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STRAIGHT-LINEAR EQUATION LEARNING DESIGN THROUGH PROBLEM BASED LEARNING TO STIMULATE JUNIOR HIGH SCHOOL STUDENTS' CRITICAL THINKING SKILLS

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ABSTRACT

A preliminary study in a junior high school revealed that students mathematical critical thinking skills in linear equations remain low, marked by learning barriers dominated by concrete-arithmetic reasoning. This study aims to develop a draft instructional design based on Problem-Based Learning (PBL) specifically formulated to stimulate the four indicators of Facione's critical thinking framework regarding the concept of pure slope. The method used was instructional design research based on the Instructional Development Model (IDM) by Suparman and was limited to the stage of designing the initial draft product. This design was integrated with the "Future Savings" financial context within the worksheets. The results showed that each designed PBL syntax successfully mapped activities that stimulated critical thinking in a systematic manner. The "interpretation" indicator was triggered through problem orientation; "analysis" through the organization of tabular data; a combination of "analysis" and "evaluation" through the investigation of the $\frac{\Delta y}{\Delta x}$ ratio in graphs; "inference" through the formal derivation of the gradient value (m); and "evaluation" through visual challenge questions. The study concludes with an initial draft of instructional design designed to serve as a theoretical basis for bridging students' transition toward formal algebraic reasoning.

Keywords: Instructional Design, Critical Thinking, Problem-Based Learning, Straight Line Equation.

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PRELIMINARY

Critical thinking continues to be widely promoted as one of the most essential twenty-first century competencies for student success (Kast & Paran, 2026). This cognitive skill is highly valued because it enables each individual to observe, understand, and improve the various situations around him or her (Crilly, 2026). Therefore, this ability to think is universally recognized as one of the core goals that must be achieved in the educational process (Terblanche et al., 2025). In addition to serving as an instrument for analyzing and evaluating information, this skill is also a fundamental competency for lifelong learning and readiness for the world of work (Yu et al., 2025). This process involving analysis, synthesis, and evaluation is crucial not only for students' academic achievement, but also to support their personal and professional development (Marini et al., 2026). Ultimately, critical thinking is the active use of cognitive skills to systematically dissect various issues in order to reach conclusions supported by sound reasoning and evidence (Yin, 2026).

Straight Line Equations form a critical gateway to algebraic functions, as they explicitly map input-output variable dependencies and constant rates of change (gradient) in practical applications (Wardina & Sudihartinih, 2019). Learning this material actually provides a crucial opportunity for educators to connect relatively abstract mathematical ideas with basic examples from students' concrete experiences (D. Wijayanti, 2018). Therefore, PGL material is considered very ideal to be used as teaching material to train as well as improve students' critical thinking skills in a targeted manner (Naufal & Kurniasari, 2022). Through the exploration of contextual problems close to their environment, students are actively encouraged to construct as well as analyze the mathematical ideas behind linear functions to make them more meaningful (Kaunang, 2018). Cognitively, problem solving in this material really forces students to think critically because they are required to be able to present concepts into various forms of visual representation and develop the requirements of their problem-solving algorithms (Arumsari & Adirakasiwi, 2023).

Empirically, students' mathematical critical thinking skills in straight-line equation material are still relatively low which may be associated with students' limited exposure to non-routine problem-solving tasks (Fitri et al., 2023). The high rate of procedural and conceptual errors is greatly influenced by the habits of students who are only fixated on solving such as example problems without understanding the basic concepts in depth (Novitasari & Fitriani, 2021). As a result, many students are proven to be less thorough in constructing information from questions and experience obstacles when determining the right formula(Yuliyani et al., 2023). Furthermore, the limited understanding of coordinate systems and the relationships between variables makes it very difficult for students when asked to formulate a mathematical model of a contextual problem (Maulani et al., 2025). This cognitive problem manifests in the classroom, where most students struggle to calculate gradients from given linear equations and accurately plot their corresponding graphs (Wijayanti et al., 2020).

