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THE DEVELOPMENT OF STUDENT WORKSHEET TO ENHANCE STUDENTS' MATHEMATICAL UNDERSTANDING ON TWO VARIABLE LINEAR EQUATION SYSTEM TOPIC

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ABSTRACT

Student worksheets play a crucial role in mathematics education by providing a structured framework for exploring concepts, practicing exercises, and achieving learning goals. However, understanding slope, intercepts, and graphing in linear equations with two variables (LETV) remains a common challenge for many students. Therefore, this study aims to develop a student worksheet for linear equations with two variables to enhance students' comprehension in that specific area of mathematics for junior high school students based on their difficulties in solving problems on linear equations with two variables and to identify such difficulties based on articles written by 20 scholars published in Sinta-accredited journals. This qualitative study used text data from 20 nationally Sinta-accredited peer-reviewed mathematics education journals that presented articles about the challenges or difficulties of this topic as experienced by students. The data were analyzed through an SLR method by identifying the patterns of students' difficulties or challenges and by analyzing how the student worksheet will handle such problems as reported in journal articles. This study also reveals that students' challenges in studying this topic of maths involve conceptual misunderstandings, procedural errors, graphical interpretation issues, lack of real-world application, lack of creativity, lack of ability in writing mathematical representations, difficulty in understanding word or story problems, lack of mathematical process skills, and recklessness.

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INTRODUCTION

It appears that the ability to comprehend mathematical concepts goes a long way in moulding problem-solving skills of students with mathematical acumen. Research has indicated that conceptual understanding have a very high impact on students mathematical problem solving (Pramuswara & Haerudin, 2024). This awareness allows students to learn, retain and reuse mathematical concepts perfectly (Anggraini). For example the application of a good realistic mathematics leaning approach (PMR) and also train multiply thinking can affect the students' conceptual understanding (Supriadi et al., 2022). Students are able to solve mathematical problems well when they understand math concepts and those who do not have a good concept understanding are not able to cope up with task (Amir 2015). So teachers need to construct learning environment that supportive students' concept discovery on accord with mathematical abilities (Amir 2015) in enhancing students' mathematical ability. Over and above, focusing on conceptual understanding empowers students with the skill they need to deconstruct real-life problems, identify all theirs derivatives and create responsible answers.

In junior high school, Mathematics works as the building blocks of the students' cognitive development. During this period, students are exposed to a multitude of mathematical topics, the important one being linear equations with two variables (LETV) since it serves as a prerequisite for more advanced algebra and calculus concepts. To bridge these issues, a multitude of research shows that students face challenges in the comprehension and the underlying concepts related to slopes and intercepts in linear equations with two variables (LETV) as indicated by Wahyuni et al (2023), Fatio et al (2020) and Iqbal and Hw (2022), such as in graph plotting among others. These factors not only affects their grades in mathematics, but it also impacts their self-esteem and interest levels towards the subject. Thus, the need to develop new effective instruction materials such as textbooks or students worksheets, becomes imperative to enhance students' understanding of linear equations with two variables.

This current study is significant because plenty of students experience difficulties in learning linear equations with two variables (LETV). Many researchers have noted the problems faced by the junior and senior high school students while learning LETV. Common problems include transformation of the word problems into variables, appropriate mathematical concepts to be used, and the equations formation (Pradini & Winarsih, 2020). Determining the solutions to LETV systems seems to be a difficulty area for many students which indicates a problem with some processes (Fatio et al., 2020). Difficulties through concepts, which he terms "thematic difficulties," are accompanied by an inability to comprehend information provided in a concept or policy document and "a problem" is how to use the information to solve a problem (Wahyuni et al., 2023). Some of the other contributory factors for these problems are poor reading skills, problem misunderstanding and the nature of language and number interaction (Pradini & Winarsih, 2020). At the same time, misconceptions based on incorrect definitions of what LETV systems are could also arise (Fatio et al., 2020). Moreover, students do not find it easy to carry out mathematical operations and do not understand the meaning of mathematics which makes it more difficult for them to learn arithmetic operations (Wahyuni et al., 2023).

Taking into consideration these obstacles, developing a worksheet for students focusing on LETV was important and relevant, as pointed by Prabawati & Herman, and Rohani et al. 2021. This worksheet can provide students with an orderly way of approaching the topics of slope, intercepts, and graphing which can, at the same time, be more fun and less stressful. Incorporating a variety of exercises, visual aids, and practical implications into the worksheet will enable students to understand linear equations and their importance in life better. Moreover, with regard to the collaborative nature of this work, which included contributions from expertise in mathematics pedagogy, it was ensured that the worksheet is backed with teaching-theoretical frameworks and is up to date with the requirements of the educational system.

In particular, the development of helpful student worksheets in teaching linear equations with two variables (LETV) for junior high school mathematics has taken invigorating inputs from recent researches. In this perspective, several methods of researching have been applied, such as; mathematical understanding through worked examples (Lubis & Wahyuni, 2022), higher-order thinking skills definition (HOTS) (Agustarina et al., 2020), project-based learning (PjBL) (Asmi et al., 2021), and problem solving (Putri et al., 2022). These development researches have used-the ADDIE and Tessmer development research methods-in designing and validating the students' worksheet. It resulted in valid, practical, and effective materials for improving students' understanding and skills of problem solving. In particular, the PjBL worksheet significantly improved the student's performance in LETV (Asmi et al., 2021). Contextual problems and worksheet-based HOTS activities helped students to practice higher-order thinking relevant to this topic (Agustarina et al., 2020). These results substantiate that innovative worksheet design needs to be a very effective part of LETV instruction while addressing some of the challenges of mathematics education today.

