Modification of the Routine Didactic Scheme in Elementary School Mathematics Learning: An Evaluation of Its Impact on Students Thinking Skills

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Abstract

Math also presents unique challenges to students and teachers, maybe because it's harder than other subjects. Although all the disciplines have the three basic common elements that shape the teaching and learning system: the teacher, the content on the subject matter, and the learner, but in a subject like Mathematics, it should not be a one-size-fit-all standard teaching, there must be a more focused approach for each. A serious weakness of today's textbook-based math education is the absenceOne of the main issues in mathematics education is the lack of attention to students' individual characteristics within the existing routine, leading to inadequate student understanding of the material. The purpose of this study is to assess the influence of a changed routine didactic scheme for learning mathematics in elementary school towards the thinking skills of students. The research involved 90 students studying at three elementary schools in Banten Province, Indonesia, which consisted of 90 students: 30 students of Grade 4 at a school in Pandeglang Regency, 30 students at a school in Cilegon City, and 30 students at a school in Serang City, also in Banten Province, Indonesia. The research method used was Didactical Design Research or DDR, which focused on designing and evaluating didactic situations to become better at learning mathematics in elementary schools. The results of the research indicated that the routine scheme that was already established for learning mathematics in elementary school should be modified to become more effective, both for students and teachers in teaching mathematics. There followed three didactic scheme modifications respectively called Scheme I, Scheme II, and Scheme III that were intended to improve time management, problem-solving ways, and collaboration among students in learning. These results suggest that modifying a didactic situation can have a positive impact on the thinking skills of students in elementary school mathematics education.

Keywords: *Mathematics Education, Didactical Design Research, Didactic Schemes, Student Thinking Skills, Modification of Routine Teaching*

Introduction

Mathematics as a subject presents unique challenges for both teachers and students, distinguishing it from other subjects. Mathematics is often perceived as more difficult compared to other subjects. However, there are similarities in how mathematics content is presented in the classroom compared to other subjects: a) there are three core components in every lesson—teacher, student, and subject matter; and b) the learning process typically begins with an introduction, followed by an explanation of the material, providing examples, and concluding with an evaluation. Yet, this routine approach may not be suitable for all subjects, especially mathematics. There is a period, to put it mildly, when the characteristics of the student are not sufficiently considered in the teaching-learning process. According to (Loewenberg Ball et al., 2008) mathematics instruction contains three interrelated elements (teacher, student and content area) all affecting each other during the teaching process. (Wang et al., 2018) also stated that while math lessons usually start with preliminary activities in which students recall previous material, that does not necessarily suffice for determining if students are academically ready for subsequent lessons. During my observations of elementary school math lessons in Banten Province, it was clear that many of the students lacked some of the foundational skills; that is, they did not know their multiplication facts, and therefore, could not complete newer tasks involving more complex ideas, such as a finding the area of plane figures. As pointed out by (Arhin et al., 2023), like comprehesion, the best way to engage in aperception is to assess initial readiness of the students to identify barriers to teaching the material that follows.

Second, when students are given problems to solve at the board, they feel they do not have enough time to think. As a result, when other students come up to write their answers, some students simply copy them. This leads to a lack of understanding across all students. Third, during evaluations, students often struggle with the initial readiness needed to solve the evaluation problems. If students have difficulty understanding a single problem, the situation is unlikely to improve with the introduction of additional problems. Fourth, the quantity of evaluation problems given is ineffective. Too many problems place undue burden on students, which negatively impacts the completion of the material. Therefore, accurate and effective evaluation methods are needed to assess students' abilities. These observations led the researcher to consider modifying the didactic situation in mathematics teaching. This study aims to investigate several modifications to the didactic situations in elementary school mathematics classrooms and how these modifications affect student behavior in response to the identified issues. The research method used is Didactical Design Research (Suryadi, 2013) to modify the teaching situation for optimal learning outcomes.To adjust the didactic situations to maximize the outcomes of teaching. The degree of variability and awareness of the teaching situation, related to student outcomes, is referred to as the modulation of didactic situations. This notion of modulation refers to critical pedagogical action that moves away from strict indivisibility of learning environments. All the studies relate to how students can be supported through an adjustment of the didactic situation. The relevance of these connections to instruction and teacher development, through modulations of didactic situations, can be prioritized within complex realities in music education and any number of variations related to both developing teachers and teacher education programs, given the multiplicity of pedagogical positions.

In order for students to collaborate and think critically. This design needs to address not just the content but how students engage with that content. Some of (Arthur et al., 2022) research on mathematics teaching strategies highlights the significance of understanding essential concepts before delving into higher order topics. They point out that many students struggle with mathematics because they are not confident in basic concepts such as arithmetic operations, and therefore fail to comprehend higher order topics like geometry or algebra. In addition, research conducted by (Supriadi et al., 2014), (Suryadi, 2019) indicated that very many teachers in Indonesia still teach mathematics using traditional methods, which are based on providing practice problems and some form of quantitative evaluation without providing students the opportunity to think critically, and reflect on what they have learned. This is problematic as students are focused on the answer and do not contemplate the process they undertook to obtain the answer.

