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Problem-Solving Ability and Self-Efficacy: The Effect of Mathematics Instruction-Based Theory of Didactical Situation

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Abstract

This study investigates how Theory of Didactical Situations-based mathematics training affects problem-solving and self-efficacy. A quasi-experimental approach with pre- and post-tests and a control group was used in this study. The research sample comprised 58 students and was allocated into two groups: an experimental group, which received TDS intervention, and a control group, which received traditional explanatory learning. The two-way analysis of variance (ANOVA) results indicated a substantial interaction between the teaching methods employed in mathematics instruction, the early mathematical skills of the students (EMS), and the link between class and EMS. This interaction significantly improved students' capacity to solve arithmetic problems. Similarly, these characteristics have a notable impact on the degree of self-efficacy. The study emphasises the practical consequences of the necessity for teachers to consider students' cognitive abilities when planning mathematics instruction carefully. Additionally, it underscores the importance of designing learning environments that align with specific learning goals. This study further enhances the existing empirical evidence about the correlation between the learning environment, mathematical problem-solving abilities, and self-efficacy.

Keywords: Problem-Solving Ability; Self-efficacy; Theory of Didactical Situation, Senior High School

Abstrak

Penelitian ini menguji efek dari pengajaran matematika berbasis Teori Situasi Didaktis terhadap kemampuan pemecahan masalah matematika dan efikasi diri. Penelitian ini menggunakan desain kuasi-eksperimental yang menampilkan kerangka kerja pre-test dan post-test, serta melibatkan kelompok kontrol. Sampel penelitian terdiri dari 58 siswa yang dialokasikan ke dalam dua kelompok: kelompok

eksperimen, yang menerima intervensi TDS, dan kelompok kontrol, yang menerima pembelajaran eksplanatori tradisional. Hasil analisis varians (ANOVA) dua arah menunjukkan adanya interaksi yang substansial antara metode pengajaran yang digunakan dalam pembelajaran matematika, kemampuan awal matematika siswa (EMS), dan hubungan antara kelas dan EMS. Interaksi ini secara signifikan meningkatkan kemampuan siswa dalam memecahkan masalah aritmatika. Demikian pula, karakteristik ini memiliki dampak penting pada tingkat efikasi diri. Penelitian ini menekankan konsekuensi praktis yang muncul dari perlunya guru mempertimbangkan kemampuan kognitif siswa ketika merencanakan pengajaran matematika dengan hati-hati. Selain itu, penelitian ini juga menggarisbawahi pentingnya merancang lingkungan belajar yang selaras dengan tujuan pembelajaran yang spesifik. Penelitian ini semakin memperkuat bukti empiris yang ada tentang korelasi antara lingkungan belajar, kemampuan pemecahan masalah matematika, dan efikasi diri.

Kata Kunci: Keterampilan Pemecahan Masalah; Efikasi diri; Teori Situasi Didaktis, Sekolah Menengah Atas

Introduction

The effectiveness of guided instruction can be better comprehended when we consider human cognitive architecture, the differences between experts and novices, and the concept of cognitive load. Although unguided or minimally directed teaching methods are widely recognised and appear intuitive, it is essential to acknowledge that these approaches frequently overlook the foundational cognitive structures inherent in human thought processes. Minimally guided practice is known by various terms, including discovery, problem-based, inquiry, and constructivist learning (Sweller et al., 2007). Several studies have shown that cooperative learning effectively develops students' mathematical problem-solving abilities (Yapatang & Polyiem, 2022). The findings indicated that the discovery learning model, which incorporates reading, inquiring, and replying, enhanced students' problem-solving abilities relative to traditional learning methods (Hariyanto et al., 2023).