Mastering linear equations is not needed for success in future math classes, but for the continuous development of critical thinking and problem-solving, which could be useful across many disciplines (Fadhilah et al., 2021; Susandi, 2021). As students prosper in their educations, a sound understanding of linear equations will enable them to interact with more complicated mathematical concepts and practically apply the knowledge to real life (Fatmawati et al., 2020). Thus, improving understanding in LETV of students is, indeed, not only academic; it is a significant issue in their entire educational development.

Reviewing the previous studies concerning students' problems with LETV clearly validates the need to develop different types of interventions. Indeed, there have been several studies conducted recently to prepare students worksheets aimed at improving the comprehension of linear equations with two variables in mathematics classroom instruction. In fact, these worksheets were aimed at improving the skills of mathematical literacy (Prabawati et al., 2019), mathematics understanding (Lubis & Wahyuni, 2022), higher-order thinking skill (Agustarina et al., 2020), and realistic mathematical education (Rohani et al., 2021). Development processes typically followed several stages such as analysis, design, development, and evaluation (Lubis & Wahyuni, 2022; Agustarina et al., 2020). Validation by experts and student feedback is essential to ensure the worksheets can be effectively used by students (Prabawati et al., 2019; Lubis & Wahyuni, 2022; Agustarina et al., 2020; Rohani, 2021). To enhance engagement and understanding among students, these worksheets incorporate problem-based learning (Prabawati et al., 2019), worked examples (Lubis & Wahyuni, 2022), and contextual problems (Agustarina et al., 2020; Rohani, 2021). The outcome of the researches shows that the instructional materials can effectively deal with students' challenges in LETV and enhance mathematics instruction.

Studies in recent time have created emphasis on field efficacy of specialized worksheets improving the comprehension of linear equations with two variables among students. The use of problem-based learning approaches can enhance mathematical literacy skills and provide students with real life applications (Prabawati et al., 2019, Masitoh, 2021). Contextualization of problems aids in making students relate the mathematical problems with real situations which is the flourishing of change in relevance and interest (Masitoh 2021). Research shows that solved example worksheets reduce cognitive load and facilitate comprehension (Lubis & Wahyuni, 2022). Worked-examples didactical design research has shown that well-structured worksheets for linear equations can decrease learning difficulties and common difficulties in understanding (Nurhasanah et al., 2019). They highlight the need for students to clearly see mathematical ideas and access structured practice as well as immediate feedback. Together, the

use of these strategies can be used to provide scaffolding to enable students develop adequate understandings of linear equations with two-variables and enhance performance.

Based on our review of current issues in literature and experienced educators regarding mathematics education pedagogy, this current research proposes an effective resource in the form of a student worksheet to improve students' understanding of linear equations with two variables. Although Pradini and Winarsih (2020) previously identified several challenges experienced by junior high school students when learning LETV and explored obstacles faced by students when learning LETV, in reality there is still a huge gap of learning materials leading to no improvement and further targeted learning materials developed toward this area, especially corpora data, namely doing a thorough investigation of large

Therefore, this study aims to identify problems, difficulties, and challenges experienced by students learning the material and the teachers who teach it and examine how a student worksheet can possibly respond to such problems through its relevant elements.

METHOD

Drawing on a qualitative research design in the form of a SLR method, this study was aimed at developing a student worksheet for purposes of improving junior high students' comprehension on linear equations in two variables (LETV) as suggested by Cresswell & Cresswell (2023) and at identifying the problems that students faced in studying LETV which can potentially be solved using the worksheet. It was this qualitative approach that guided the researchers in determining what it is that really makes the process of learning LETV difficult for students as well as how instruction materials could be prepared to address those areas effectively. The research process made use of the two major methods: document analysis and expert evaluation.

RESULTS AND DISCUSSIONS

Results

Document Analysis

The first stage of the research was to conduct a thorough review of 20 peer-reviewed Sinta-indexed journal articles that analyzed the problems students encounter with linear equations and similar topics. These articles were selected as they relate to the topic and provide insights into the misconceptions and hurdles that students face when learning LETV. The selected studies were required to provide empirical evidence for challenges students face, theoretical perspectives to understand these challenges, as well as potential productive instructional strategies.

Table 1. Data Sources from Peer-Reviewed Journal Articles

No	Journal Articles	Years of Publication	Types of Errors Found
1	Article 1	2022	Final Answer Writing Errors
2	Article 2	2024	Errors in Reading, Understanding, Transformation, Process, Final Answer Writing
3	Article 3	2023	Conceptual Errors
4	Article 4	2023	Concept Interpretation Errors
5	Article 5	2023	Conceptual Errors
6	Article 6	2023	Misconceptions of procedural concepts