While there has been extensive research on the mathematics teaching field at the elementary level and the nature of modifying didactic designs, there still exists much research that is lacking, especially on the application of didactic design modifications in the area of mathematics education in Indonesia. Most researchers have discussed teaching, overall teaching strategies but rarely specifically discussed how modifying the didactic design intends to include efforts to respond to specific issues to mathematics teaching; such issues with insufficient time for mathematical thinking, unbalanced assessment, and little collaboration among students.

A key gap in the literature is the absence of research that explicitly links changes in didactic design to the improvement of students' critical thinking skills. There are studies on teaching strategies generally, but few examine how changes in didactic design can improve students' thinking skills in an elementary school context.

This study will work to address this gap by examining changes to the didactic situation in elementary school mathematics purposed with improving student critical thinking. To achieve this, the research will explore how disruptions to routine didactic situations can improve the learning process, create more opportunities for student thinking, and encourage a collaborative process of learning.

The chief aims of this study are:

1. To identify and develop a didactic design that can overcome the learning barriers faced by elementary school students in mathematics.
2. To evaluate the implementation of the didactic design and its impact on changes in the learning situation and its influence on students' critical thinking skills.
3. To assess the results of revising the initial didactic design based on feedback from students regarding the modified learning situation.

This study is limited to mathematics teaching in elementary schools in Banten Province, Indonesia. The focus of the research is on modifications to didactic design related to improving students' critical thinking skills in solving mathematics problems. The study will not cover other topics in mathematics that are not directly related to the modified didactic schemes. Additionally, the study will involve students in grades 4 and 5, who exhibit varying levels of readiness in learning mathematics. Therefore, the findings of this study may not be fully generalizable to all levels of elementary education or to learning contexts outside Indonesia.

The process of mathematics teaching and learning in elementary schools is an area of research that has been closely studied given its importance to students' mathematics understanding and their ability to apply mathematics more generally. Nevertheless, while routine didactic plans are often used in mathematics classrooms, they may not lead to the cognitive advancement of knowledge, including of students' critical thinking capabilities. This literature review presents the existing body of research on didactic design processes, routine pedagogy in elementary school mathematics, and the impact of such changes on revising students' thinking skills.

LITERATURE REVIEW

1. The Role of Didactical Design in Mathematics Education

Didactical design (Gravemeijer & Van Eerde, 2009; Cobb et al., 2003) is a conceptual framework that is concerned with the planning and use of the teaching materials and activities organized in a systematic and reflective manner for the purpose of record learning. One of the purposes of didactical design in mathematics is to develop an environment that supports knowledge transfer and knowledge understanding and cognitive and metacognitive development. A structured didactical design, in a mathematics context, is, according to Gravemeijer & Van Eerde (2009), effective to guide students through problem-solving activity, to foster engagement, and support connections across students' understandings of mathematical concepts.

The most habitual and essential process of instructional schemes occurs at the elementary school level, where students first encounter basic, yet fundamental numbers like addition, subtraction, multiplication, and geometry. Efficacy of didactic schemes is most often seen in elementary school education. Ordinarily, instructional schemes tend to be very similar in structure: the introduction a topic, followed by examples and student practice and then, an assessment stage. Yet, research has indicated that while these forms of instruction are designed to be structured, (Fung et al 2021), they do not always provide enough flexibility for the needs of all learners, or create opportunities for the students to grasp deeper conceptual understanding**.**

2. Changes to Routine Didactic Schemes: The Need for Adaptation

Most models of routine didactic schemes of mathematics education do not take into account the different paces of learning, student's schooling, and background prior to the lesson. As appropriately stated by , (Suryadi, 2019), inattention to students’ level of initial readiness creates disengagement and obstacles to understanding mathematical concepts. In particular, students' previous level of schooling, historical patterns of success, and potential for a cumulative knowledge base are especially significant to the learning process in mathematics. Research by Boekaerts and Cascallar, (2006) suggests that at this time there needs to be adjustments made to the traditional models of teaching routines in order to account for the different level of student need. It can include adjustments to the way in which the material is being presented, time needed for learning to occur for each phase,the types of issues enacted in practice, as well as how the evaluation would be conducted. Furthermore, research has shown a more individual approach while teaching, where the pace and content match learners' needs, produces improved learning outcomes (Wenglinsky, 2000). Additionally, changing the traditional routine didactic scheme is likely to address typical problems such as lack of students’ grasp of fundamental ideas, insufficient room for critical thinking, or relying on rote knowledge rather than understanding. Even to establish that traditional didactic schemes emphasise rote memorisation and repetitive tasks over deeper, freer thinking with reference to problem solving, which is critical for students’ long term development of mathematics (Tobias & Weissbrod, 1980).

3. The Importance of Didactic Modifications on the Student's Thinking Skills

The overturning of the classic didactic schemes in mathematics teaching can lead to cognitive development in students, in particular their critical thinking skills. As previously noted, (Schraw et al., 2006), thinking skills, of which critical thinking and problem solving are two examples, can be approached through other methods, when students can independently and with more engagement and reflection time with the content. Critical thinking skills develop with more reflection time. Students are able to better understand and conceptualize mathematical situations when they embrace concepts with peers when reflection is allocated a substantial justification.

