# Effect of an Explicit Teaching Strategy on the Early Numeracy Skills of Children with Mathematics Learning Difficulties: The Case of Mandallo Primary School, Dukem Town, Oromia Region, Ethiopia.

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**Abstract**

*The purpose of this study was to examine the effect of an explicit teaching strategy intervention on the early numeracy performance of children in grade two with mathematics learning difficulties. A single-case experimental design with pretest and post-test assessments and naturalistic observations was employed. A total of seventeen grade two children with mathematics learning difficulties (MLDs) were selected from Mandallo Primary School in Dukem, Oromia, Ethiopia. The sample consisted of eleven boys and six girls, all between the ages of 7 and 8 years. These children shared Afan Oromo as their mother tongue and received instruction in Afan Oromo; they also came from similar socioeconomic backgrounds. The data were collected using the adapted Early Grade Mathematics Assessment (EGMA) tool, which assesses nine domains of early numeracy skills specific to the second grade. Additionally, careful observation was conducted. The quantitative data were analyzed using paired sample t-test, while the qualitative data were analyzed through narration. The findings of the present study revealed that the explicit teaching strategy intervention had a significant effect on the achievement of early numeracy skills in children with MLD. In conclusion, explicit teaching strategy intervention proved to be an effective approach for improving the early numeracy skills of children with MLD.*

**Keywords**: *Early Numeracy Skills; Explicit Teaching Strategy; Mathematics Learning Difficulties*

## 1. Introduction

Enhancing children's numeracy skills during the early grades is of utmost importance for several compelling reasons (Parviainen, 2019). First, a strong foundation in numeracy lays the

groundwork for future academic success (Aunio, Mononen, Ragpot, & Törmänen, 2016). Proficiency in mathematics is crucial not only for various science, technology, engineering, and mathematics (STEM) fields but also for everyday life (Maass, 2019). According to Ogunleye (2019), by developing a solid understanding of numbers, operations, and problem-solving strategies at an early age, children are better equipped to tackle more complex mathematical concepts as they progress through their education.

In addition, improving children's numeracy skills at an early stage fosters critical thinking and logical reasoning abilities (Girard, 2021). Numeracy is not limited to computations; it also involves analyzing patterns, making connections, and solving problems systematically (Nelson, 2019). By engaging in activities that promote numeracy, such as counting objects, recognizing shapes, and solving puzzles, children develop cognitive skills that extend beyond mathematics. These skills, including logical reasoning, problem-solving, and attention to the details, are transferable to other subjects and real-life situations, enhancing their overall cognitive development (Parviainen, 2019).

Early numeracy encompasses a wide range of abilities that play a vital role in later mathematical development (Aunio, 2016). These abilities include understanding the mental number line and differences in magnitude, recognizing and naming number symbols, developing numerical relationships and counting skills, acquiring cardinal knowledge, mastering basic addition and subtraction, and solving early arithmetic word problems (Clarke,2021). Numerous studies have consistently demonstrated that proficiency in these early numeracy skills strongly predicts future mathematical performance (Morris et al., 2021). Conversely, poor performance in early numeracy can indicate potential difficulties in mathematical learning. Weak counting skills, limited understanding of numerical relationships, and inadequate basic arithmetic skills are observable indicators of low development in early numeracy skills (Aunio, Mononen, Ragpot, & Törmänen, 2016). Hence, it is crucial for early mathematics instruction to prioritize the development of these skills.

Globally, the literature suggests that early numeracy learning plays a crucial role in a child's overall development and academic success (Schere et al., 2019). These authors particularly highlighted the importance of providing children with a strong foundation in numeracy skills, as this not only enhances their mathematical abilities but also contributes to their cognitive

development and problem-solving skills (Clarke, 2021). The literature also emphasizes the need for educators to adopt evidence-based instructional approaches that promote active engagement, conceptual understanding, and the use of manipulatives to support children's learning (Doabler et al., 2019).