7	Article 7	2020	Misapplication of Formulas, Mathematical Operations, and Elaboration
8	Article 8	2020	Errors in Understanding Problems and Applying the Formulas
9	Article 9	2021	Errors in Problem Understanding, Calculation, and Making Inferences
10	Article 10	2022	Concept Understanding Errors
11	Article 11	2021	Mathematics Problem Solving Errors
12	Article 12	2021	Errors in Stages or Procedures of Solving Problems
13.	Article 13	2021	Errors in Visual representation, Mathematical expression, representation, Word or text representation
14.	Article 14	2022	Errors in creating equivalent equations (forward process) or reverse the equation to its original form (reverse process), indicating low overall reversible thinking ability.
15	Article 15	2020	Errors in understanding concepts and solving linear equations with two variables in HOTS problems
16	Article 16	2021	Errors based on SOLO taxonomy (prestructural, unistructural, multistructural, relational)
17	Article 17	2020	Reading, Understanding, Transformation, Process Skills, Answer Writing, Carelessness
18	Article 18	2022	Conceptual and Procedural Errors
19	Article 19	2020	Reading, Understanding, Transformation, Process Skills, Encoding
20	Article 20	2021	Difficulty understanding linear equations with two variables: concepts, methods, and supporting materials

The analysis of the documents unfolded in multiple phases. First, by leveraging academic databases of Google Scholar a systematic literature search for journal articles about mathematics education, particularly around LETV and written by Indonesian researchers was conducted. The keywords used to identify relevant articles were: "linear equations", "students' difficulties", and "misconceptions in linear equations," and "mathematics education.

From the search results, however, we only selected 20 those articles that specifically focused on junior high school students and addressed the specific problems they faced in terms of LETV. This selection included both qualitative and quantitative studies, providing a balanced overview of the different issues involved.

Afterwards, we identified main themes and findings from each article focusing on the unique challenges experienced by students regarding slope, intercepts, graphing, and algebraic vs. graphical representation. We conducted a thematic analysis to identify common patterns and issues, which informed the development of the student worksheet.

In conclusion, the insights from the document analysis were combined to create a detailed summary of the issues that students encounter when learning about LETV. This summary was essential for creating the student worksheet, making sure it tackled the problems that were found.

Expert Review

The next stage of the study involved three experienced senior mathematics teachers evaluating the created student worksheet. These teachers have a strong background in teaching algebra and mathematics education. The goal was to assess the worksheet's content, clarity, and its possible effectiveness in enhancing students' comprehension of LETV.

The Selection of Evaluators: Three experienced mathematics teachers who had been teaching junior high school mathematics for several years were involved in the evaluation due to their familiarity with LETV learning processing and students' learning problems. All evaluators had a minimum of ten years of practice teaching experience and had received professional development training that focused on mathematics instruction.

1. Worksheet Review: The evaluators were given a draft version of the student worksheet, which was filled with exercises, visual aids, and real-world applications meant to help students make sense of linear equations. The worksheet also encouraged students to think more broadly about things like slope, intercepts, and graphing.
2. Evaluation Criteria: Evaluators were asked to evaluate the worksheet based on a specific set of criteria including the clarity of instructions and explanations, the relevance and appropriateness of exercises, the engagement and interactivity of the activities, and how well it matched the challenges identified in the document analysis.
3. Feedback Collection: After reading the worksheet, evaluators provided written feedback and rated it from 1–5, with 1 corresponding to “not suitable” and 5 meaning “very suitable.”
4. Revision of the Worksheet: The student worksheet was revised based on the evaluators' feedback to address any weaknesses and enhance its overall effectiveness. This ongoing process ensured that the final version of the worksheet was informed by both research and expert insights.

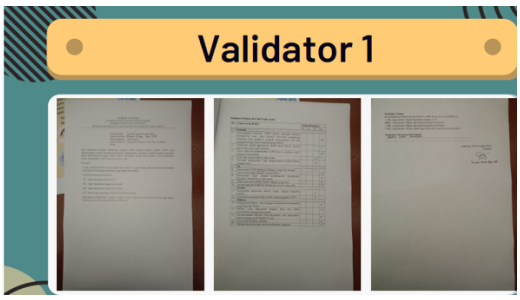

Figure 1. Proof of the first validation

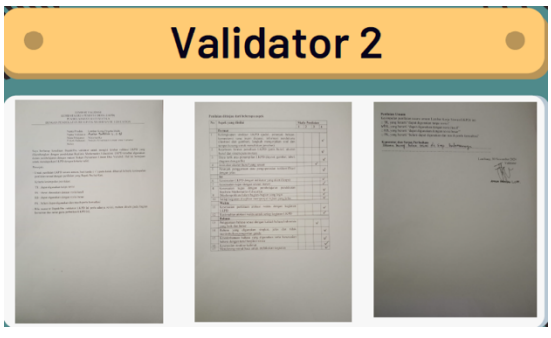

Figure 2. Proof of the second validation

As shown in figure 1 and figure 2, the average score for validation 1 is 62/17 which is equal to 3.65 and the average score for validation 2 is 66/17 which is equal to 3.88, both of which are close to 4.

Data Analysis

A thematic analysis approach was used to analyze the qualitative data obtained from document analysis and expert evaluations. This entailed coding the data in order to identify recurring themes and trends regarding students' struggles with LETV and the efficacy of the worksheet. The document analysis results were then compared to the responses from the expert evaluations to ensure that the worksheet addressed the previously identified problems.

This study drew upon a qualitative research design comprising document analysis and expert review in an effort to develop a student worksheet to improve understanding of linear equations with two variables in junior high school students. The goal of this research was to create the worksheet relying on empirical literature and expert knowledge, developing an important tool to be used by educational practitioners to improve the practice of mathematics education and student learning in this fundamental domain of the discipline.Results and Discussion

The analysis of 20 peer-reviewed journal articles highlighted several common themes related to the challenges junior high school students encounter when learning linear equations with two variables (LETV). These challenges were grouped into four primary categories: conceptual misunderstandings, procedural errors, issues with graphical interpretation, and a lack of real-world application. Table 2 summarizes the types of errors, their descriptions and causes of those errors.