Changes, such as providing more time for a student to solve the problem, giving the assignment with other students where they can collaborate to solve the problem and/or modifying the modifications to the practice problems (e.g., adjusting the difficulty level and/or number of practice problems) can allow students to develop more effective conceptual systems. Vygotsky's (2020) notion of the zone of proximal development, supports the idea of "scaffolding" learning activities by providing students with other ways of thinking and understanding to use along with what they can do alone and what they can do if they get support. Using scaffolding to change didactic schemes provides students with the opportunity to think and understand with the higher level of reasoning and understanding.

In addition, Fisher and Frey (2014) did research on the active learning techniques and have concluded that when students are allowed to explore mathematical concepts through hands-on activities and cooperative problem-solving, it allows them to think critically. Active engagement and exploration with changes to the usual didactic scheme make deeper learning more likely and enhance a student's ability to think.

4. Analyzing the Outcome of Didactic Modifications

Analyzing modifications to the standard didactic scheme is important if we want to understand the effectiveness of those changes to improve students' thinking skills. Many studies have combined qualitative and quantitative design to understand how changes to teaching learning approaches change students' learning outcomes. Studies such as (Paas et al., 2016) on cognitive load theory suggest that learning outcomes can improve with respect to cognitive load. Cognitive load is managed effectively making modifications to the presentation and practice of MORE THAN ONE PIECE of information. In the modified didactic scheme, when we reduce the unnecessary cognitive load, students can focus on deeper problem-solving processes instead of being overwhelmed by the material.

Research by Hiebert et al. (1996) on the role of mathematical discourse emphasizes the merits of assessment strategies that stress communication and critically thinking among students. Changes designed to foster peer collaboration, discussion, and the explanations of reasoning is an effective way to facilitate students developing the problem solving strategies and understandings, that improve not only thinking skills, but the preparation to use mathematics in the “real world”.

5. In Closing: Implications for Teaching Practice

In summary, the literature suggests that changes to the traditional didactic plan can potentially improve student thinking in mathematics at the elementary level. Changes to the traditional didactic plan should include allowing students to reflect and inquire into their learning, as well as collaborating with their peers. These changes can help to combat the limitations of common practices in teaching at elementary schools that did not consider to learning strengths and needs of the students. By changing the design of the didactic plan and introducing active learning into the learning environment, teachers can be able to improve their learning process in mathematics and provide students a better opportunity to think critically and gain greater engagement with mathematical processes.

As this paper has indicated, any insight that contributes to improved student thinking in mathematics is about creating a responsive environment to teach them mathematics with fewer mechanistic and passive practices. In future studies, there are surely many possibilities as regards the various ways of changing the didactic plan to facilitate student cognitive development and thinking skills in the teaching process in elementary school mathematics education.

Method

Research Design

This study used Didactical Design Research (DDR) approach which was conceptualized by Suryadi (2019) that focusses on analyzing and enhancing learning processes by designing and redesigning didactical situations in the authentic classroom context. Unlike researching the efficacy of learning through various statistical tools, DDR stresses that researchers qualitatively evaluate the learning trajectories, teacher's responses, and student thinking processes both during and after the actual implementation of a hypothetical didactic design (HDD). Following the DDR framework, the study proceeded over three main phases:

1. Preliminary Analysis (Observation Phase)

This was done with Grade 4 students from Pandeglang Regency, with the aim of identifying learning obstacles, both epistemological and didactical on the existing mathematics instruction, especially on multiplication and geometry topics.

2. Design and Experimentation Phase

From the findings in the observation phase, we designed an initial HDD, then implemented the HDD with Grade 3 students from Cilegon City to investigate the possible learning trajectories and students’ anticipated responses (Anticipated Pedagogical and Didactical Situations). The observations conducted in this phase were able to establish discrepancies between anticipation and the students' actions.

3. Retrospective Analysis and Redesign

The last phase was implemented with Grade 3 students in Serang City, and in this case we implemented the revised didactic design. The circumstances that arose during the third phase systematically evaluated students’ thinking processes and how