Recent studies indicate that problem-based learning frameworks significantly enhance students' problem-solving abilities (Jatisunda & Nahdi, 2020; N. J. Kim et al., 2022; Magaji, 2021; Sari et al., 2021; Simanjuntak et al., 2021). The research indicated that participants in the experimental group exhibited a notably greater enhancement in their problem-solving capabilities via active learning exercises centred on problem formulation, in contrast to the control group (Polat & Özkaya, 2023). The RICOSRE approach reliably improved students' problem-solving ability across various academic levels, including high, medium, and low groups (Mahanal et al., 2022). Studies suggest that online learning methodologies for mathematical problem-solving could improve students' problem-solving ability more efficiently than other approaches (Suarsana et al., 2019). Recent studies

suggest that undergraduate students' mathematical problem-solving abilities are significantly improved by implementing a 5E virtual learning framework (Yonwilad et al., 2022). Based on the facts above, the teacher's position and learning technique are also significant. Thus, problem-solving success depends on both the approach and the teacher's implementation.

Problem-solving plays a central role in mathematics education, with a significant portion of learning time dedicated to this skill (Divrik et al., 2020; Gick, 1986; Reiss & Törner, 2007). It has emerged as a critical area in mathematics education (Boero & Dapueto, 2007). In executing these problem-solving situations, teachers must possess the requisite competencies (Jensen et al., 2017). The results show that teachers struggle to integrate practices and activities in their implementation (Brousseau & Gibel, 2005; Malepa-Qhobela & Mosimege, 2022). The challenge lies in unstructured and unpresentable problems, often difficult or impossible to resolve with the available information, leading to multiple potential solutions (J. Y. Kim & Lim, 2019). It is not enough for students to have prior knowledge, rules, and knowledge of concepts and ideas in a related domain; it also requires metacognitive knowledge to combine these in solving problems (Belland, 2014). Solving the problem situation should be detrimental to students, especially if they struggle (MerriëNboer, 2013) because cognitive activity is essentially limited by working memory and its capacity to process only a few pieces of information at a time (Jalani & Sern, 2015; Merriënboer et al., 2003; Phumeechanya & Wannapiroon, 2014). Human cognition can only process a small amount of information simultaneously (Kirschner et al., 2006; Sweller et al., 2019). There is a need to optimize the learning process, where teachers must pay attention to students' cognitive capacity (Garrett, 1989; Könings et al., 2019).

Research indicates that minimally guided instruction is less effective and efficient than instructional methods that enhance student learning (Kirschner et al., 2006; Sweller et al., 2007). The benefits of guided instruction are especially apparent when learners have a sufficiently high level of prior knowledge. Recent advancements in instructional research and design models emphasize strategies that improve guidance throughout the instructional process. The Theory of Didactical Situation (TDS) provides a framework for systematically instructing mathematical problem-solving, integrating mathematical competence with problem-solving. It establishes a learning environment tailored to the cognitive capabilities of the student. The findings demonstrate that the TDS is an effective problem-solving tool (Abdüsselam et al., 2022; Selman & Tapan-Broutin, 2018). Guy Brousseau formulated the Theory of Didactical Situations (TDS) in the 1980s by analyzing the interactions between the teacher, the student, and the subject matter.

The didactic triangle delineates the mathematics learning process as an interaction among the educator, the learner, and the subject matter (Kansanen & Meri, 1999; Van Dijk, 2009). The TDS outlines a conceptual framework that includes knowledge structures, instructional settings, and the roles of teachers and students in the classroom environment (Artigue, 2000; Delacour, 2016).

The TDS provides a valuable account of how the design situation emphasises the specific mathematical knowledge intended to be acquired by students (Rønning, 2021). A TDS-based design is divided between periods where students are encouraged to argue and defend their answers and phases where the teacher is actively involved in bridging common language and scientific terminology (Brousseau, 2006). As such, the TDS provides a strong foundation for designing mathematics learning experiences that focus on the dynamic interactions between teachers, students, and learning materials and emphasize the importance of developing students' specific mathematical knowledge. TDS, developed by Brousseau (2006), focuses on creating learning situations centred on mathematical problems that students need to solve and to develop specific mathematical knowledge, called target knowledge.