Table 2. Categorization of Difficulties in Learning Linear Equations with Two Variables: A Qualitative Analysis of Students Errors in LETV

No	Types of Errors	Errors' Descriptions	Causes of Errors
1	Final Answer Writing Errors	Students incorrectly wrote the final answers, both in mathematical otations and did not provide the right conclusions in LETV problems.	Students were not careful in writing the final answer, did not understand the correct format for writing conclusions, and did not check their work again.
2	Reading, Understanding, Transformation, Process, Final Answer Writing	Errors include difficulty reading symbols, understanding problem information, transforming story problems into mathematical models, completing calculation operations, and writing the final answer correctly. final answer appropriately.	Low mathematical literacy, lack of accuracy, not understanding the steps to solve the problem.
3	Conceptual Errors	Students do not understand the concept of LETV so students' answers are sometimes wrong and not as expected often just	Students' concept understanding ability is low, lack of practice problems. Re-study at home and the form of story problems makes it difficult for students to

		write a perfunctory answer.	understand the the problem.
4	Concept Interpretation Errors	Students cannot translate story problems into mathematical models and have difficulty understanding the information given in the problem.	Lack of understanding of the LETV concept, difficulty analyzing data in story problems, lack of practice working on similar problems, and unfamiliarity with elimination or substitution methods in LETV.
5	Conceptual Errors	Students were mistaken in preparing mathematical models of LETV story problems. For example, writing the wrong variables and coefficients in the equation.	Lack of understanding of basic LETV concepts and inability to translate contextual problems into the form of mathematical equations.
6	Misconceptions of procedural concepts	Students misunderstand the procedure of LETV addition and subtraction operations in the elimination method.	The concept of LETV conveyed by the teacher is not fully understood by students; students do not check their work. their work back.

From table 2, we then managed to re-categorize and summarize the issues surrounding the students' problems and challenges in mastering the system of linear equations with two variables along with their percentages in table 3 as follows:

Table 3. Major Categories of Students' Problems with LETV

No.	Categories of Problems	Percentages
1.	Conceptual misunderstandings	27.35%
2.	Procedural Errors	12.09%
3.	Graphical Interpretation Issues	10.01%
4.	Lack of Real-World Application	9.75%
5.	Lack of creativity	8.19%
	Lack of ability in writing mathematical representations	7.14%
6.	Difficulty in understanding word or story problems	14.37%

7.	Lack of mathematical process skills	5.25%
8.	Recklessness	14.92%

As noted in table 3, the majority of students (27.35%) expressed conceptual misunderstandings: One of the fundamental obstacles they mentioned was the conceptual misunderstandings when students were problematizing the concepts of slope and intercepts.

Discussions

Based on the findings of Utami et al. (2024), many students only know slope as a number and not a slope indicator of whether the line is steep or flat. Common mistakes include getting stuck in transforming mathematical models from word problems and solving systems of linear equations (Ikfini et al., 2024). Muthmainnah (2023) found students commonly failed to express forms of mathematical expressions referenced in proper mathematical language and to utilize them for real life. Indeed, the research indicated that as many as 71% of students struggled to identify solutions to linear equation systems in algebraic form, suggesting a problem with procedural understanding (Fatio et al., 2020). A number of different assessments point out the need to use realistic teaching activities for better understanding of slope concepts (Utami et al., 2024) as well as the need for good mastery of foundational material and practice (Ikfini et al., 2024) to address these issues. Moreover, the emphasis on teacher engagement and the application of various learning models could potentially enhance the understanding of concepts (Muthmainnah, 2024).

It turns out that the procedural errors (12.09%) are also one of the most common problems as well of many students. Procedural errors were also common in students as they erred when algebraic techniques were applied to manipulate linear equations. This concurred with the study from Hulu (2023) who observed that students often struggle with the mechanics of solving the equations, particularly, the transition of one form of the equation to another. Hulu (2023) Identification of errors making mistakes including in procedural errors (error in mathematical calculations and in equation manipulations); The most common types of mistakes include organizing data (54%), procedural (62%) and draw conclusions (75%) (Hulu, 2023). Islamiyah et al. (2018) classified errors into reading (17.78%), comprehension (55.56%), transformation (18.52%), process skills (36.67%), and encoding (83.70%). The causes itself of the errors were difficult to understand relevant concepts, difficulty of giving rise to creative solutions to the problem, and low diligence in doing computations (Santoso et al., 2019; Ikfini et al., 2024). In addressing these issues, some researchers recommend providing more practice exercises, focusing on mastering conceptual fundamentals, and improving students' understanding of mathematical models (Hulu, 2023; Ikfini et al., 2024).