The various cognitive problems experienced by these students are basically rooted in the learning climate at school which generally encourages students to simply give the right answers rather than coming up with new critical ideas (F. Z. Hadi et al., 2020). This condition massively occurs because many educators still maintain teacher-centered learning methods (*teacher-centered*), so that the classroom atmosphere seems rigid and completely dominated by the teacher (Pratiwi & Setyaningtyas, 2020). The use of this conventional model makes learning activities only limited to the process of transferring knowledge from teacher to student, which ultimately triggers the tendency of students to be passive (Rauf et al., 2022). Facing these problems, improvements in the learning process that fundamentally require changes in teaching methods are needed to improve learning outcomes and students' critical thinking (Saputri, 2020). Therefore, in order for critical thinking skills to develop, the role of educators must be transformed into facilitators who fully support the learning process to be more active, creative, and fun (Riyanto et al., 2024).

Answering the need for the transformation of the role of educators, the model *Problem-Based Learning* (PBL) is present as an alternative pedagogical solution that has proven to be significantly more effective in improving motivation and learning skills than conventional lecture methods (Alrefaie et al., 2026). The application of this active approach is directly able to improve students' academic performance because it has great potential in stimulating their interest and deep understanding of the subject being studied (Hussain et al., 2019). Comprehensively, the PBL methodology does not only aim to transfer theoretical knowledge, but is very superior in training competencies in independent learning, social communication, and problem-solving (Trullàs et al., 2022). Through active involvement in authentic real-world problem scenarios, students are fundamentally encouraged to continue to hone their critical thinking skills in order to respond to the complexity of future challenges (Alsmadi et al., 2024). At its peak, the implementation of the PBL model is believed to be the most appropriate solution because it has been proven to be effective in triggering active engagement, collaborative interaction, and improving student learning outcomes in a holistic manner (Cahyanti et al., 2024).

Although various previous literature has proven the effectiveness of *the Problem-Based Learning* (PBL) model in general, studies that specifically formulate PBL learning designs to stimulate critical thinking skills on the characteristics of Straight Line Equations (PGL) material at the junior high school (SMP) level are still very limited. Most previous research has tended to focus only on the analysis of students' learning difficulties or the application of PBL to the basic cognitive domain, without associating it with instructional designs that specifically target critical thinking indicators on linear functions. Therefore, the *novelty* of this study lies in the effort to integrate the contextual problems of PGL with the structured steps of the PBL model to create a learning environment that directly forces students to analyze, evaluate, and infer information. Based on this rationalization and urgency, this study aims to formulate a draft Problem Based Learning design tailored to address learning barriers and enhance junior high school students' mathematical critical thinking skills in Straight Line Equations.

METHODS

The instructional design prosedure in this study was adapted from the Instructional Development Model (MPI) proposed by Suparman (2014). The procedure was limited to the initiak development stages, consisting of the following steps:

1. Need and instructional analysis: Identifying empirical learning obstacles in Straight Line Equations, analyzing Grade VIII student characteristics, and mapping core competencies needed to foster critical thinking skills.
2. Formulation of Learning Objectives: ranslatig the results of te instructional analysis into specific learnin indicators focused on mathematical critical thinking
3. Instructional Strategy and Draft Design: Designing the Problem-Based Learning activity flow, student worksheets (LKS), and observation/interview guidelines as an initial instructional draft.

RESULT AND DISCUSSION

Curriculum and Material Analysis

Straight Line Equations (PGL) material is one of the crucial concepts in mathematics at the junior high school level that bridges the relationship between algebraic concepts and visual representations of geometry. Based on the Independent Curriculum, this material is included in the Algebra Element. In phase D (grade VIII), the Learning Outcomes (CP) that must be met by students as in Table 1.