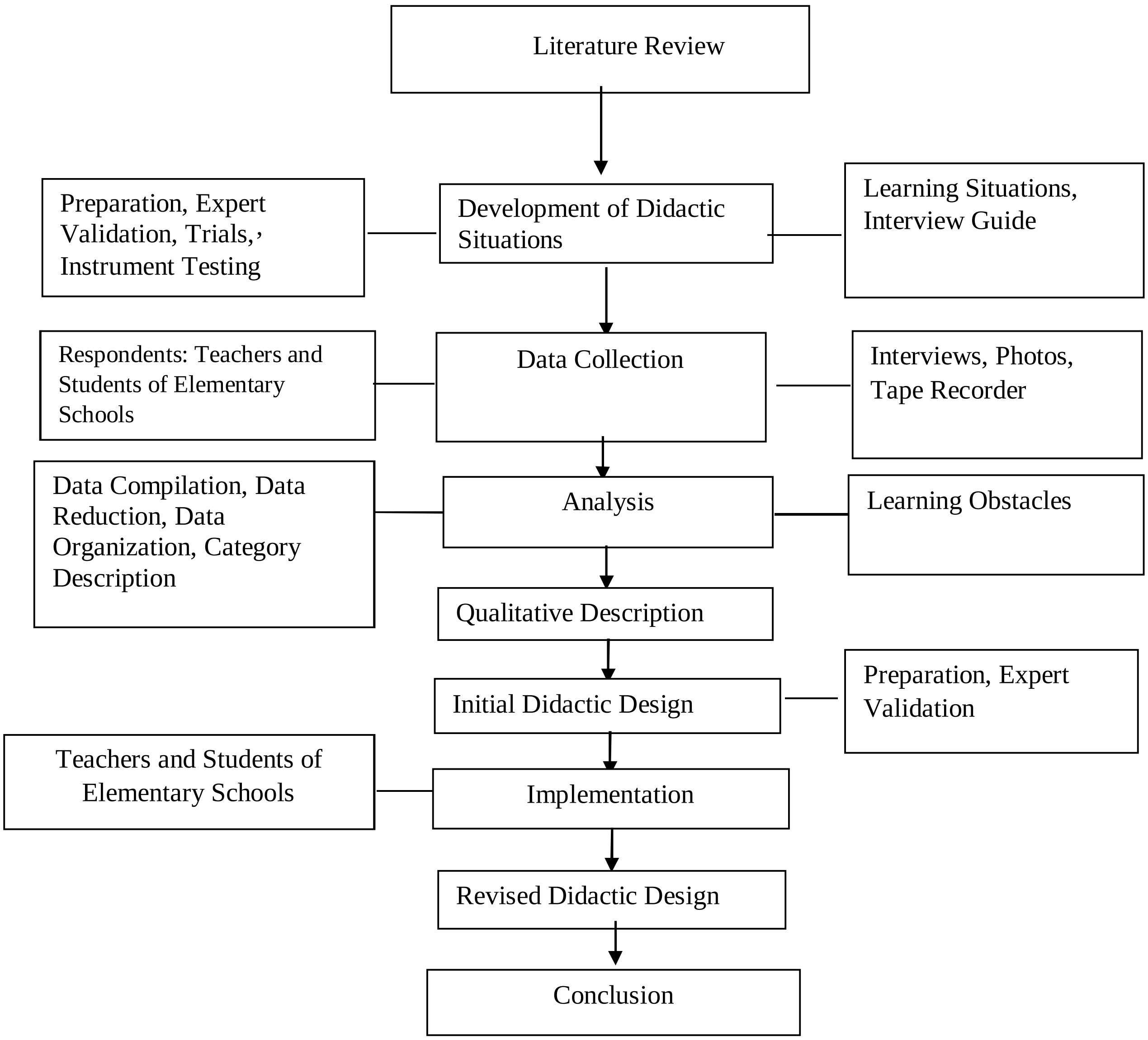

Figure 1. Diagram of Research Implementation

Participants

Data were collected in three public elementary schools in Banten Province, Indonesia. The sample population consisted of 90 total students: 30 4th grade students in Pandeglang Regency, 30 3rd grade students in Cilegon City, and 30 3rd grade students in Serang City.

The schools were selected to provide a variety of educational contexts and student populations to allow for implementation and testing of the didactic design under different conditions. The student population was selected based on students who regularly attended mathematics classes and volunteered to be a part of the study.

Data collected

In order to measure how successful the modified design was, the following instruments were used:

1. Professional Development Materials: Designed and developed based on an HDD framework while trying to incorporate contextual problems and cultural elements (for example, traditional games). The goal was to motivate students and overcome unfamiliar abstract problems.

2. Observation Forms: Used to document classroom events through observations and paying particular attention to how students interacted with each other regarding the tasks they were engaged with. Also observing change in students within the didactical situation during the habilitation stage and throughout implementation of the didactic design.

3. Interviews: Research interviews were individual to document student and teacher experiences, students' understanding of mathematics, clarity of understanding and any barriers they faced. The interviews were scheduled and contained structured questions aiming to triangulate the data sets collected through observation.

4. Student Work Samples and Evaluation Sheets: This information was gathered both during the lessons and afterward as we traced students' mathematical reasoning, strategies, and mistakes to serve as evidence of conceptual change or persistence of a misconception.

Data Analysis

In keeping with DDR, the data analysis was entirely qualitative and included:

1. Didactical Analysis: This analysis involved comparing the hypothetical learning trajectory represented in the HDD with the learning process that occurred throughout implementation. This type of analysis looked at the students' responses to the tasks, teachers' adaptations to tasks, and changes in the didactical contract as a result of implementation.

2. Retrospective Analysis (RA): Retrospective Analysis is the heart of the DDR process: investigating and interpreting data collected through the experiment phase in order to (modify) revise an initial HDD. This analysis considered how instructional decisions changed students' thinking and whether learning changes were occurring regarding obstacles to learning identified in the studies presented in the HDD.

3. Thematic Coding: Interview transcripts and observation notes were thematically coded for evidence of "conceptual shift", "persistent misconception", "productive struggle" and "teachers' interventions".