Knowledge constitutes an attribute of a system comprised of a subject and its interacting milieu (Brousseau, 2006). The milieu must be structured to promote the selection of one strategy over another, with the selected strategy facilitating the acquisition of the desired knowledge (Strømskag, 2017). Learning transpires through this interaction: the subject engages with the environment and receives feedback (Mackrell et al., 2013). In addition to the milieu, the concept of the didactic contract deals with the relationships between a situation's adidactic and didactic dimensions, and it is the teacher's task to organise them (Artigue, 2014). The adidactical size allows students to solve mathematical problems without much teacher intervention. To a didactical extent, the teacher's role is to guide students to understand the target knowledge. Although the principles of TDS emphasize the importance of didactic learning situations, this is often difficult to achieve. It shows that applying the TDS concept in mathematics teaching requires teachers' careful planning and attention to create practical learning situations that meet the teaching objectives.

For over four decades, research has focused on the correlation between the learning environment and its effects on cognitive and affective outcomes (McMinn et al., 2021). This study investigated the influence of learning environments on cognitive processes. This study investigates the affective dimensions associated with the learning environment, particularly focusing on self-efficacy. 'Self-efficacy' refers to an individual's belief in their capacity to execute particular tasks, as

articulated by Bandura (1988). Self-efficacy positively correlates with performance outcomes and affects students' motivation during the learning process (Bandura, 1992). This study investigates the substantial influence of self-efficacy beliefs on cognitive processes, particularly in the context of complex learning and decision-making (Bandura, 1993). Accurately solving a complex problem and interpreting the solution process as successful offers the learner mastery experiences that improve self-efficacy (Böswald & Schukajlow, 2023). The issues are significant within the TDS framework. This proposition's theoretical framework is based on the epistemological assumption that acquiring mathematical knowledge depends on engaging with and solving problems (Artigue & Houdement, 2007). Each problem students encounter in educational settings, whether explicitly stated or implicitly suggested, is viewed as part of a broader context known as a scenario. This scenario is considered the essential unit of analysis in the study of problem-solving-related cognitive elements, aimed at understanding possible outcomes or current realities within this framework (Brousseau, 2006). By addressing a specific problem situation, students can gain positive experiences that improve their self-efficacy.

Previous studies have clarified the impact of the learning environment on self-efficacy. Research findings indicate a consensus on the positive correlation between learning quality and students' self-efficacy (Zhu & Kaiser, 2022). The study's findings demonstrate that students involved in the flipped classroom intervention enhanced self-efficacy (Algarni & Lortie-Forgues, 2023; Ramadoni & Mustafa, 2022). The findings indicate that implementing the cooperative learning model, particularly the Teams Games Tournament approach, enhances students' self-efficacy (In'am & Sutrisno, 2021). The ability of students to perform gestures and physical movements is recognized as a factor that improves their self-efficacy in head-mounted display virtual reality (HMD VR) learning (Huang, 2022). Implementing the Integrated STEM approach in educational practices significantly enhanced self-efficacy (Johnson et al., 2021). There is a notable deficiency in research investigating the influence of the instruction-based theory of the didactical situation on self-efficacy. The project provided a significant opportunity to improve understanding of the application of instruction-based theory regarding the effects of didactical situations. This study provides an in-depth examination of the impact of instruction-based theory of didactical situations on problem-solving ability and self-efficacy.

Method

This research is a quasi-experiment to examine the impact of the instruction-based theory of didactical situations on problem-solving and self-efficacy. Ethical

and practical considerations favour the view that a quasi-experiment is more realistically chosen (Campbell & Stanley, 2015). Authentic experimental designs are distinguished by using random sampling and random assignment of participants, ensuring that each individual has an equal chance of being selected and assigned to different groups. In contrast, quasi-experimental designs lack the element of unpredictability in participant selection and assignment (Kabore, 2022; Mwale & Muula, 2019). The technique applied matched only the pre-test and post-test control group design. The procedure is described below.