The Ethiopian mathematics curriculum for Grade 2 outlines several early numeracy abilities that children are expected to develop (Tsebella, 2022). These abilities include understanding and representing numbers up to 100, counting forward and backward from any given number, and recognizing patterns in numbers and shapes. Additionally, children are introduced to basic addition and subtraction concepts, such as adding and subtracting within 20 using concrete objects or pictorial representations (Tiruneh et al., 2021). They also learn to compare and order numbers, identify odd and even numbers, and solve simple word problems involving addition and subtraction.

Children with MLD exhibit certain characteristics that distinguish them from their peers. One key characteristic is a persistent struggle with understanding and applying mathematical concepts (Ebrahim et al., 2020). These children may have difficulty grasping basic arithmetic operations, such as addition, subtraction, multiplication, and division (Verschaffel et al., 2018). Additionally, children with mathematical difficulties often have trouble with spatial reasoning and visualizing mathematical concepts, which can further hinder their ability to solve mathematical problems (Doabler et al., 2019).

Several terms are used in the literature to describe the levels of difficulties in mathematics performance. The term mathematics learning difficulties (MLD) is often used for individuals who perform between the 11th and 35th percentiles (Verschaffel et al., 2018). Penford (2020) refers to this group as low-performing or low-achieving in mathematics, suggesting their risk for severe MLD. Moderate or mild mathematics learning difficulties may stem from external factors such as poor teaching, low socioeconomic status, behavioral attention problems or domain-general cognitive deficits (Doabler et al., 2019). In this study, the researchers used the term MLD to refer to all children who performed below average (50%) in mathematics skills.

The global prevalence of children facing difficulties in mathematics learning during primary school is a serious concern (Grigorenko, 2020). Numerous studies have been conducted to

estimate the extent of this problem, shedding light on the challenges faced by children worldwide (Alfonso, 2018). While the exact percentage may vary across different regions and countries, it is evident that a substantial number of children encounter difficulties in grasping mathematical concepts during their early education (Fletcher, 2018).

In the context of Ethiopia, the prevalence of children struggling with math learning is also a topic of interest (Iyer, 2020). Although specific data on the estimated percentage of children facing difficulties in math learning in Ethiopia may be limited, it is widely acknowledged that numeracy skills pose a significant challenge for many young students in the country (Bashir, 2018). Factors such as limited access to quality education, inadequate resources, and a lack of specialized support contribute to the struggles experienced by Ethiopian children in their math learning journey (Fletcher, 2018).

Furthermore, in Ethiopia, the Ministry of Education has consistently conducted National Learning Assessments (NLAs) every four years upon completion of the lower and upper primary education (grades four and eight) to evaluate the overall quality of education. A comprehensive analysis of the six consecutive NLAs conducted between 2000 and 2019 showed that average mathematics scores for students in grades four and eight fell below the minimum standard of 50% set by the Ministry of Education (Tiruneh et al., 2021). The Ethiopian sixth NLA conducted for assessing grades four and eight students in Ethiopia in 2019 reported that 68.79% and 90.1% of grade 4 and 8 students scored below 50% in mathematics, respectively (MoE, 2019). In addition, the Early Grades Mathematics Assessment (EGMA) was conducted in 2017 to measure the extent to which Ethiopian students in grades 2 and 3 performed in mathematics, more specifically, foundational skills (the basic competencies that should typically be mastered in the very early grades). The findings of this study revealed gaps in the acquisition of expected learning outcomes in foundational mathematics skills. Specifically, the study showed that a substantial percentage of Grade 2 children did not attain minimum competency in number identification (20.17%), missing number (36.7%), addition (16.2%), subtraction (13.7%) or word problems (16.6%).

Effective instruction for students who are struggling in learning mathematics emphasizes the use of explicit instruction that includes a series of support mechanisms and scaffolding (Hughes et al., 2018). The effectiveness of explicit teaching intervention in improving the early numeracy

skills of children with MLD is supported by a wealth of research findings (Nelson & McMaster, 2019). Studies have consistently shown that explicit instruction, which involves clearly explaining mathematical concepts, providing guided practice, and offering immediate feedback, leads to significant improvements in students' mathematical abilities (Scherer et al., 2017). This approach allows teachers to address the specific needs of struggling learners, providing them with the necessary scaffolding and support to develop a solid foundation in numeracy (Morris et al., 2021).