There were no numerical gains to indicate success of the modified design only qualitative improvements in classroom discourse, student strategy use, and conceptual understanding as reflected in both observation during the lessons and retrospective analysis.

Results and Discussion

Application and Effectiveness of the Modified Modes

The three modes (Modes I, II, III) were designed to directly address the problems by:

- Supporting students' abilities to attempt the tasks prior to group or teacher discussion,

- Tightening the number of evaluative questions to enable discussions of depth of understanding rather than breadth (number of questions),

- Encouraging each student to engage with the tasks both individually and in groups,

- Considering the teacher as an observer/facilitator rather than the primary explainer.

Sources of Evidence of Effectiveness

- From Observations: Student engagement demonstrated a progression to noted increases. Students attempted problems independently, demonstrated their reasoning, asked clarifying questions.

- From Student Work: Compared with initial samples of student math work, post implementation student work included more organized procedural steps for problem-solving and self-corrections. Students expressed their mathematical reasoning more clearly, even when answers were not complete or correct.

- From Interviews:

Students commented on feeling "less rushed" and "more confident" when they had the opportunity to think about their answers to the questions and tasks.

Teachers described seeing students using more initiative, collaborating more successfully with peers, and remaining focused for longer segments.

- From Retrospective Analysis:

Learning impediments previously identified via observing modes (i.e., passive engagement and low order evaluation) were significantly reduced.

Teachers became more responsive to learning difficulties as they arose, changing the way information was presented by way of task and/or providing contextual scaffolding (i.e., referencing local games).

There were no numerical scales used, rather judgment about their effectiveness was made based on evolution of student engagement..

Table 1. The Didactical Process in Mathematics Learning

Observed Obstacle	Didactic Modification	Student/Teacher Response
Students copying answers	Individual work time before group/whole-class talk	Students attempted tasks independently
Low understanding in evaluations	Reduced to 1 key problem, more depth	Higher quality of written reasoning; fewer blank answers
Passive group work	Task distribution to all group members	More equitable participation; visible peer collaboration
Time pressure	Adjusted pacing in task presentation	Students expressed greater confidence in solving problems

Clarification about Findings and Measures of Effectiveness

The findings with participants - both students and teachers - were drawn from qualitative sources in accordance with Didactical Design Research (DDR) principles. In particular, effectiveness was not measured using numerical scales, rather it was assessed by interpreting shifts in behavior and engagement. Findings from students included increases in independent problem-solving, clearer articulation of reasoning, and more active collaboration. Teachers reported- improved classroom dynamics, more equitable student participation, and increased confidence among students. The findings came from students' work samples, semi-structured interviews, classroom observations, and retrospective analysis. Therefore, it is necessary to understand that the study values depth of understanding and process-based evidence to adjudicate the effectiveness of teaching rather than assess value using a deterministic quantitative measure.

The observation of mathematics learning previously conducted by the researcher was initially carried out at the first primary school. The initial didactic design was then tested at the second primary school, and the implementation of the didactic design was carried out at the third primary school. From the observations made by the researcher, along with discussions with elementary school teachers and Primary Teacher Education lecturers, a routine didactic scheme for mathematics learning at the elementary school level was derived as follows:

The primary classroom mathematics lessons we saw started with an opening of taking roll, some pre-lesson activities (aperception), and an introduction to definitions and related concepts. The teachers then proceeded with examples of some problems and asked students to solve them on the board without giving students a chance to work on the problems first. Stockero et al. (2020) explained that teachers' orientations toward using student mathematical thought during whole class discussion have a clear relationship to the teachers instructional practice. Their study showed that the teachers' belief and preferences about student engagement can impact their use of student engagement as a means to instructional impact. Similarly, Stewart & Ball (2023), discussed the importance of providing sufficient teacher direction to get students to struggle with the problem during the problem-solving lesson which is important for design. The authors explain that although providing support is a good thing, the teachers that support to the point where it undermines the students' struggles leads to a lack of resilience and confidence. With all of this in mind, I think it makes sense that the observed teacher calling the students up to solve problems without giving them expectations of practicing on their own does not reflect best practices conducive to actual student engagement and practice change.