Table 3 also shows that 10.01% of graphical interpretation issues happened. For many students graphical interpretation was clearly an important problem because students struggled to translate from the algebraic form of a linear equation to its graphical representation. This challenge is further supported by research conducted by Clements and Sarama (2009), which states that students frequently do not relate algebraic expressions to their corresponding graphs and thus misinterpret the graphs and make errors when solving problems. Students, in fact, commonly struggle with graphical interpretations, and do not, therefore, relate algebraic expressions with their representations on graphs Knuth (2000). Students from algebra through calculus who had relied on algebraic methods, even when graphical or other approaches would have been more appropriate. Parr & Lippe (2024) noted challenges we see in employing algebraic expressions for distances implied on function graphs, emphasizing how crucial it is to keep in mind that a symbolic form can represent either a variable (x) or a distance within a graph. Parr (2023) also described how students interpreted calculus expressions in function

graphs, explaining how many students missed using magnitude interpretations of difference expressions. Factors causing these problems are low reading comprehension level, improper strategy, and complexity of linguistic and numerical components of word problems (Pradini & Winarsih, 2020). To overcome these challenges, researchers recommend creating didactic designs that prioritize concept comprehension over rote learning (Nurhasanah et al., 2019). These type of approaches can allow students to learn with less road blocks, and logically communicate from algebraic and graphical representation to analyze and demonstrate his/her understanding of according to the parameter of the linear equation.

In terms of the problem of lack of real-world application (9.75%), this finding suggests that there students had insufficient knowledge of mathematics application of reality and the students had difficulty understanding the importance of linear equations in everyday life. This result is in line with previous research (Muthmainnah, 2023; Rahmawati & Saputro, 2019). In doing so, however, the Contextual Teaching and Learning (CTL) model is considered to have better learning outcomes than conventional ones (Makaluas et al., 2023). Research findings show that learners encounter challenges in terms of defining mathematical ideas, recognizing instances, and relating linear equations to other subjects or real-life situations (Muthmainnah, 2023; Rahmawati et al., 2019). To reduce these problems, educational stratums are built by their learners to decrease the barriers to learning and promote the mastery of concepts (Nurhasanah et al., 2019). Moreover, to enhance students' conceptual understanding, it is also suggested that (1) teachers maximize their roles in the classroom, (2) implement various types of learning models, and (3) prepare lessons carefully (Muthmainnah, 2023). In conclusion, this study highlights the need for contextualization of mathematical concepts and strategies to strengthen mathematical connections for students specifically in the domain of linear equations in the two variable domain.

The table also shows creativity (8.19%) is missing in the education of linear equations two variable. This finding is consistent with previous studies that revealed graduates do not play well with creative problem-solving skills, posing barriers to both employability and progress in the nation (Hafizi & Kamarudin, 2020). Similar to mechanical derivation, traditional mathematics education in United States focuses on computational skills rather than their creative application, hindering students on ppreciate mathematics fully (Mann, 2006). Turkish high school teachers have a limited notion of what mathematical creativity entails, with a focus on cultivating different means for problem-solving (Aktaş, 2015). English Abstract Aspects That Hinder the Development of Creativity: Standardized Tests, Iron-Cage Curriculum, and the Education System Itself Key Words: Creativity, education, standardized tests, iron-cage curriculum, education system Abstract Barriers in the way of developing creativity: standardized test, iron caged curriculum, and the education system itself (Aktaş, 2015). This study highlighted the various views of the participating prospective mathematics teachers and the mathematician related to creativity when contrasted (Yazgan-Sağ & Emre-Akdoğan 2016; Yazgan-Sağ 2016) and the focused differences between prospective mathematics teachers and a mathematician regarding creativity focused on the teacher although classroom activities and problem approaches were observed through the implementation of the study. The Trends in International Mathematics and Science Study (TIMSS) measures 4th and 8th-grade students' mathematics performance on an international level and has shown that students are not able to successfully formulate and solve mathematical problems as their creativity is not being utilized enough within mathematics education.

Based on the journal articles analyzed, we identified some problems or obstacles students encounter in creating mathematical representations. This is evidenced by Astiati (2024) while Supandi et al. (2018). The current study suggested that these types of skills were difficult for many students, which was also supported by a study on student set doses in mathematics

education programs stated that 67.5% of students had very poor mathematical representation ability (Ratumanan et al., 2022). An analysis conducted on junior high school students also found different levels of proficiency across each mathematical ability category (Mulyaningsih et al., 2020). Low mathematical representation skills can be attributed to a lack of prerequisite knowledge and teacher-centered learning, affecting the development of mathematical representation skills (Ratumanan et al., 2022). A possible way to overcome this challenge is to implement innovative teaching methods, such as the think-talk-write model to improve students' mathematical representation skills (Supandi et al., 2018). Needless to say, these skills should be enhanced, for poor mathematical representation abilities can inhibit students from understanding mathematical ideas and solving mathematical problems (Mulyaningsih et al., 2020).

The results of this study also showed as presented in the table 3, students commonly face challenges when going through mathematical word problems and helps in the understanding of them, more and more, especially in (Jan & Rodrigues, 2012). It is mainly due to difficulties in understanding abstract or ambiguous language that can result in a misinterpretation of problem structures (Cummins et al., 1988). Research has demonstrated that students perform better when given problems in their first language, when the problem statements are restructured to help clarify the relationships between known and unknown quantities, and for students of higher academic achievement levels (Bernardo, 1999). Researchers have tried numerous strategies to overcome these challenges, such as problem-solving or question-and-answer methods, both of which yielded substantial improvements in students' comprehension of word problems (Ubaidillah et al., 2023). Hence revisiting classroom practices and strengthening students' understanding of the concept is recommended to curb the barriers faced by students when solving mathematical word problems (Jan & Rodrigues, 2012).

