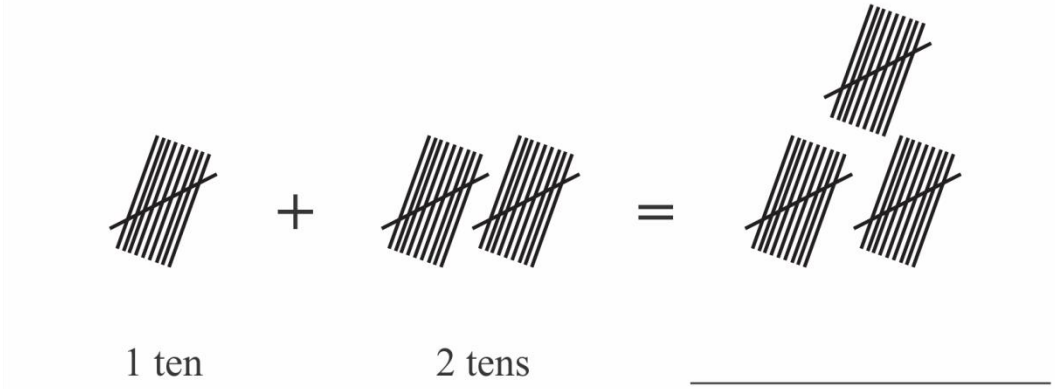
| **Objective** | **Skills** | **Activity** |
|---|---|---|
| Addition with regrouping | Classification | Group flash cards according to their shapes (e.g., triangle, squares) |
| Addition by breaking apart | Number Value | Breaking numbers into tens. (e.g., 12 = 10 + 2) |
| Addition by using counters | Pairing | Match counters by their numbers (e.g., OO = 2) |
| Addition by counting on | Color Recognition | Count numbers 1 to 20 |

**Appendix IV: Learners Mathematics Achievement Test**

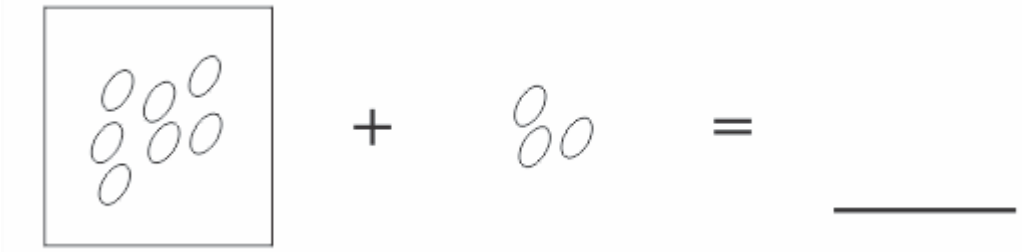
**Addition with regrouping**

Work out

a) 1 tens + 2 tens = _____ tens




b) Count and add



**Breaking apart**

Which of the following is equal to

a) 20 + 32

Choose 1 answer

A. 20 + 30 + 2

B. 2 + 0 + 3 + 2

C. 20 + 20 + 3

b) 36 + 57 = ____

**Addition by using counters**

| **Hundreds** | **Tens** | **Ones** |
|---|---|---|
| 0000<br>0 | 000<br>00 | 000<br>0 |
| | | |

| **Hundreds** | **Tens** | **Ones** |
|---|---|---|
| 3<br>+ 2 | 4<br>5 | 6<br>6 |
| | | |