Table 1. Matching-Only Pretest-Posttest Control Group Design (Fraenkel dkk., 2011)

Pre-test	*Treatment*	*Post-test*
O	*X*	*O*
O		*O*

The investigation commenced by providing a pre-test to both course cohorts to ascertain the comparability of their mathematical problem-solving skills and self-efficacy. The experimental group, denoted by the X sign in the table, was subjected to the instruction-based theory of didactical situation intervention, while the control group received traditional explanatory training. The study was conducted at SMA Negeri 2 Majalengka for two months, from 12 January to 3 March 2023. The present study has successfully obtained legal clearance from all participants, who believe their participation in this research carries no potential for bodily, psychological, or legal repercussions. The study commenced by developing research instruments, assessing problem-solving abilities, and evaluating self-efficacy.

Following this, the sample was carefully chosen through a purposive technique, after which the educational intervention was executed and the collected study data were examined. A total of 58 students were allocated into two groups for the study. The experimental group consisted of 30 students, while the control group included 28. The sample was chosen through a non-probability sampling approach. This research employed a purposive sampling technique, which is categorised as a non-probability sampling method. This methodology was chosen after engaging in dialogues with educators that focused on the insights from research concerning students' Initial Mathematical Ability classifications. A variety of criteria determined the choice of these categories. The preliminary categorisation of fundamental mathematical competence evaluated students' capacity to scrutinise their prior academic material.

Data collection for the study was made easier by the use of self-efficacy ratings and assessments of mathematical problem-solving. The study tool includes a test of self-efficacy and mathematical problem-solving skills. Quezada (2020) examined the development of mathematical problem-solving skills in a range of scenarios, including pure mathematical, realistic, fantasy, and practical scenarios. Based on the general self-efficacy (GSE) theory put forth by Luszczynska et al. (2005), the self-efficacy measure was developed. It is necessary to incorporate expert assessments, classroom trials, and relevant research in the field in order to evaluate the validity and reliability of the instrument. After these techniques are finished, it will be feasible to confirm that every instrument the researcher created complies with validity and reliability requirements. The validity coefficient of the test of problem-solving skills is roughly 0.75 for each

The exam exhibits a reliability coefficient of 0.81, indicating a consistent and reliable assessment of problem-solving ability. The score for each item evaluates the individual's capacity to solve mathematical problems, considering the questions' complexity. The General Self-Efficacy Scale exhibits validity and reliability, comprising 25 statement items. Data analysis commenced with normality testing, proceeded to homogeneity of variance testing for both pre-test and post-test data, and concluded with N-gain analysis. The Kolmogorov-Smirnov test assessed the normality of the four data sets, and the F-test evaluated the homogeneity of variance. The analysis involved an independent samples t-test and a two-way ANOVA utilising univariate General Linear Model (GLM) techniques. An independent samples t-test was conducted to assess the difference in mathematical problem-solving ability and self-efficacy between the two classes. ANOVA was utilised to analyse differences in improving mathematics problem-solving ability between the two classes, based on the category level of Early Mathematics Skills (EMS). The significance level for hypothesis testing was set at 0.05.

Results

In order to evaluate the participants' self-efficacy and mathematical problem-solving ability, this study examines the information obtained from pre-test and post-test assessments. It is clear from the pre-test results that the students in both classes have similar foundational competencies, which makes the framework for comparing the two groups suitable. This study examined the variations in self-efficacy and mathematical problem-solving skills between two distinct courses. The analysis used N-gain and post-test data, which represent different learning styles.

The following hypothesis was used in the current study to gauge the extent of improvement in mathematical problem-solving skills:

1. The experimental group exhibits enhanced problem-solving abilities and a greater sense of self-efficacy than the control group.
2. The experimental group exhibits a significant difference in improving mathematical problem-solving ability and self-efficacy among varying ability levels—high, medium, and low—outperforming the control group.