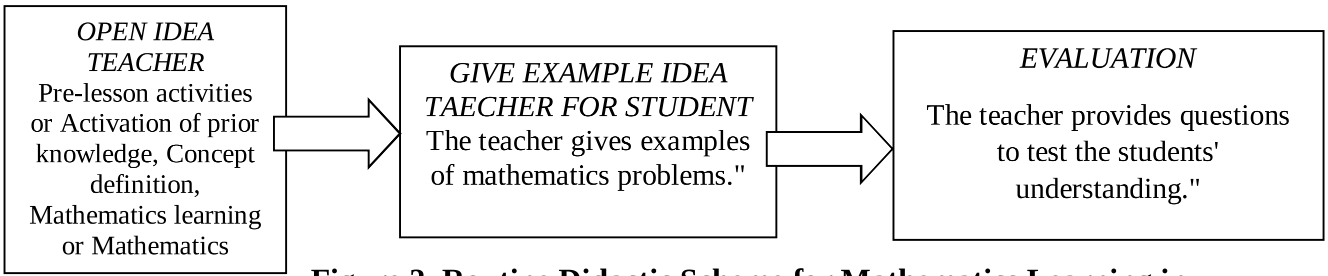

Figure 2. Routine Didactic Scheme for Mathematics Learning in Primary Schools

After observing several primary schools, the researcher found that almost all of them followed a routine in their mathematics lessons. This led the researcher to consider modifying the routine to address several issues encountered in the lessons, including: 1) unequal preparedness of students at the start of the lesson, 2) insufficient opportunity for students to think and understand the problems, 3) a tendency for students to be passive in their learning, 4) students tending to copy answers from their peers, 5) evaluations not being maximized, as the questions given do not adequately measure students' comprehension, which is still low, 6) the number of evaluation questions being too high (around five), while even with just one question, many students have not fully understood the material, 7) problems given during lessons not being accompanied by enough time for each student to complete them, 8) in group work, mathematics tasks often being dominated by one person because the questions are only given to the group leader, and 9) a lack of collaboration in mathematics learning within the classroom. According to (Hembree, 2020), math anxiety can cause math avoidance, leading to less competency and exposure, leaving students more anxious and mathematically unprepared to achieve. Additionally, (Ashcraft, 2002) suggests that highly anxious math students will avoid situations in which they have to perform mathematical tasks, resulting in decreased performance and increased anxiety. Furthermore, (Beilock & Willingham, 2014) that math anxiety is directly connected with math avoidance, and alleviating math anxiety may lead to a marked improvement in student achievement.

After observing several primary schools, the researcher found that almost all of them followed a routine in their mathematics lessons. This led the researcher to consider modifying the routine to address several issues encountered in the lessons, including: 1) unequal preparedness of students at the start of the lesson, 2) insufficient opportunity for students to think critically and understand the problems, 3) a tendency for students to be passive in their learning, 4) students enjoying copying answers from their peers, 5) evaluations not being maximized, as the questions given do not adequately measure students' understanding, which is still low, 6) the number of evaluation questions being excessive (around five), while even with just one question, many students still do not understand, 7) problems provided during lessons not being accompanied by sufficient time for each student to complete them, 8) in group work, mathematics tasks often being dominated by one person because the questions are only given to the group leader, and 9) a lack of collaboration in mathematics learning within the classroom.

According to (Hembree, 2020), math anxiety can cause math avoidance, leading to less competency and exposure, leaving students more anxious and mathematically unprepared to As stated by Hembree (2020), math anxiety can result in math avoidance, resulting in less competency and exposure, leaving students increasingly anxious and unprepared to achieve mathematically. Problematic consequences can occur in learning situations where students encounter math avoidance, which Ashcraft (2002) discusses in her research by suggesting that high levels of anxiety can lead anxious math students to avoid situations where they must perform mathematical tasks, leading to poor performance and higher anxiety instead. (Beilock & Willingham, 2014) continue to support the concern for anxiety in math, they mention that avoidance is directly associated with anxiety in math, and that addressing math anxiety may result in substantial improvements in student achievement.

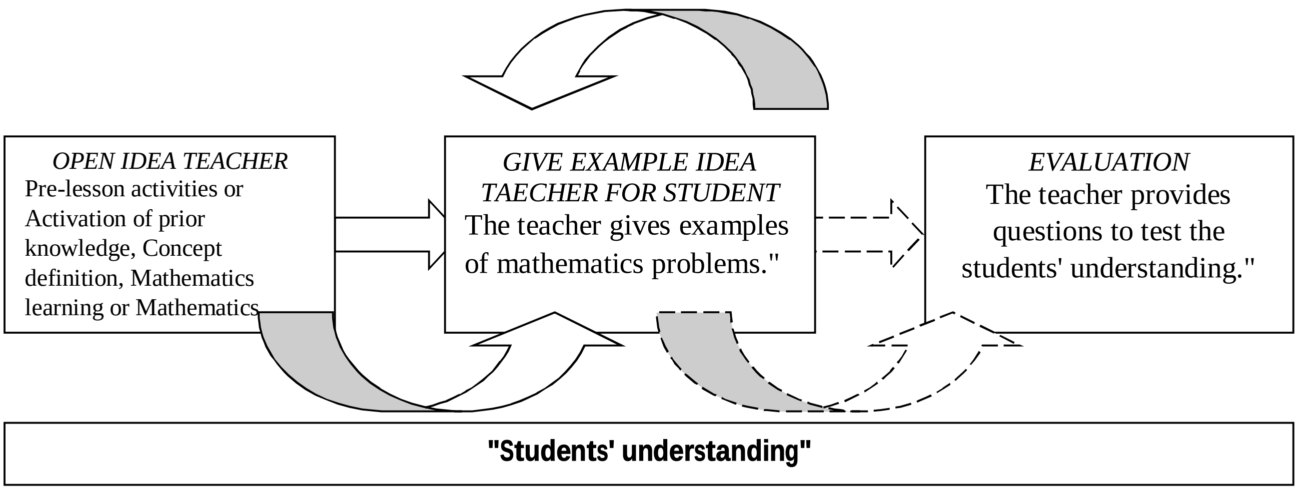

Figure 3. Adapted Didactic Scheme I context in relation to Mathematics Learning in Primary Schools