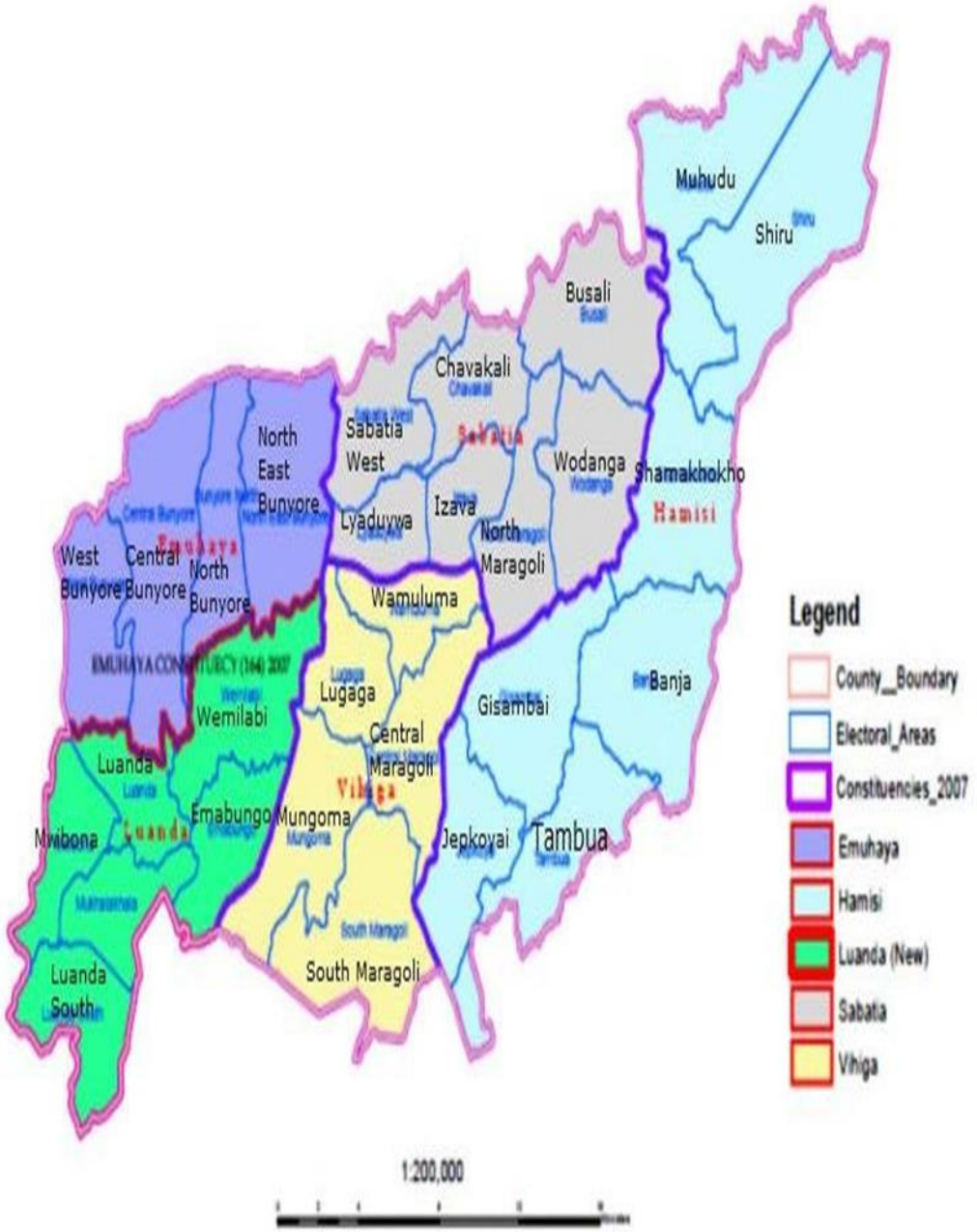
**Addition by counting on**

Start at the first number. Use the dice to count on. Write the new number in the box

