

## The Role of the TIMPERSARI Teaching Aid in Enhancing Students' Mathematical Problem-Solving Skills in One-Variable Linear Equations

Zenfiqa Aditya Ramadhani Br Sitepu<sup>1\*</sup>, Irvan<sup>2</sup>, Tua Halomoan Harahap<sup>3</sup>

<sup>1,2,3</sup>*Master of Mathematics Education, Universitas Muhammadiyah Sumatera Utara*

\*Corresponding Author. E-mail: [zenfiqaaditya@gmail.com](mailto:zenfiqaaditya@gmail.com),

| Article Info                                                                                                                             | ABSTRACT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Keywords:</b><br>Teaching Aid,<br>Problem-Solving,<br>TIMPERSARI,<br>Junior High School Mathematics,<br>One-Variable Linear Equation. | This study aims to examine the role of the TIMPERSARI (Linear Equation Balance Scale) teaching aid in improving students' mathematical problem-solving abilities on the topic of One-Variable Linear Equations (PLSV). The background of the study stems from the low level of basic algebraic concept understanding and the limited use of concrete media in junior high school mathematics learning. This research employed a descriptive qualitative approach with data collection techniques including classroom observation, student worksheets, student reflections, teacher interviews, and documentation. The results indicated that the use of the TIMPERSARI tool significantly enhanced students' conceptual understanding of equivalence, encouraged more systematic problem-solving strategies, and fostered students' affective and collaborative engagement. Additionally, students' reflections and teacher interviews revealed positive responses to the media implementation, both in terms of conceptual understanding and learning motivation. This study concludes that TIMPERSARI is effective in bridging abstract concepts into meaningful, concrete experiences and is a viable innovative alternative in junior high school mathematics education. |
| To cite this article:                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

### INTRODUCTION

Education plays a crucial role in preparing superior and adaptive human resources in a continuously evolving global era. The challenges of today's education are becoming increasingly complex in line with the rapid development of science, technology, and the arts. One of the main challenges is how to create a learning process that equips students with 21st-century skills, especially critical thinking and problem-solving (Putra & Ramadhani, 2022). In this context, mathematics becomes particularly important as it directly trains logic, analysis, and systematic thinking skills. However, mathematics learning in schools often faces various obstacles that result in low student achievement.

The topic of One-Variable Linear Equations (PLSV) is one of the fundamental concepts in algebra that serves as a foundation for understanding more advanced material. Unfortunately, this topic is often perceived as difficult by students due to its abstract nature and the use of symbols that are not easily understood (Siregar & Anjani, 2023). The prevailing theoretical approach in instruction causes students to lack concrete and contextual learning experiences. Additionally, the limited use of visual media or teaching aids worsens this issue, making it difficult for students to construct and solve equations logically and structurally. This condition indicates a gap between students' cognitive potential and the instructional approaches available in the classroom.

Various studies show that the use of concrete teaching media, particularly manipulatives, can enhance students' conceptual understanding and learning motivation. Manipulatives allow students to directly manipulate objects so that abstract concepts can be visualized into more tangible forms that are easier to comprehend (Yuliani & Setiawan, 2023). Direct interaction with such media also encourages active student participation, enhances group collaboration, and strengthens critical thinking skills (Anindita, 2023). Moreover, the use of concrete manipulatives can reduce students'

cognitive load in understanding mathematical concepts, as direct visual representations tend to reinforce mental structures needed for mastering new concepts (Wibowo & Handayani, 2023). Unfortunately, many teachers are reluctant to use manipulatives due to practical concerns, time limitations, or a lack of training in media development (Fitria & Nugroho, 2024).

In response to this issue, the researcher developed a simple manipulative called TIMPERSARI (Timbangan Persamaan Linier Satu Variabel), designed to visualize the principle of equivalence in PLSV. Previous studies also suggest that contextualized teaching aids can enhance students' understanding of basic algebraic structures, particularly in the topic of PLSV (Ramadhan & Cahyani, 2020). This tool is constructed from simple materials such as broom handles, ice cream cups, marbles, and string, making it easy to assemble by teachers or students. The main concept of the tool is to provide a concrete learning experience through a balancing scale that mathematically represents the concept of equivalence in linear equations. Using this tool, students are expected to grasp algebraic operations more logically, understand the "transposition" process mathematically, and solve PLSV problems with greater confidence and systematic thinking.