Several studies, such as (Kroesbergen & Van Luit, 2003), suggest that to achieve the intended modifications to didactic situations, in order to advance the students' understanding of mathematical concepts, three factors are important: repeated exposures, pacing, and assessment practices. In relation to pacing, (Kroesbergen et al., 2003) emphasize that repeated and direct instruction can be very effective in developing basic arithmetic skills through systematic instruction in primary schools with respect to developing primary school children; they also highlighted that similar instructional strategies can improve student performance either through increased practice or more direct-instruction opportunities. Therefore, as they assert, the relationship between teacher-assigned problems, practice problems, and time-on-task suggest that the more time that is dedicated to practicing problems, the higher level of understanding that will be achieved. Further, (Rizos et al., 2024) found that allowing time for students to struggle with mathematical problems before providing answers led to higher achievement levels. Additionally, Rizos, et al. demonstrated that even allowing more time, at least in some areas, leads to more attractive levels of deep understanding in students when approaching problem-solving with mathematics.

Moreover, (Black & Wiliam, 1998) stresses the efficaciousness of formative assessment in improving student performance. Their meta-analysis demonstrates that formative feedback, if properly used, can significantly improve student learning. Their findings in concert provide support for the previously proposed changes in didactic situations (e.g., repetition, time to solve problems, and assessment) in an attempt to improve students' understanding of mathematical ideas and constructs. Next is presented the modified didactic scheme II in assessment of mathematics learning:

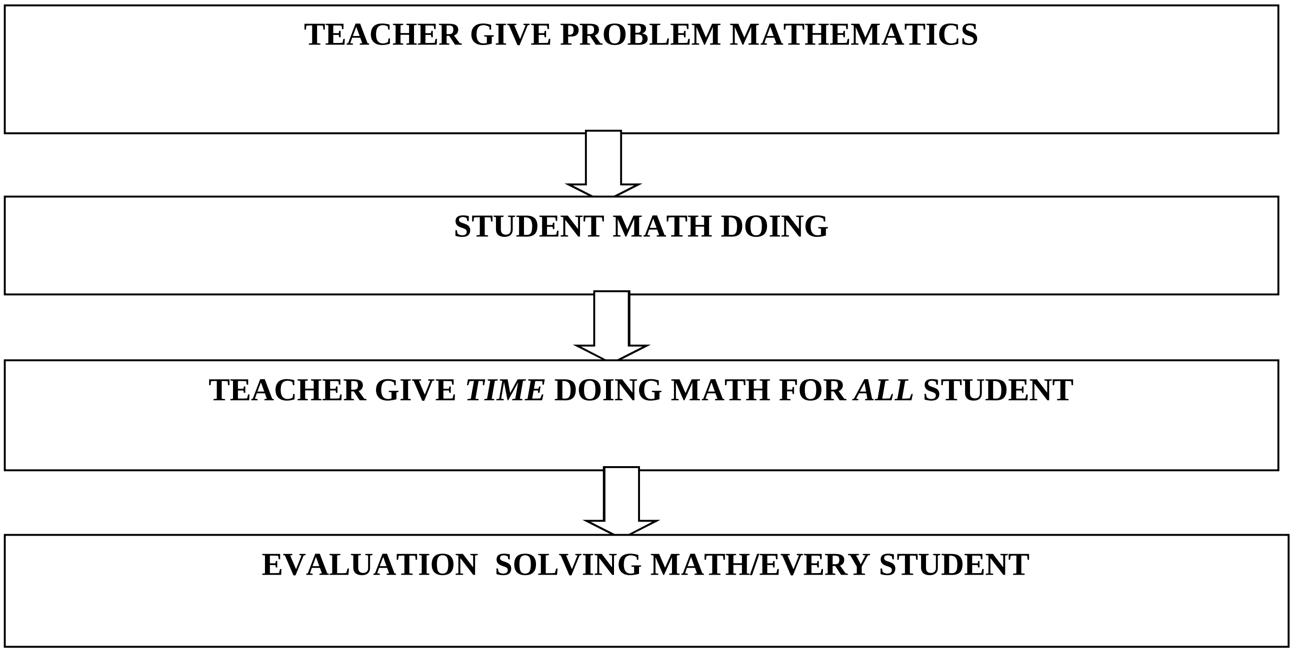

Figure 4. Modified Interview Scheme II for Primary School Instruction

In addition to the proposed changes in didactic situations to improve how students understand mathematical concepts, several studies highlight the repetition of instruction, pacing through the lesson, and assessment intent as critical factors. For example, Kroesbergen & Van Luit (2003), in their systematic review of the research found that persuasive evidence of the effects of repeated direct instruction concentrates on the acquisition of basic arithmetic skills of detailed programs for improvement among the primary level teaching. Rizos et al. (2024) describe how thoughtful pacing with not rushing to give the answers after students have had a chance to think through the mathematical problem in mathematical reasoning prompts a better understanding and critically thinking. The effectiveness of pacing as indicated in Rizos et al. (2024) study shows that when lessons of mathematics included a period of student attempts to problems while it was not rushed prompted a better understanding of mathematical concepts. Additionally, Black & Wiliam (1998) describe the power of formative assessment to improve student achievement, and that thoughtful enough formative feedback, in a meta-analysis, demonstrates that well-known success feedback has a large positive effect on learning. Thus, the conclusion to our arguments strongly promotes taking seriously the proposed changes in the didactic situation for revision but find it important to incorporate the ideas of avoiding a rushed instruction, pacing of each teaching, that allows students to receive a formative like response of serious intent.