Many studies and research reviews (Ebrahimi et al., 2020) have shown that explicit teaching strategies have a positive effect on the mathematics performance of students with mathematics learning difficulties (MLDs) in elementary, middle, and high school settings and from diversified social and economic backgrounds. These studies showed that in an explicit teaching strategy, the learning process is guided and supported so that the student masters a new skill. The process consists of clear statements and explanations of the instructional goals, learning expectations, step-by-step demonstrations, an adequate range of examples and frequent feedback (Hughes et al., 2018).

Research conducted across the globe provides evidence on the predictive effect of early mathematical knowledge and skills on later academic achievement and economic status (Platas et al., 2016). Tsisindu et al. (2016), using longitudinal studies, reported that performance in mathematics in early grades is a good predictor of mathematical performance later in school. The significance of these findings is that the difference in mathematics performance between low- and high-performing pupils tends to increase over time. This implies that if adequate support is not provided for pupils who score low grades, it may eventually become a source of variance not only in educational achievement but also in personal fulfillment, citizenship, social inclusion, and employability.

The purpose of this study was to examine the effect of an explicit teaching strategy on the early numeracy skills of Grade Two students with mathematics learning difficulties. This study aimed to confirm whether intervention in explicit teaching strategies could enhance the mathematics performance of children with MLD. The effect of the explicit teaching strategy on improving diverse numeracy skills was also investigated. The findings of the study may be useful for

improving the performance of children in mathematics in general and those with mathematics difficulties in particular. The findings may also serve a purpose in designing intervention programs to enhance the achievement of learning with MLD and other learning difficulties. Teacher trainers may also use the findings of the study for equipping trainee teachers with relevant knowledge and skills on early identification and intervention of children with mathematics learning difficulties. The findings of this study may also help curriculum developers and other stakeholders appreciate the importance of early identification and intervention in addressing mathematics learning difficulties and improving the general academic performance of learners with learning difficulties. The study may also provide relevant data that may inform strategies for stakeholder collaboration in the intervention of mathematics difficulties.

Mathematics learning difficulties affect people of different ages. This study focused on learners aged between 8 and 9 years and recognized, based on reports from earlier studies, that most successful interventions occur during this age. Second, the intervention methods used may differ between public and private schools. Therefore, this study focused on a public primary school called Mandallo, which is located in Dukem town administration. Factors influencing early numeracy skills among grade two children might vary from place to place. The results may not be generalizable to other primary schools and districts that are not similar to this population but rather may provide insight into the problem and ways to address it. A total of seventeen grade two students with MLD participated in the intervention. Although mathematics learning difficulties affect children at all level of schooling, this study was limited to mathematics learning difficulties among children in lower primary schools where optimum return is attained through early identification and intervention.

**Research Question**

Is there a significant difference in mathematics performance among grade two children with mathematics learning difficulty as a result of intervention in explicit teaching strategies?

## 2. Research Methods

Design

The study used a single-case experimental design (SCD), consisting of pretest and post-test assessments as well as naturalistic observations, to collect comprehensive and detailed information regarding the participants' experiences and perceptions. The study was conducted on a single group of participants in which all participants underwent the same intervention and assessments. The effect of the intervention was mainly assessed by quantifying the disparity between the scores obtained during the pretest and post-test and substantiating the findings with evidence gathered through careful observation throughout the designated period of intervention.

A single-case experimental design aims to explore the impact of the independent variable in a small number of subjects (Shadish et al., 2016). This design is particularly useful for documenting three important elements in the intervention process: 1) If the independent variable has an observable and important impact, 2) If the observed change in the dependent variable occurs as a result of the application of the independent variable and 3) Whether this change is generalizable across different settings and targets (Maggin et al., 2017). By systematically manipulating and measuring variables within a single case, SCD enables researchers to establish strong internal validity and draw reliable conclusions about the effectiveness of the intervention(Ozcan et al., 2017). This design compares the effects of explicit teaching strategy interventions across grade two students with those of MLD, where the dependent variable—early numeracy skills—was measured twice, once at the beginning and once at the end of the intervention. The selection of schools for the study was carried out using a non-probability judgmental sampling design technique. This decision was made considering the difficulties associated with obtaining completely random samples, mainly due to the relatively smaller population of children with MLD who were eligible to participate. The selection of the school was based on specific criteria, such as having a large student population and offering support services to students with learning difficulties.