Table 1. The results of the different tests are based on the average post-test problem-solving ability

Levene's Test for Equality of Variances	F	Sig.	T	df	Sig. (2-tailed)
Equal variances assumed	8.677	.001	5.210	56	.000

Table 1 delineates the statistical analyses that juxtapose the test scores of the experimental group against those of the control group. Levene's test for equality of variances evaluated the comparability between the two groups, yielding significant results. The F-statistic of 8.677, along with a significance level of 0.001, suggests a noteworthy disparity in variance between the two groups. The premise of uniform variances was not satisfied. The t-test analysis yielded a t-statistic of 5.210, 56 degrees of freedom and a significance level of 0.000. The results of this study indicate a statistically significant disparity in average test scores when comparing the experimental group to the control group. The empirical intervention seems to notably impact the documented examination outcomes. The findings of this study reveal a noteworthy statistical disparity in test scores when comparing the experimental group to the control group.

Table 2. The results of the different tests are based on the average post-test self-efficacy

Levene's Test for Equality of Variances	F	Sig.	t	df	Sig. (2-tailed)
Equal variances assumed	9.373	.003	4.610	56	.000

Table 2 offers a comparative examination of the average self-efficacy scores following the intervention across different groups. The investigation began with the implementation of Levene's test to assess the uniformity of variances. This evaluation aimed to ascertain whether the self-efficacy scores demonstrated

comparable degrees of variance among the groups examined. The results of Levene's test demonstrated a statistically significant outcome. The F-statistic of 9.373 and a significance level of 0.003 indicate a noteworthy and statistically significant variance difference among the groups. A significance level below 0.05 is typically considered to denote statistical significance. This observation suggests that the premise of uniform variances lacks substantiation. The findings presented in Table 2 reveal a statistically significant disparity in the variability of post-test self-efficacy levels across the groups.

Furthermore, a two-way analysis of variance (ANOVA) with GLM Univariate was used to test the second hypothesis. Table 3 shows the study's results.

Table 3. Analysis of variance of data on improving problem-solving based on the mathematics instruction and EMS

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3943.068[a]	5	812.414	174.055	.000
Intercept	200578.312	1	200577.612	43350.437	.001
Model	1463.199	1	1450.200	339.452	.000
EMS	2130.545	2	1095.263	233.207	.000
Class * EMS	199.376	2	57.638	11.176	.000
Error	245.817	52	3.602		
Total	204795.000	58			
Corrected Total	4309.984	57			

a. R Squared = .946 (Adjusted R Squared = .923)

The two-way ANOVA results for the dataset investigating the impact of mathematics instruction and EMS on problem-solving skills show significant findings. Table 3 presents the adjusted model with squares of 3943.068, 5 degrees of freedom, and a mean square 812.414. The high F-statistic of 174.055 ($p < 0.001$) indicates that the model significantly explains the variation in improved problem-solving skills. The intercept variable has a substantial impact, with a sum of squares of 200578.312 and an F-statistic of 43350.437 ($p < 0.001$), suggesting the influence of unaccounted factors. The Model variable also significantly affects problem-solving enhancement, with a sum of squares of 1463.199 and an F-statistic of 339.452 ($p < 0.001$), highlighting the importance of combining mathematics and EMS education. The interaction between class and EMS (class*EMS) affects data dispersion, with a sum of squares of 199.376 and an F-statistic of 11.176 ($p < 0.001$),

indicating varying effects of instruction across different grade levels or EMS scenarios. This two-way ANOVA reveals that mathematics teaching, EMS, and the class-EMS relationship strongly influence problem-solving improvement. The high R-squared (0.946) and adjusted R-squared (0.923) values indicate the model's effectiveness in explaining data variability.