Table 1. Straight Line Equation Learning Outcomes

Elements	Learning Outcomes
Algebra	Students can distinguish several nonlinear functions from linear functions graphically. Students can present, analyze, and solve problems using linear equations

Learning Outcomes (CP) that instruct students to distinguish, present, and analyze linear functions are basically formulated through the assessment of essential competencies along with indicators that must be achieved in the classroom (Kholisah et al., 2024). The selection of Straight Line Equations (PGL) material is very much in line with the curriculum target, considering that mathematics is a chain discipline where the mastery of an initial knowledge will always be a foothold to form a new understanding of concepts (Nababan et al., 2024). Characteristically, the fulfillment of CP's demands in distinguishing linear function graphs requires a continuous transition process, namely from visual representation to symbolic representation (Hadi & Rahma, 2025). In the end, a complete alignment between the material and the CP guidelines is crucial to be designed in such a way that students no longer experience confusion in interpreting the presentation of mathematical information when faced with a problem (Aprilianti et al., 2022).

Based on the Learning Outcome target in Table 1, students are required not only to be procedurally skilled, but also to be able to reason about the relationship between linear variables. To measure and stimulate these competencies, a clear benchmark of critical thinking skills is needed. In this study, the critical thinking indicators adopted refer to the theory Facione (2013) described in Table 2.

Table 2. Indicators of Critical Thinking Ability

No.	Indicator	Explanation
1.	*Interpretation*	Ability to understand problems by identifying known information and what is asked appropriately.
2.	*Analysis*	The ability to examine the relationship between information in a problem and relate it to mathematical concepts to form a model or solution accordingly.
3.	*Evaluation*	The ability to assess the truth of a statement or solution by considering the reasons and calculations used.
4.	*Inference*	The ability to draw the right conclusions based on the information and settlement process that has been carried out.

Analysis of Student Barriers and Needs

In fact, the target learning outcomes are often difficult for students in the field to meet. Based on the needs analysis that has been carried out by the researcher on 31 grade VIII students of Private Junior High School in Bekasi, it was found that there are significant *learning obstacles* in the PGL material. The results of the initial test showed that most of the new students were able to meet the *Interpretation* indicator, but failed in the *Analysis*, *Evaluation,* and *Inference* stages. One of the student answer sheets that represents the tendency of obstacles in *Analysis* can be seen in Figure 1.

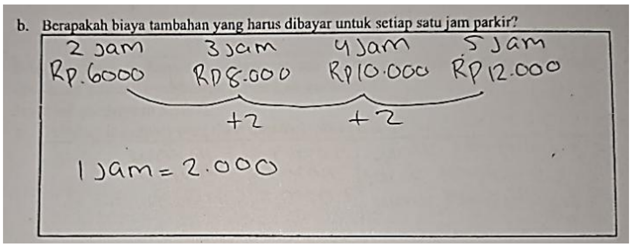

Figure 1. Results of Student Work in Determining Parking Surcharge

Based on Figure 1, it can be seen that students solve the cost change problem using transitional arithmetic reasoning in the form of a repeating number pattern (+2). Although students are able to identify constant changes in values ($1jam = 2.000m$), students' critical thinking processes have not yet reached the formal stage of algebra. Students have not been able to abstract the constant pattern as a representation of the slope of the line (gradient). This learning obstacle emphasizes the need for a Problem-Based Learning (PBL)-based learning design to stimulate students' critical thinking skills from the concrete-arithmetic level to the abstract-algebra.

Results of the Development of PBL-based PGL Learning Design

After conducting a needs analysis and determining critical thinking parameters, the next stage is to draft a Straight Line Equation (PGL) learning design. This design was developed by integrating the five instructional stages of the Problem-Based Learning (PBL) model and the Facione critical thinking indicator. This integration manifests itself in the form of a series of instructional activities, *learning trajectories*, and contextual problem orientations that are designed in a structured manner. The logical mapping between the PBL syntax, the focus of PGL material activities, and the stimulation of the targeted critical thinking indicators are presented comprehensively in Table 3.