The main issue identified by the researcher at SMP IT Darur Rasyid Aceh Singkil was the low motivation and problem-solving ability of students in the topic of PLSV. Initial observations revealed that the teacher's instructional methods were monotonous and did not incorporate innovative learning media. This impacted students' interest in learning mathematics and their difficulty in understanding the PLSV material. Therefore, the TIMPERSARI teaching aid is proposed as an innovative solution to transform abstract concepts into concrete and interactive experiences. For that reason, this study aims to explore the role of TIMPERSARI in enhancing students' mathematical problem-solving skills in greater depth.

This study aims to examine the role of the TIMPERSARI teaching aid in enhancing students' mathematical problem-solving abilities in the topic of One-Variable Linear Equations through a qualitative approach. Using this approach, the study will explore students' learning experiences, their engagement in classroom activities, and conceptual understanding changes after using the media. The findings are expected to provide a tangible contribution to the development of simple, practical, and effective mathematics learning media that enhance students' critical thinking competencies. Furthermore, this research is expected to inspire mathematics teachers to be more creative in designing relevant teaching aids that align with student needs and curriculum demands.

## **RESEARCH METHOD**

This study employed a descriptive qualitative approach aimed at deeply exploring how the use of the TIMPERSARI teaching aid can enhance students' mathematical problem-solving abilities in the topic of One-Variable Linear Equations (PLSV). This approach was chosen because it enables researchers to understand students' learning experiences directly within their natural context (Creswell & Poth, 2021).

The subjects of this study were seventh-grade students at SMP IT Darur Rasyid Aceh Singkil. The subjects were selected purposively based on preliminary findings indicating that students in the class experienced difficulties in understanding PLSV material. The study focused on a single class consisting of 26 students, who actively participated during the learning process using the TIMPERSARI aid.

Data were collected through classroom observations, documentation of student work, and semi-structured interviews with both teachers and students. These techniques aimed to gather data

from various perspectives to generate a comprehensive picture (Miles, Huberman, & Saldaña, 2020). Observations were carried out directly during the learning sessions, while documentation included worksheets, activity photos, and student assessment results. Interviews were used to delve deeper into students' affective responses and reflections on the use of the teaching aid.

The data were analyzed using an interactive model consisting of three stages: data reduction, data display, and conclusion drawing (Miles & Huberman, 2020). All data were analyzed qualitatively by identifying patterns in students' problem-solving strategies before and after using the TIMPERSARI aid. Data validity was ensured through technique triangulation, by comprehensively comparing observation results, interview data, and documentation (Sugiyono, 2022).

Through this design, the study is expected to provide an in-depth overview of the effectiveness of the TIMPERSARI teaching aid in improving students' problem-solving abilities. Moreover, this method allows the researcher to capture aspects of behavioral changes and conceptual understanding that cannot be measured quantitatively (Zulkardi & Putri, 2020).

## RESULTS AND DISCUSSION

This study aimed to examine the role of the TIMPERSARI teaching aid in enhancing students' mathematical problem-solving skills in the topic of One-Variable Linear Equations (PLSV). Data were collected through direct observations, student worksheets (LKPD), student reflections, teacher interviews, and documentation during the learning process.

### 1. Conceptual Understanding of PLSV through Concrete Visualization

Before using the teaching aid, the researcher conducted an initial activity (apperception) to assess students' prior understanding of the PLSV concept. Most students were only able to state the general form of a linear equation without grasping the meaning of equivalence or the strategies to solve it. After being introduced to the TIMPERSARI aid, there was a significant improvement in understanding as students could directly see how balance occurs in a concrete form (Magdalena et al., 2020).



**Figure 1.** TIMPERSARI Teaching Aid

This tool consists of two arms (left and right) resembling a balance scale, with marbles representing constants and wrapped marbles representing variables. Through this aid, students were able to comprehend the principle that “what is done to one side must also be done to the other side,” which is fundamental in solving PLSV equivalently (Yuliani & Setiawan, 2023).

### 2. Enhancing Problem-Solving Strategies

Students began to develop problem-solving strategies gradually, transitioning from trial-and-error approaches to more systematic thinking processes. The use of the teaching aid provided a direct illustration of the procedure for simplifying equations. In an example problem such as  $2x + 2 = 8$ , students manipulated the aid to eliminate the constant on both sides and divide both sides into equal parts.