## Participants

This study focused on a group of seventeen children—eleven boys and six girls—who were in the second grade of a public middle school. These children, aged between 7 and 8 years, all had Afan Oromo as their mother tongue and were taught using Afan Oromo as medium of instruction. Additionally, they came from similar socioeconomic backgrounds. The selection of participants was purposefully made based on specific criteria during both the identification and group intervention phases. Two teachers teaching at this grade level who were willing to collaborate took part in the study. To identify suitable candidates for the intervention program, the performance of the children in mathematics performance during the first semester of grade one and grade two was taken into consideration. The grade two classes comprised a diverse group of learners, each exhibiting varying degrees of mathematical proficiency. As a result, the 25 children with the lowest academic performance were identified based on their previous mathematics performance, specifically the ones that belonged to the lowest quartile in both sections. These 25 children were evaluated using a modified version of the Basic Numerical and Calculation Abilities (BANUCA) (Frost & Little, 2014; Tesfaye & Ludago, 2016) tool, which was adapted to the Ethiopian context by the Ministry of Education to identify children with MLD. Seventeen of the 25 children were identified as eligible participants for inclusion in the study as children with MLD.

## Ethical considerations

Informed consent was obtained in writing from the Dukem City Administration Education Office in consultation with Mandallo Primary School after the individuals were informed of the study requirements and verbally from the participants before the testing commenced.

## Assessment Tools

For the initial assessment (pretest) of children's mathematical ability in early numeracy skills and for monitoring their progress (posttest), the researchers used the adapted Early Grades Mathematics Assessment (EGMA) tool used in the Ethiopian context by MoE in 2014 and 2018 to measure essential early mathematical knowledge and skills in the early grades that are foundational to more sophisticated mathematical abilities, predictive of later achievement, and teachable (Platas et al., 2016). The adapted EGMA tool consists of nine specific tasks, scored

from 216 score points. These include 1) oral counting, 2) rational counting (one-to-one correspondence), 3) number identification, 4) quantity discrimination, 5) missing numbers, 6) addition levels 1 and 2, 7) subtraction levels 1 and 2, 8) pattern extension, and 9) world problems.

Procedure

One-on-one questionnaires were administered four days a week over two weeks. One week was used for the pretest assessment, and one week was used for the post-test assessment. In the pretest assessment, the nine sub-tests assessing early numeracy skills in early grades were assessed through the adapted EGMA tool in the Ethiopian context. After the pretest assessment was conducted, the trained and recruited primary school mathematics teachers arranged afternoon sessions and conducted an explicit teaching strategy with seventeen selected students to help them develop early numeracy skills for 32 sessions, each lasting 45 minutes.

During the instruction session, the trained mathematics teacher reviewed prerequisite skill(s) to ensure the readiness of the students for instruction, engaged students by asking them to perform tasks for which they had prerequisite knowledge, and asked the students to complete the mathematical task together. The implementer further encouraged his students to independently complete the mathematical task and offered feedback and support whenever an error occurred. Ultimately, the teacher concluded the lessons by highlighting the most important aspects, seeking the students' opinions on the day's teaching process, addressing any common mistakes, and acknowledging achievements. The researchers were involved in conducting thorough observations to ensure the validity of the intervention and track the progress of the children's early numeracy performances.

The intervention was intensified by providing explicit and systematic instruction, continuous use of Bruner’s theory of instruction strategy, a concrete-representation-abstract (CRA) strategy and increased time for student engagement to allow students to explore numeracy concepts freely by using manipulatives and pictures and to guide students to develop new concepts (Ebrahimi et al., 2020). The post-test assessment employed the adapted EGMA assessment tool to assess the effect of the explicit teaching strategy on the early numeracy skills of children with MLD.