5 + **OO** = ☐

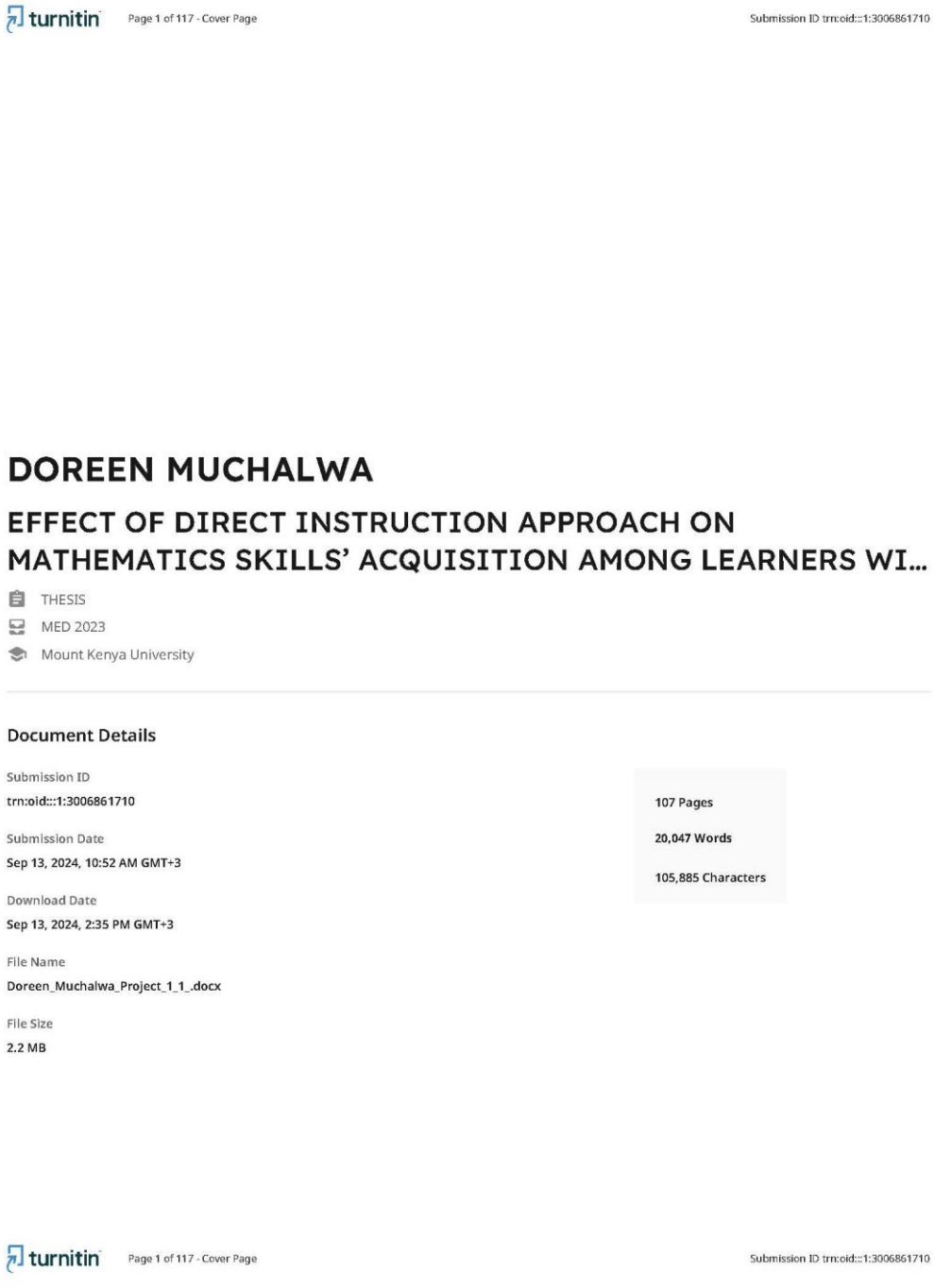
8 + **OO**<br>**OO** = ☐

**Appendix VII: Map of Kakamega County**




**Source: Kakamega CICD (2018)**

## Appendix IX: Similarity Index



# 17% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

## Exclusions

▸ 265 Excluded Matches

## Match Groups

**104** Not Cited or Quoted 8%
Matches with neither in-text citation nor quotation marks

**82** Missing Quotations 6%
Matches that are still very similar to source material

**14** Missing Citation 3%
Matches that have quotation marks, but no in-text citation

**0** Cited and Quoted 0%
Matches with in-text citation present, but no quotation marks

## Top Sources

14% Internet sources
8% Publications
12% Submitted works (Student Papers)

## Integrity Flags

**0 Integrity Flags for Review**

No suspicious text manipulations found.

Our system's algorithms look deeply at a document for any inconsistencies that would set it apart from a normal submission. If we notice something strange, we flag it for you to review.

A Flag is not necessarily an indicator of a problem. However, we'd recommend you focus your attention there for further review.

## Appendix X: Research Authorization

REPUBLIC OF KENYA

MINISTRY OF EDUCATION
STATE DEPARTMENT FOR BASIC EDUCATION

Telephone:
Fax:
E-mail: wespropde@yahoo.com
When replying please quote our Ref.

County Director of Education
Kakamega County
P. O. BOX 137 - 50100
KAKAMEGA

**REF: KAKA/C/GA/29/17/VOL.VI/337**

**21st August, 2024**

DOREEN KHAYESI MUCHALWA
MOUNT KENYA UNIVERSITY
P O BOX 342-01000
**THIKA**

**RE: RESEARCH AUTHORIZATION**

Reference is made to a letter from NACOSTI Ref No: NACOSTI/P/23/29419 dated 12th September, 2023 concerning subject matter.