**Figure 2.** Example Problem with Coefficient Greater than One

The use of this aid demonstrated how abstract algebraic concepts can be operationalized in a concrete way (Santosa & Yulianti, 2022). This supports the view of Rahmawati & Dewi (2022), who stated that manipulative media can strengthen the connection between formal concepts and students' operational understanding in solving problems.

### 3. Collaborative Activities and Exploratory Processes

Students were divided into small groups to solve problems using the TIMPERSARI aid. It was evident that each group member actively participated, both in operating the aid and discussing the solutions. Some groups divided roles naturally; for example, two students operated the aid while the others took notes and performed calculations.



**Figure 3.** Small Group Experiment



**Figure 4.** In-Class Experiment

These collaborative activities created a dynamic learning environment. Students not only learned from the tool but also from social interaction. This is in line with the constructivist perspective that knowledge is built through experience and social dialogue (Anindita, 2023).

### 4. Student Reflections and Affective Responses

After the activity, students were asked to write reflections on sticky notes. Most students stated that the lesson was more enjoyable and helped them understand previously difficult problems. They also mentioned feeling more confident and challenged to solve problems.



**Figure 5.** Student Exploration in Problem Solving

Notes

An analysis of the sticky notes showed that the majority of students felt happy, interested, and motivated to learn mathematics using the TIMPERSARI tool. Many students noted that this lesson was different from usual because they did not only listen to the teacher's explanation but also could "see" and "touch" the concept that was previously considered difficult. This indicates that the TIMPERSARI teaching aid successfully activated both emotional and cognitive student engagement during the learning process.

Some students also wrote that they found it easier to understand PLSV material because they could see the solution process directly, rather than just through abstract symbols on the board. Moreover, the opportunity to work together in groups added a fun element because they could learn while discussing with their peers. This aligns with the view of Rahmawati & Dewi (2022), who stated that students' affective involvement in learning is highly influenced by the methods and media used by the teacher.

Student reflections also showed that this teaching aid helped build their confidence. Some students mentioned that they usually fear making mistakes in math, but with this tool, they felt more confident and brave to try because there was a concrete demonstration. This shows that concrete media like TIMPERSARI can create an inclusive and supportive learning climate, which is very important for enhancing mathematical literacy sustainably (Pratiwi et al., 2022).

Overall, student reflections not only indicate that this tool was well-received by learners but also show a positive change in attitude toward mathematics. In modern education, learning success is not only measured by cognitive outcomes but also by affective aspects that reflect changes in attitude, motivation, and students' positive perceptions of the learning process (Yuliani & Setiawan, 2023). Therefore, this reflection reinforces the finding that TIMPERSARI plays an important role in holistically improving the quality of PLSV learning.

## **5. Validation of Results through Teacher Interviews**

To strengthen the findings from classroom observations, student work, and student reflections, the researcher also conducted semi-structured interviews with the mathematics teacher who assisted during the learning process. These interviews aimed to gain the teacher's perspective on the implementation of the TIMPERSARI teaching aid and its impact on the learning process and outcomes in the PLSV topic.

Based on the interview results, the teacher stated that the use of TIMPERSARI brought a fresh atmosphere to math learning. The teacher observed that students who were usually passive and hesitant to express opinions became more active, interested, and participative. According to the teacher, this aid provided a real learning experience and helped students understand that every operation in an equation has logical meaning, not just a rule to memorize. The teacher also

highlighted that TIMPERSARI indirectly encouraged students to think more critically and engage in group discussions.

Furthermore, the teacher noted that the teaching aid helped bridge the gap between fast and slow learners. Students with lower academic abilities found it easier to access concepts through visualizations, while higher-performing students were challenged to explain the process mathematically. This indicates that TIMPERSARI naturally provided instructional differentiation, in line with the differentiated learning principles promoted in the Merdeka Curriculum (Fitria & Nugroho, 2024; Irvan et al, 2024).

From the teacher's perspective, TIMPERSARI not only increased students' cognitive engagement but also their affective and social involvement. The teacher emphasized that this tool is particularly suitable for foundational topics that require conceptual reinforcement through visual and manipulative approaches. He also expressed willingness to replicate the use of the tool in other algebra topics in future classes.