## 3. Results and Discussion

### Effect of Explicit Teaching Strategy Intervention

The effectiveness of the intervention was assessed by conducting a parametric statistical t-test on dependent paired samples. This approach allowed us to evaluate the intervention's effect on children's progress by comparing their performance before and after the intervention. The pretest scores (M = 85.294, SD = 7.88) showed a significant improvement over the post-test scores (M = 165.411, SD = 10.665). Furthermore, paired sample t-test demonstrated a significant main effect (t = -37.649, p = .000<.005), indicating the substantial impact of the explicit teaching intervention on grade two students with MLD. The study revealed that the average score for the group of 17 students with MLD prior to the intervention was 85.294. Following the intervention, the average score rose to 165.419, representing an almost twofold increase compared to the pretest score. Moreover, the 95% confidence interval for the mean difference in scores between the 17 students (μ-post) and (μ-pre) was (-84.62, -75.606), signifying the significant effectiveness of the explicit teaching strategy intervention.

**Table 1: Intervention effects on early numeracy skills**.

| | | Mean | N | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Pair 1 | Scores before the training | 85.2941 | 17 | 7.88008 | 1.91120 |
| | Scores after the training | 165.4118 | 17 | 10.66571 | 2.58681 |

**Paired Samples Test**

| | | Paired Differences | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 95% Confidence Interval of the Difference | | | | |
| | | Mean | Std. Deviation | Std. Error Mean | Lower | Upper | T | df | Sig. (2-tailed) |
| Pair 1 | Scores before the training - Scores after the training | -80.11765 | 8.77413 | 2.12804 | -84.62889 | -75.60641 | -37.649 | 16 | .000 |

The study findings showed that an explicit teaching strategy has a significant impact on the early numeracy skills of grade two children with MLD. The mean score increased from 85.2941 at the pretest to 165.4118 at the post-test, which was almost twice the initial mean value. Furthermore, the results of the hypothesis tests conducted using SPSS indicated a paired samples t-test value of -37.649, with a p-value of .000. This provides clear evidence of the significant influence that the explicit teaching strategy has on the early numeracy skills of grade two students with MLD (Table 1). Table 1 presents the results of the paired t-test for a total of 17 children. At a

significance level of 5%, the alternative hypothesis is accepted, leading to the conclusion that there is a statistically significant difference between the mean scores of the pre- and post-tests for each early numeracy skills domain. Thus, it is strongly evident that an explicit teaching strategy effectively enhances the achievement of early numeracy skills in children with MLD. Moreover, based on careful observation, the researchers verified that the children demonstrated active involvement and engagement, as well as meaningful interactions with their peers. They were seen exchanging ideas, experiencing a sense of achievement, and developing the ability to become independent learners. Additionally, the children displayed confidence in tackling mathematical challenges, which was evident across all nine subsets of early numeracy skills.

**Table 2: Intervention effects on each early numeracy skills subset**

| Early Numeracy Skills | **N** | Mean Pretest | Mean Posttest | Gain |
|---|---|---|---|---|
| Oral counting | 17 | 53.941 | 88.176 | 34.235 |
| Rational counting | 17 | 8.353 | 18.294 | 9.941 |
| Number Identification | 17 | 6.824 | 16.824 | 10.000 |
| Quantity discrimination | 17 | 4.471 | 7.294 | 2.824 |
| Missing number – Practice | 17 | 3.588 | 7.000 | 3.412 |
| Addition: Level 1 | 17 | 3.882 | 7.882 | 4.000 |
| Addition: Level 2 | 17 | 1.294 | 4.706 | 3.412 |
| Subtraction Level 1 | 17 | 1.706 | 6.235 | 4.529 |
| Subtraction: Level 2 | 17 | 0.471 | 3.824 | 3.353 |
| Pattern extension | 17 | 0.471 | 1.824 | 1.353 |
| Word Problems | 17 | 0.294 | 3.353 | 3.059 |
| Valid N | | | 17 | |

As shown in Table 3 above, there were mean value changes in each early numeracy skill subset after Grade Two students with MLD received explicit teaching strategy intervention. The mean has progressed from 53.941 to 88.176 in oral counting; from 8.353 to 18.294 in rational counting (one-to-one correspondence); from 6.824 to 16.824 in quantity discrimination from 4.471 to 7.294 in quantity discrimination; from 3.588 to 7 in missing number; from 3.882 to 7.882 in addition to level 1; from 1.294 to 4.708 in addition to subtraction level 1 from 1.706 to 6.235; from 0.471 to 3.824 in subtraction level 2; from 0.471 to 1.824 in pattern extension; and from

0.294 to 3.059 in the world problem. Therefore, from the t-test and mean values, it can be concluded that the explicit teaching strategy has a positive and significant effect on the early numeracy skills of Grade Two students with MLD. These results agree with the findings of Fuchs et al. (2020), who stressed that explicit teaching strategies have a positive impact on the acquisition of mathematical concepts for students with learning difficulties.