Table 4. Analysis of variance of data on self-efficacy based on the mathematics instruction and EMS

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4954.068[a]	5	902.521	275.055	.000
Intercept	300378.420	1	311687.722	44380.548	.000
Model	1463.210	1	2560.200	489.564	.000
EMS	2230.550	2	1296.370	346.318	.000
Class * EMS	206.380	2	68.648	23.287	.000
Error	256.820	52	4.734		
Total	215899.000	58			
Corrected Total	4419.894	57			

a. R Squared = .946 (Adjusted R Squared = .923)

The statistical analysis of the two-way ANOVA, as presented in Table 4, reveals significant effects on self-efficacy. These effects are based on the factors of mathematics teaching and EMS. The revised model incorporates both components and demonstrates a statistically significant impact on self-efficacy (F-statistic = 275.055, $p < 0.001$). The intercept variable shows a statistically significant effect on self-efficacy (F-statistic = 44380.548, $p < 0.001$), suggesting that unexplained factors influence self-efficacy. The combined implementation of mathematics instruction and the EMS (model) demonstrates a substantial impact on self-efficacy, as evidenced by the statistically significant F-statistic of 489.564 ($p < 0.001$). The statistical analysis reveals a meaningful relationship between class and EMS, denoted as class*EMS. This relationship has a notable impact on the variability of the data, as indicated by the F-statistic of 23.287 and a p-value of less than 0.001. These findings suggest that the effects of class and EMS may differ depending on the specific class or EMS situation being considered. In summary, the instruction of mathematics, the use of educational materials and resources, and the dynamic interplay between these factors substantially impact an individual's self-efficacy.

Discussion

Prior investigations have underscored the significance of problem-solving ability within mathematics education, emphasising the active engagement of students in their learning journeys (Schindler & Bakker, 2020; Singer & Voica, 2013; Voica et al., 2020). The findings from these research endeavours underscore the pivotal role that affect, or the emotional dimension, plays in mathematical activities, especially in problem-solving, and its considerable impact on students' future mathematical behaviours (Hannula, 2019). Within this framework, self-efficacy is categorised as a notion within the affective domain, particularly as "beliefs" (McLeod, 1992). This pertains to a person's belief in their capacity to excel in mathematical problem-solving tasks (Pajares & Miller, 1994). This study underscores the critical role of problem-solving abilities within mathematics education, accentuates the profound influence of affect in mathematical endeavours, particularly in problem-solving scenarios, and acknowledges self-efficacy as a pivotal element shaping individuals' strategies and involvement in mathematical problem-solving activities.

Problem-solving and self-efficacy abilities allow pupils to enhance their capacity to adapt and modify approaches in response to novel circumstances (Zulnaidi et al., 2021). Studies by Pajares and Miller (1994) confirmed that self-efficacy significantly impacts academic performance, particularly in mathematics subjects. The survey conducted by Jatisunda (2017) established a statistically significant correlation between students' self-efficacy and their problem-solving abilities. According to Hesse et al. (2015), acquiring problem-solving skills includes constructing a series of sequential processes to formulate an efficient and effective plan. Solving mathematical problems can develop students' cognitive abilities, including critical thinking skills, perseverance, and inquisitiveness (Mairing, 2017). The level of self-efficacy in mathematics has a significant impact on an individual's career decision-making process. The significance of mathematical problem-solving skills extends beyond mere quantitative aptitude, encompassing individuals' levels of self-efficacy in their mathematical capabilities (Evans et al., 2021). Our results show that students with low prior self-efficacy can overcome their disadvantage in improving self-efficacy during mathematics instruction by being taught to create various problems (Schukajlow et al., 2019). Enhancing students' learning achievement is contingent upon their proficiency in problem-solving and the cultivation of self-confidence. The pivotal role of instructors and educators is paramount in imparting these abilities to students.