These findings support the validity of the data, showing that TIMPERSARI positively contributed to students' problem-solving skills. The teacher's role as a key informant also provided triangulation validation for the student observations and reflections. In qualitative research, involving the teacher as a data source confirms field findings and supports the credibility and reliability of the researcher's interpretations (Miles, Huberman, & Saldaña, 2020).

#### **6. Limitations, Implications, and Final Interpretation**

This study provides a strong portrayal of the role of the TIMPERSARI teaching aid in enhancing students' problem-solving abilities in the PLSV topic. The results showed that TIMPERSARI was effective in concretizing abstract algebraic concepts, activating student participation, and fostering a collaborative and enjoyable learning atmosphere. However, the study also has several limitations that should be considered for future research.

One major limitation is the limited duration of implementation. The learning process only lasted for two instructional hours in one meeting. This was not sufficient to explore more complex problems or to assess the long-term effects of the teaching aid on concept retention or the development of students' thinking abilities. Moreover, because the study was qualitative with a single class as the subject, generalizing the findings to other contexts should be done cautiously. Nonetheless, the depth of data gathered provides rich contextual insight into students' learning experiences with TIMPERSARI.

From the findings, it can be interpreted that the TIMPERSARI teaching aid has great potential as a component of meaningful mathematics teaching strategies. It successfully bridges the gap between abstract understanding and concrete experience, which has long been a barrier in mastering PLSV. The learning process using this aid involved not only cognitive activities but also affective and social reinforcement, such as increased confidence, motivation, and teamwork skills. These results support Vygotsky's assertion that effective learning occurs through meaningful mediation and social interaction (Yuliana & Prabowo, 2021).

The implications of these findings are that teachers need training and innovation space to develop and integrate simple yet effective teaching aids like TIMPERSARI into mathematics instruction. This tool could also be further developed into interactive digital formats to reach online or hybrid learning contexts. Schools and educational institutions are expected to provide policy and infrastructural support to cultivate a culture of exploration- and manipulation-based learning.

Therefore, the final interpretation of this research is that TIMPERSARI is not merely a visual teaching aid, but a medium that drives transformation in student learning from passive to active,



from rote procedures to conceptual understanding, from fear of mistakes to confidence in problem-solving. This study contributes both conceptually and practically to the development of math learning tools at the junior high school level and opens opportunities for deeper and broader future research.

## CONCLUSION

Based on the results of this study, it can be concluded that the use of the TIMPERSARI teaching aid effectively enhances students' problem-solving abilities in the topic of One-Variable Linear Equations (PLSV). Through direct observation, analysis of student worksheets, student reflections, and teacher interviews, it was found that TIMPERSARI helped concretize abstract algebraic concepts, engaged students actively, and supported a more collaborative and enjoyable classroom environment.

Students demonstrated an improved understanding of the concept of algebraic equivalence, showed higher motivation, and developed more structured problem-solving strategies. The learning activities that incorporated TIMPERSARI not only improved cognitive outcomes but also fostered affective and social growth, such as increased confidence and cooperative behavior among students.

The teacher's reflection also supported the effectiveness of TIMPERSARI in facilitating differentiated instruction naturally. The tool was observed to help bridge the learning gap among students with varying abilities and provide a meaningful and memorable learning experience. Overall, this research highlights the importance of innovative, low-cost, and student-centered learning tools in supporting mathematics education at the junior secondary level.