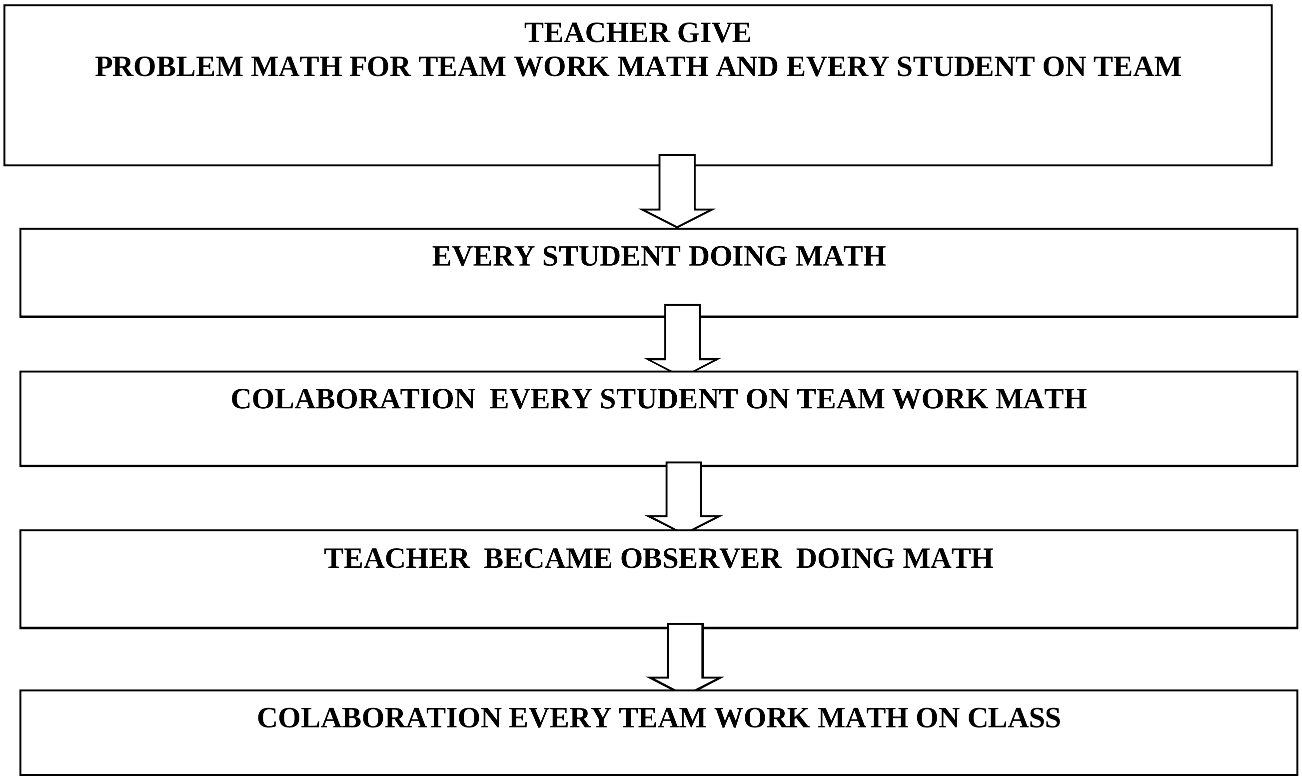

Figure 4: Modified Didactic Scheme III for Primary School Mathematics Learning

Nine learning barriers were consistently observed, including low student engagement, unequal readiness, and lack of conceptual understanding. These findings aligned with prior literature (Hembree, 2020; Ashcraft, 2002) on math anxiety and avoidance behaviors stemming from instructional design.

Conclusion

The research results show that in elementary school mathematics education, a teacher has formed a concept image in the context of mathematics learning. The concept image of the mathematics learning situation in elementary schools is as follows: a. The teacher provides pre-lesson activities (aperception) and explains the material. b. The teacher gives examples of problems. c. The teacher gives practice problems. The didactic situation above creates a routine scheme that has become a habit in elementary school mathematics education. Therefore, modifications to the didactic situation are necessary to optimize the quality of mathematics learning. The modified didactic schemes I, II, and III were developed in the context of elementary school mathematics education.The learning situation using the modified schemes has been proven to optimize the quality of elementary school mathematics education. Students' thinking processes have improved, student engagement has aligned with the learning objectives, and the evaluation process has taken into account students' understanding of a concept."

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