This is to inform you that you have been authorized to carry out research on **'Effects of direct instruction approach on Mathematics skills acquisition among learners with autism in Public Primary Schools, Kakamega County'** for the period ending 12the September, 2024.

Please accord him/her any necessary assistance he/she may require.

FOR COUNTY DIRECTOR OF EDUCATION
KAKAMEGA COUNTY

HELLEN NYANG'AU
COUNTY DIRECTOR OF EDUCATION
**KAKAMEGA COUNTY**

***Copy to*:**

Regional Director of Education
**WESTERN REGION**

## Appendix XI: Authorization / ERC letter from MKU

# Mount Kenya University

REF: **MKU/ISERC/2924**
TO: **MUCHALWA K. DOREEN**

Date: 11 August 2023

REG: **MEDSNE/2016/51859**

Dear Sir/Madam,

**RE: EFFECT OF DIRECT INSTRUCTION APPROACH ON MATHEMATICS SKILLS' ACQUISITION AMONG LEARNERS WITH AUTISM IN PUBLIC PRIMARY SCHOOLS WITHIN KAKAMEGA COUNTY KENYA**

This is to inform you that **Mount Kenya University** has reviewed and approved your above research proposal. Your application approval number is **1968**. The approval period is **11/08/2023 - 10/08/2024.**

This approval is subject to compliance with the following requirements;

i. Only approved documents including informed consents, study instruments, MTA will be used
ii. All changes including amendments, deviations and violations are submitted for review and approval by **Mount Kenya University**
iii. Death and life-threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to **Mount Kenya University** within 72 hours of notification
iv. Any changes anticipated or otherwise that may increase the risks or affect the safety or welfare of study participants and others or affect the integrity of the research must be reported to **Mount Kenya University** within 72 hours
v. Clearance for export of biological specimens must be obtained from relevant institutions
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal
vii. Submission of an executive summary report within 90 days upon completion of the study to **Mount Kenya University**

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://research-portal.nacosti.go.ke and also obtain other clearances needed.

The Chairman
Mount Kenya University
Ethics Review Committee
P.O. Box 342 - 01000 Thika

Yours sincerely,

**Dr. Alfred Owino, PhD**
**Chairman, Mount Kenya University ISERC**

Main Campus, General Kago Road, P.O. Box 342-01000 Thika.
Tel: 020-2878 000, Cell: +254 709 153 000
Email: info@mku.ac.ke Web: www.mku.ac.ke

**Appendix XII: Introduction Letter to NACOSTI**

Mount Kenya University

## DIRECTORATE OF GRADUATE STUDIES

**MEDSNE/2016/51859**

14th August, 2023

*National Commission for Science Technology & Innovation (NACOSTI)*
*Off Waiyaki, Upper Kabete*
*P.O Box 30623- 00100*
*NAIROBI, KENYA*

Dear Sir/Madam,

**RE: MUCHALWA K. DOREEN- REGISTRATION NO. MEDSNE/2016/51859**

The purpose of this letter is to introduce the above named student who is pursuing **Master of Education in Special Needs** in the **Department of Special Needs Education** in the **School of Education.**

The title of the research is **"Effect of Direct Instruction Approach on Mathematics Skills' Acquisition among Leaners with Autism in Public Primary Schools within Kakamega County, Kenya."** It been cleared by the University's Ethics Review Committee (Certificate attached) and now has to proceed to the field to collect data between **August, 2023 and October, 2023.**

Any assistance accorded to the student will be highly appreciated.

Thank you.

Mount Kenya University
P. O. Box 342 - 01000, THIKA
Office of the Director
Graduate Studies

**Dr. Samuel M. Karonga, Ph.D**
**Director, Graduate Studies**
**Enc.**

## Appendix XIII: Research Permit from NACOSTI

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **674643**

Date of Issue: **12/September/2023**

**RESEARCH LICENSE**

**This is to Certify that Miss.. DOREEN KHAYESI MUCHALWA of Mount Kenya University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Kakamega on the topic: EFFECTS OF DIRECT INSTRUCTION APPROACH ON MATHEMATICS SKILLS' ACQUISITION AMONG LEARNERS WITH AUTISM IN PUBLIC PRIMARY SCHOOLS WITHIN KAKAMEGA COUNTY, KENYA for the period ending : 12/September/2024.**

License No: **NACOSTI/P/23/29419**

**674643**

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

**See overleaf for conditions**