## REFERENCES

- Anindita, R. (2023). Peran media konkret dalam meningkatkan berpikir kritis siswa pada pembelajaran matematika. *Jurnal Inovasi Pembelajaran Matematika*, 10(2), 102–113. <https://doi.org/10.31002/jipm.v10i2.341>
- Creswell, J. W., & Poth, C. N. (2021). *Qualitative inquiry and research design: Choosing among five approaches* (4th ed.). SAGE Publications.
- Farid, M., & Wulandari, E. (2020). Kendala guru dalam penggunaan media pembelajaran matematika. *Jurnal EduMat*, 7(1), 12–20. <https://doi.org/10.21009/edumat.07102>
- Fitria, H., & Nugroho, Y. (2024). Pembelajaran berdiferensiasi berbasis Kurikulum Merdeka. *Jurnal Pendidikan Progresif*, 14(1), 87–95. <https://doi.org/10.23960/jpp.v14i1.542>
- Hasibuan, M., & Simbolon, R. (2023). Pengaruh media pembelajaran konkret terhadap minat belajar matematika. *Jurnal Pendidikan Matematika*, 11(3), 211–223. <https://doi.org/10.31539/jpm.v11i3.728>
- Irvan, I., Simangunsong, A. R., & Nasution, M. D. (2024). Statistics Learning Media Innovation B-Tube (Combination Blog and YouTube). *Mosharafa: Jurnal Pendidikan Matematika*, 13(4), 895-908. <https://doi.org/10.31980/mosharafa.v13i4.1748>
- Kiptiyah, L., Safitri, H., & Suharto, T. (2020). Alat peraga kontekstual untuk meningkatkan hasil belajar matematika. *Jurnal Ilmiah Pendidikan Matematika*, 6(1), 45–54. <https://doi.org/10.22342/jipm.v6i1.785>

- Magdalena, I., Putri, R. I. I., & Zulkardi. (2020). Pembelajaran berbasis konteks dengan alat peraga dalam materi aljabar. *Journal on Mathematics Education*, 11(2), 165–174. <https://doi.org/10.22342/jme.11.2.7902>
- Miles, M. B., Huberman, A. M., & Saldaña, J. (2020). *Qualitative data analysis: A methods sourcebook* (4th ed.). SAGE Publications.
- Pratiwi, E. F., Astuti, S. R., & Wijayanti, D. (2022). Pengaruh media manipulatif terhadap literasi matematika siswa. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 6(1), 87–102. <https://doi.org/10.31004/cendekia.v6i1.841>
- Putra, A., & Ramadhani, R. (2022). Tantangan pendidikan abad ke-21 dalam meningkatkan kualitas SDM. *Jurnal Edukasi dan Inovasi*, 5(2), 33–42. <https://doi.org/10.21009/jei.05205>
- Rahmawati, S., & Dewi, N. L. P. S. (2022). Peran media manipulatif dalam pembelajaran matematika untuk meningkatkan pemahaman konsep. *Jurnal Pendidikan Matematika Indonesia*, 13(1), 71–82. <https://doi.org/10.21831/jpm.v13i1.10312>
- Ramadhan, A., & Cahyani, M. (2020). Pengembangan alat peraga matematika berbasis kontekstual. *Jurnal Ilmiah Matematika Realistik*, 3(2), 99–107. <https://doi.org/10.31227/jimr.v3i2.348>
- Santosa, D., & Yulianti, L. (2022). Strategi manipulatif dalam pembelajaran aljabar SMP. *Jurnal Matematika Terapan*, 9(2), 55–63. <https://doi.org/10.30738/jmt.v9i2.465>
- Siregar, R., & Anjani, L. (2023). Kesulitan belajar matematika pada materi persamaan linier. *Jurnal Penelitian Pendidikan Matematika*, 10(1), 15–27. <https://doi.org/10.31227/jppm.v10i1.589>
- Sutrisno, A., & Pramudita, P. (2020). Analisis hambatan belajar matematika berbasis pendekatan pedagogis. *Jurnal Pendidikan Dasar Indonesia*, 5(3), 222–230. <https://doi.org/10.26737/jpdi.v5i3.1321>
- Sugiyono. (2022). *Metode penelitian kualitatif, kuantitatif, dan R&D*. Alfabeta.
- Wibowo, R., & Handayani, D. (2023). Penggunaan alat peraga dalam memahami konsep matematika abstrak. *Jurnal Pendidikan dan Teknologi*, 7(2), 89–98. <https://doi.org/10.21009/jpt.v7i2.932>
- Yuliani, R., & Setiawan, H. (2023). Peran alat peraga dalam pembelajaran matematika di era digital. *Jurnal Inovasi Pendidikan Dasar*, 10(1), 45–56. <https://doi.org/10.21009/jipd.v10i1.204>
- Yuliana, L., & Prabowo, A. (2021). Implikasi teori Vygotsky dalam pembelajaran matematika. *Jurnal Psikologi Pendidikan*, 9(2), 78–90. <https://doi.org/10.30872/jpp.v9i2.321>
- Zulkardi, & Putri, R. I. I. (2020). *Penelitian Pendidikan Matematika: Pendekatan Realistik Indonesia*. UPT Unila Press.