The current findings also align with Iwuanyanwu (2021), as it discovered that students often do not have basic mathematical process skills to implement their mathematical concepts in real-world cases or complex scientific concepts. Some of these are challenges in mathematical communication, reasoning, and connections across disciplines (Sayın & Orbay, 2024; Iwuanyanwu, 2021). Many solutions have been proposed to solve these problems. It good be implemented with an approaches in mathematical process skills to improve students' mathematical literacy (Aini, 2016), facilitate pre service chemistry students with special mathematics courses could close gap between mathematical skills that are benefits in chemistry field (Iwuanyanwu, 2021). Moreover, It can improve the mathematical process skills of teacher candidates (Sayın & Orbay, 2024). In classroom environments, the process of sociomathematical norm negotiation has proven effectiveness in cultivating specific mathematical process skills like communication, reasoning, and creativity, but it has also been found to restrict the advancement of connection skills (Gülburnu & Gürbüz, 2022).

Lastly, this study found careless errors of students (14.92%). This finding mainly proved that the students frequently made careless mistakes in mathematics problem-solving, especially because they were too hasty, inaccurate, or misread lines with Legarde (2022), Ratnaningsih & Hidayat (2021), and Clements (1982). These errors may be as common as systematic process skill errors (Clements, 1982). Language obstacles, lack of understanding in mathematical principles, and limited translation abilities (Legarde, 2022; Ratnaningsih & Hidayat, 2021) are some of the reasons behind errors. A student's habit of mind also plays a role in error patterns, in which students with fewer habits of mind struggle more with interpreting a concept and communicating it (Ratnaningsih & Hidayat, 2021). Some argue nearly all math errors are systematic (Clements, 1982), others that studying careless errors is critical. One of the solutions for these problems is that educators need to emphasize conceptual understanding of students instead of algorithmic shortcuts (Takker, 2019). Analysis of errors must be done with

caution, but it can yield useful interpretations of learner thinking and inform teaching practices (Takker, 2019).

Proposed Worksheet for Linear Equations with Two Variables

Following is our proposed worksheet to be used in a mathematics class.

Figure 3. Aims of the teaching of linear equations with two variables

Layout and Design

We designed this worksheet with a simple and clean layout, because we wanted to guide and help students with the content while also trying to keep the sections well defined to make it easy to go back and forth between instructions, case studies and activities. This is based on recent studies that are aimed at developing effective student worksheet in teaching linear equations in two variables. A good and well-organized layout is appropriate for increasing Higher Order Thinking Skills (HOTS) (Agustarina et al., 2020), problem based learning (Prabawati et al., 2019), and Realistic Mathematical Education (RME) (Rohani et al., 2021). The pacing guides also include worksheets aimed at increasing students' numeracy, ability to solve problems, and ability to think abstractly (Pangaribuan, 2018). Worksheets that are developed usually have contextual problem, clear layout, and organized parts which can help students comprehend more (Agustarina et al., 2020; Prabawati et al., 2019; Rohani, 2021). These worksheets were demonstrated as valid, practical, and potentially effective to increase students' understanding of linear equations with validation process using expert review and student testing (Agustarina et al., 2020; Prabawati et al., 2019; Rohani, 2021). In addition, scaffolding and abstraction are encouraged in the learning process (Pangaribuan, 2018).

Visual Elements

We also made use of headings and bullet points whenever possible to make this content as readable as possible, breaking it down into smaller pieces for easier understanding. 1The presentation is organized passing through each step of the teaching-learning process. By formatting in this way, we create a visual hierarchy that highlights the important information, allowing students to hone in on the key concepts and instructions. This reaffirms previous research that document design, layout, and formatting are essential for boosting reading ability

and understanding. Headings, bullet points and other visual cues help to create a hierarchical structure that signals to readers how information is organized and guides them from point to point in the content (Gribbons, 1992; Kirsh, 2004). This template-like setup ensures the paragraph is organized resulting in readers reading faster and navigating the text more easily while also allowing metacognition making planning, monitoring, and assessing their learning process easier (Kirsh, 2004). In educational settings, effective assignment instructions can help avoid misinterpretation and enhance submitted work quality (Dyrud, 1995). Moreover, formatting texts as bullet points can lower the cognitive load experienced during reading and note-taking, resulting in lower perceived difficulty in comprehension and more precise selection of ideas (Olive & Barbier, 2017). Precisely organized perform as well as formatting strategies can enrich the learning experience by making it easier to digest complex information and highlight important concepts.

In addition, the use of colors and different shapes should make the reading of the user interface much easier, as it will help the user to distinguish sections, headings, and instructions. This is likely to assist students in swiftly finding relevant information. Using color well can also help the worksheet to seem a bit more appealing, and having students pay more attention on it; making the whole experience far more enjoyable. It seems like this use of colors and shapes confirms the idea that the use of colors and shapes in educational materials helps to improve the educational effort. Wallace et al. (1998), while exploring the use of knowledge maps that use color, shape, and groupings highlighted information that is recalled better than either text or un-enhanced maps. Likewise, colored flash cards in Stitt & Pula (2013) resulted in better usage and retention of vocabulary than black-and-white ones. According to Rim & Yoon (2015), colored test papers enhance particular skills of learning: yellow for math performance, blue for English learning by heart, and orange for calculation & comprehension. Nasution et al. showed that worksheets using color chips had a very positive effect on students' mathematical and logical reasoning skills. This research suggests that attention to the colors and shapes used in educational materials can improve the readability of content, help students find information quickly, and make learning easier. Colored materials can attract students' attention and promote learning performance across subjects by presenting the materials in different sections, headings, and instructions.