The findings of the intervention are consistent with the explicit teaching strategy that has been proposed by Hughes et al. (2017). The authors underlined that the main purpose of using the explicit instruction learning model is to maximize the use of child learning time, while the positive impact of teaching is the achievement of academic content and skill completeness, increasing child motivation and increasing student learning outcomes.

Smith et al. (2016) asserted that the explicit instruction components (e.g., clear and explicit models and guided practice using visual and verbal prompts such as worked solutions) reduce cognitive load and the resulting stress on working memory for children who lack background knowledge and/or automaticity in recalling prerequisite knowledge and skills related to what is being taught to support the learning outcomes of the children. Barnes et al. (2018); Joseph et al. (2016) stated that teaching behaviors included in explicit instruction (e.g., modeling, prompting, frequent opportunities to respond accompanied by feedback) are aligned with applied behavior analysis principles such as positive reinforcement (feedback), carefully arranging examples, consistent use of terms (stimulus control), and modeling (orienting attention to critical stimuli) are cornerstones for effective learning of children with learning difficulties.

Similarly, the studies conducted by Ogunleye (2019) and Martin and Evans (2020) concluded that there is a positive and significant influence of explicit teaching strategies on the learning outcomes of children with MLD. The authors stated that an explicit instruction strategy can control the content of the material and the sequence of information received by children so that it can maintain a focus on what must be achieved by children so that learning is more active and skilled and that the learning carried out is more meaningful and provides positive motivation for children. Additionally, explicit teaching strategies provide opportunities for teachers to test, support and guide the learning processes, progress and outcomes of their children. Therefore, an

explicit teaching strategy is a means for teachers to improve the learning outcomes of their children.

**Conclusion**

Based on the findings from the intervention and discussion in relation to earlier studies, it can be concluded that the use of an explicit teaching strategy has a significant effect on the early numeracy skills of grade two children with MLD. The findings from this study were also encouraging in the sense that the explicit teaching strategy intervention programme seems to yield better outcomes in children with MLD performance in early numeracy skills.

Therefore, an explicit teaching strategy is highly useful and recommendable for teaching children with MLD. Putting this as an input, further investigation may be carried out in large scale to ensure that this strategy works in different contexts, grade levels, and mathematical skills including early numeracy skills and elementary mathematics concepts.

**Limitations and Future Research**

The current study consisted of a small sample size, and it was conducted over a short time frame. Analyzing settings across multiple grade levels would have provided a more accurate picture. Future studies with larger sample size may enhance the external validity of explicit teaching strategy intervention. Conducting studies with sample sizes across multiple schools will increase the feasibility of implementing the explicit teaching strategy intervention program in inclusive classroom settings (during and/or after school hours) for the purpose of enhanced learning outcomes for students with MLD.

**Implications of the Findings**

According to the special needs/inclusive education strategy designed by the MoE and being implemented in primary schools in Ethiopia, schools and teachers are expected to be responsible for all students, including those with learning disabilities or difficulties to enable them meet standards and achieve success in all subjects, including mathematics (Dano & Arfasa, 2020). However, the question of how to improve the performance of students with mathematical difficulty has not yet been adequately answered. The significance of numeracy skills in various domains of our lives has led to the development and enhanced utilization of effective delivery

methods in education. These methods have been and will continue to play crucial roles in supporting children with diverse needs. Therefore, effective teaching strategies, such as the one which was examined in this study, are likely to provide educators with research-based tools for supporting students in line with the requirements of the Minimum Learning Competency, the Special Needs/Inclusive Education Strategy and other national and international documents.

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