This study investigated the disparity in enhancing problem-solving skills and self-efficacy among students exposed to the theory of didactical situation-based instruction and expository instruction. The study's findings indicate that the t-test

yielded statistically significant results ($p < 0.001$), suggesting a substantial disparity in the mean values found between the two groups being examined; namely, the experimental class exhibited superior problem-solving skills compared to the control group. An additional finding indicates a notable disparity in post-test self-efficacy between the experimental and control groups. The primary discovery of this study revealed a noteworthy effect of mathematics instruction and early mathematical skills (EMS), which demonstrated a substantial influence on the enhancement of problem-solving skills. Furthermore, the interaction between class and EMS (class*EMS) impacted the variability observed in the data, suggesting that instructional outcomes varied across several grade levels. The results of the study demonstrate that how mathematics is taught, referred to as the instruction-based theory of didactical situations, has a significant impact on the enhancement of problem-solving abilities. Similarly, the research revealed a noteworthy correlation between self-efficacy and the interplay between mathematics instruction and EMS, demonstrating a substantial enhancement in individual self-efficacy. There is a need for mathematics instruction that fosters the cultivation of self-assurance and psychological fortitude, which are crucial for surmounting obstacles encountered in academic pursuits and daily life encounters.

The instruction process involving problem-solving skills will be effective and efficient if it matches the individual's working and long-term memory capacity. (Jalani & Sern, 2015; Sweller, 1988). Problem-solving activities require a lot of working memory (Kirschner et al., 2006). However, if the working memory load exceeds capacity, this may result in less efficient acquisition of knowledge content, comparable to traditional learning approaches (Strobel & Barneveld, 2009). While problem-based learning is becoming popular, there is no guarantee that it is consistently more effective in improving students' knowledge than traditional learning (Dolmans et al., 2016; Wilder, 2015). Therefore, it is essential to consider the limits of an individual's working memory capacity for optimal and efficient results. Pada konteks penelitian ini pembelajaran matematika berbasis theory of didactical situation digunakan untuk meningkatkan problem-solving skills dan self efficacy. The mathematics instruction-based theory of the Didactic Situation is designed to allow for the appropriate design of learning activities (Canu et al., 2017). The steps of the instruction process include action situations, formulation, validation, and institutionalization (Brousseau, 2006).

Research shows that problem contexts designed based on TDS led to valuable reflections that improved participants' mathematical skills (Danisman & Guler, 2019). After applying the reverse Engineering approach and the Theory of Didactic Situations, it was found that academic performance improved, and

analytical and holistic thinking skills in problem-solving were also positively affected (Abdüsselam et al., 2022). Other research has also shown that using TDS resulted in students' thinking skills exceeding the set learning objectives (Rønning, 2021). The characteristics of TDS are combined with other theoretical frameworks (Artigue, 2014). In particular, anthropological didactic theory (González-Martin et al., 2014). Based on the evidence of the research conducted and the characteristics of TDS that make learning design more precise, it is a strong assumption that the study results show that the experimental class is better than the control class. TDS-based mathematics instruction not only fosters an immersive learning environment but also facilitates the cultivation of robust mathematics comprehension among students. Furthermore, the findings indicated that TDS could exceed the established learning objectives, allowing students to transcend the confines of conventional comprehension. The aforementioned findings possess favorable consequences for the advancement of mathematics education centered on profound comprehension, as well as for the enhancement of pupils' critical thinking abilities.

Conclusion

This investigation utilised pre-test and post-test evaluations to assess the participants' mathematical problem-solving abilities and self-efficacy. The examination revealed that the students' abilities in both classes were initially similar, creating a suitable basis for contrasting the two groups. This investigation examined the differences in mathematical problem-solving capabilities and self-perception of efficacy between the two subjects. Analyses employing post-test and N-gain data revealed notable differences in the learning process. The results demonstrated that the experimental group displayed enhanced problem-solving capabilities and a greater sense of self-efficacy than the control group. Their findings revealed significant differences in improving mathematical problem-solving skills and self-efficacy across students of varying abilities—high, medium, and low—outperforming the control group. This research highlights the importance of merging mathematics education with relevant instructional materials and understanding the unique dynamics of individual classrooms to improve teaching effectiveness.

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