In the meantime, the learning objectives are clearly articulated and match the provided activities. They clearly tell the students what you expect them to accomplish by the end of the Worksheet. This is a reminder of the role of precise learning goals within education. Learning objectives are clear, observable statements that tell learners what they should achieve (Chatterjee & Corral, 2017). They underlie the instructional alignment of objectives, assessment, and teaching methods (Chatterjee & Corral, 2017; Orr et al., 2022). Learning objectives are also helpful for students to focus their studies and help organize their available study time (Osueke et al., 2018). Meaningful learning objectives could lead to better student performance and better understanding of course activities (Orr et al., 2022). A recent article described how a methods involving mathematics based in learning analytics and measurement theory can really use methods similar to those found in frameworks to measure alignment between objectives & assessments in a course (Barthakur et al., 2022). A growing understanding of the relevant research and research evidence-based guidelines and recommendations for the effective use of learning objectives can help instructors improve the way they develop and present them in their teaching (Orr et al., 2022). In sum, articulated learning objectives may help sustain student learning and course design (provided they are aligned with course activities and assessments) (Pence, 2023).

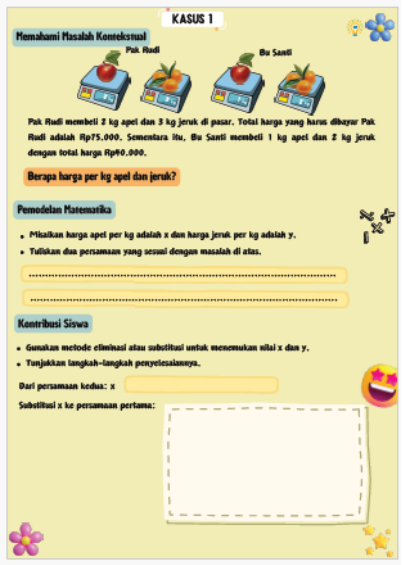

Figure 4. Example of Learning Activities

Font and Size

The font is readable and size is suitable for student reading. The font styles or font sizes used for headings and sub-headings could help show the visual hierarchy. This attribute appears to support previous research with respect to text formatting used in texts with regard to textual legibility, indicating that font size is of significant psychophysical importance with regard to reading speed and comprehension (Buultjens et al 1999). Meanwhile, Sanchez et al. (2001) showed that headings helped college students remember the content and organization of text. Different heading levels varying in fewer formatting dimensions are easier to discriminate visually, and size is the strongest cue to hierarchical position. Combining these insights, we find that relative size differences of 20% across headings levels are more easily discriminable than absolute differences (Williams & Spyridakis, 1992).

Space for Responses

The blanks give enough space for students to record answers and explanations which promote engagement. This suggests that worksheets can help students learn maths if they are developed using data on their learning. Worksheets based on the Realistic Mathematics Education (RME) can develop to enable mathematization of the students, and can be interactive and integrated (Basuki & Wijaya, 2018). Modeling worksheets using problem-based worksheets can prompt students to be active in learning and improve the ability of students to solve rich mathematical tasks (Fitriati & Novita, 2018). Worksheets based on PISA, such as Sharing and Jumping Tasks, have proven effective in helping students grasp mathematical concepts (Sutama et al., 2019). Worksheets must have the right amount of blank space. With these worksheets Cognitive Scaffolding can be provided for immediate knowledge construction and independent future learning (Fitriati & Novita, 2018). Reasearch has shown guidebooks with adequate quality can be valid, practical, and effective mathematics learning (Basuki & Wijaya, 2018; Sutama et al., 2019).

Lastly, this contemporary worksheet integrates getting LEVT to translates real world applications, increasing sensitivity to mathematics and improving problem skills. Using a Realistic Mathematics Education approach to improve critical thinking skills in solving LETV problems. (Wahyuni et al., 2023). Yet, concept definition and real-world examples are still fundamental knowledge students do not grasp well, meaning the means of instruction need a reconsideration (Muthmainnah, 2024). Overall, these studies of LETV indicate that it is

important to situate LETV in various real-life contexts to engage students with comprehend the text concerning them. Educational worksheets are excellently structured, combining theoretical and practical knowledge, which makes this one a good example. Although it does outstanding in clarity and relevance, improvement in visual methods and diverse difficulty levels would heighten its effectiveness. Overall, making a good baseline to teach collaborative and contextual linear equations of two variables.

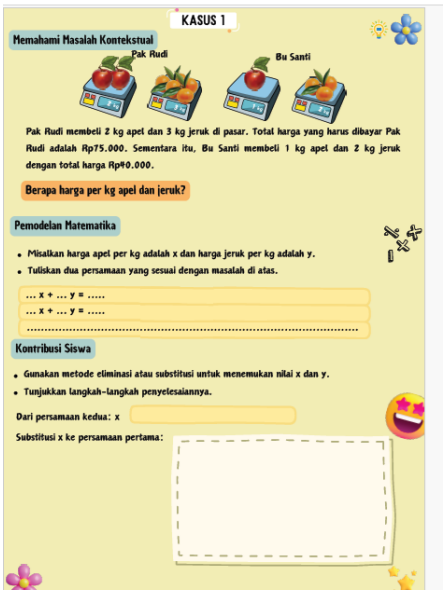

Figure 5. Contextual Teaching and Learning

Figure 5 shows an example of how the contextual teaching and learning is implemented into the teaching of linear equations with two variables where we attempted to use daily things such as apples and oranges so that hopefully the students would be able to connect their thoughts and be able to model such a shopping transaction as linear equations with two variables.

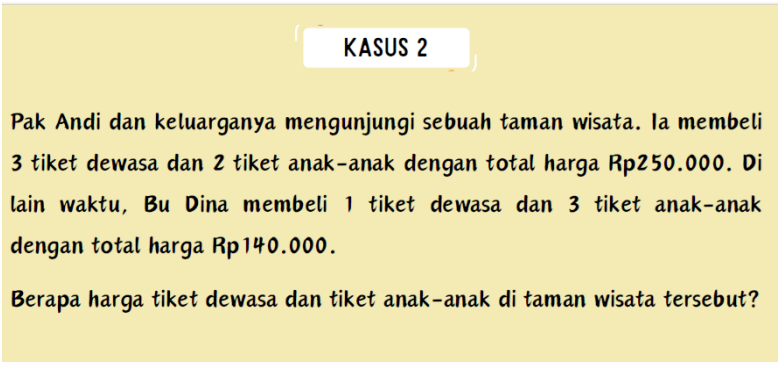

Figure 6. A Second Case for the Students to work on in groups

This student worksheet guides students through collaborative learning as they investigate the concept of linear equations with 2 variables. The ultimate goal is to cultivate student comprehension and real-world problem-solving, benefiting from collaborative learning that inspires dialogue and diversity of thought.

This feature is in line with a study determining the development of student worksheets for teaching linear equations with two variables. As stated by (Agustarina et al., 2020), worksheets purpose is to improve students' problem-solving skills and higher-order thinking skills. Different worksheets have been used to address the problem, such as Higher Order Thinking Skills (HOTS)-based worksheets (Agustarina et al., 2020), Project-Based Learning (PjBL)

worksheets or (Asmi et al., 2021), and Realistic Mathematical Education (RME)-based worksheets (Rohani et al., 2021). Our previous studies reported that these worksheets were effectively improving student achievement and understanding of linear equations (Asmi et al., 2021; Rohani et al., 2021). The validity and practicality of the developed worksheets ultimately will have positive implications for students' problem solving (Agustarina et al., 2020; Putri et al., 2022). But this worksheets cannot be separated from the contextual problem and real life problem based learning to maximize the learning process (Agustarina et al., 2020; Rohani et al., 2021).

CONCLUSION

The findings from this study affirm and extend previous research on the challenges students face when learning linear equations in two variables. Overall, this study corroborates the continuing difficulties both students have with conceptualizing linear equations with two variables. Students still face conceptual misunderstanding in mathematics and so do others regarding identifying the solutions to linear equation systems. Other known challenges are related to representing word problems to a mathematical model, understanding the main concepts, and properly implementing procedures. It was also revealed that many students struggle to express definitions of mathematical concepts and real-world applications in their own words. Both procedural and conceptual difficulties emerge regarding the errors of students which echo the need to look at how students make mistakes to see their understanding. Meanwhile, other issues involve concept clarity, providing opportunities for exploration and maximizing teacher roles in the learning process are important measures to minimize the challenges of STEM Education. Frequent practice involving various types of questions and thorough instructional thinking is also recommended to improve students' understanding of mathematical concepts.

According to our observation of the text data, regarding the absence of real-world application, previously noted in other studies, calls for contextualization in mathematics education to increase student engagement and contextual understanding. Contextualization is teaching mathematics for real problems and scenarios involving the lives and future work of the students. Thus, this method connects the theoretical and the practical sides of the experience to make the learning much more applicable and significant. Contextualization in teachers' concepts often refers to connecting lessons with life experiences of students and utilizing local resources, which can produce more effective and engaging instructions. On one hand, the results of the current study confirm many prior findings, on the other hand, they provide a detailed view on the specific difficulties students face while learning LETV. So the student worksheet is introduced as a potential solution to these problems through focused activities, visuals, and real-world uses. This study contributes to the existing dialogue around effective mathematics instruction by tailoring a worksheet to specifically address the aforementioned difficulties, as well as providing tangible solutions for educators seeking to enhance their students' understanding of linear equations with two variables. Future work may explore how effective the worksheet is in real-world classrooms and its impact on student learning outcomes.

This research was aimed at developing a student worksheet to more readily understand junior high school students LEtV by addressing their LEtV issues in these areas. Based on a qualitative methodology sensibly including the analyses of 6 peerreviewed journal articles and the assessments of three senior mathematics teachers, the study identified common challenges for students in simulating conceptual misunderstanding, procedural error, graphical issues and real-world application.

The results indicated that conceptual misconceptions were the most common difficulty, which is consistent with previous research that highlights the limited understanding that students have of core concepts like slope and intercepts. Additionally, students' success was considerably hindered by procedural errors and issues with graphical interpretation. The lack of real-world application had also highlighted the need for mathematics concepts to be contextualized in terms of ensuring student engagement and relevance.

The refined worksheet for students was well received by subject matter experts who recognized its ability to address the identified needs through exercises, visuals, scenarios, etc. This study aligns the difficulties reported in the literature with the worksheet, contributing to the improvement of teaching and learning in linear equation terms.

Thus, the results of this study emphasize the importance of evidence-based design guidelines developed by experts for the development of educational resources. Finally, the student worksheet acts as a guideline for teachers to facilitate learning LETV, which helps students be more confident and interested in mathematics. Future studies should explore the application of these materials in the classroom.

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