Table 3. PBL Syntax Integration Matrix and Critical Thinking Indicators in PGL Materials

PBL Syntax	PGL Material Instructional Activities	Stimulated Critical Thinking Indicators	Focus on Student Skills
Appropriate 1: Student orientation on the problem	Students are presented with contextual problems regarding the fulfillment of savings targets (e.g., analyzing whether daily savings plus initial savings are	Interpretation	Students are able to identify, sort, and write down known information (initial savings, daily savings nominal) as well as what is asked from real PGL problems.

PBL Syntax	PGL Material Instructional Activities	Stimulated Critical Thinking Indicators	Focus on Student Skills
	enough to buy dream items within a certain deadline).		
Appropriate 2: Organizing students to learn	Students discuss in small groups to calculate the day-to-day progression of savings and map the relationship of that data into a sequential pair table.	Analysis	Students are able to identify the logical relationships between variables, determining which are independent variables (time/day) and bound variables (total amount of savings) to model the structure of the problem.
Appropriate 3: Guiding individual and group investigations	Students are guided to draw a graph of the development of savings in the Cartesian field, find the concept of line slope (gradient m) through the ratio of daily money addition $\left(\frac{\Delta y}{\Delta x}\right)$ and test the accuracy of the graph.	Analysis and Evaluation	Students are able to analyze the relationship between the slope of straight-line graph and the daily savings rate (gradient concept), as well as evaluate plotted graph points (object) against tabulated data (criteria) to determine the mathematical accuracy of the linear model (decision).
Appropriate 4: Developing and presenting the work	Students discuss in groups to formulate the value of the line slope (gradient) from the existing data, compile a report on the LKPD, and present it in front of the class.	Inference	Students are able to draw logical inference regarding savings outcomes by interprteing the calculated gradient value (m) as a constant rate of change to predict future savings targets.

PBL Syntax	PGL Material Instructional Activities	Stimulated Critical Thinking Indicators	Focus on Student Skills
Appropriate 5: Analyze and evaluate the problem-solving process	Students and teachers reflect on the gradient discovery strategy. Students are given other savings graphs (e.g., sloping graphs) to analyze the gradient value.	Evaluation	Students are able to evaluate the validity of gradient calculations and graph depictions by detecting procedural errors and verifying them against explicit mathematical rules.

Based on the integration matrix in Table 3, the draft learning design of the Straight Line Equation (PGL) is developed specifically at each instructional stage. An in-depth description of the design of activities based on savings problems and the theoretical analysis of their stimulation of the four indicators of critical thinking of students is presented in the following section.

Syntax 1: Student Orientation to the Problem (Stimulation: *Interpretation*)

The first stage in syntax implementation *Problem-Based Learning* (PBL) is problem-orientation, which focuses on presenting problems from students' daily lives in order to create situations that are able to stimulate their critical reasoning (Faqiroh, 2020). Through an initial introduction to these questions, students are directed into a systematic learning network that will train them to be more active in expressing their opinions (Safitri et al., 2023). In this student-centered orientation phase, educators position themselves purely as facilitators in charge of motivating students to carry out problem-finding activities independently (Adiilah & Haryanti, 2023). Direct involvement from this initial step fundamentally serves to transform students to become not just passive listeners, but active contributors in their own learning journeys (Alsmadi et al., 2024).

In this early stage, the learning design is designed by presenting contextual problems regarding the savings target for buying a bicycle. This problem was deliberately chosen because it is close to the daily lives of junior high school students and has a constant value-adding structure. The narrative of the problems presented in the LKPD is as follows:

> **Problem 1:** *A student wants to buy a bicycle for IDR 1,500,000. Currently, he already has an initial savings of IDR 300,000 in a piggy bank. To add to this, he is committed to setting aside his pocket money consistently of Rp15,000 every day. If he wants to buy the bike within 60 days, analyze whether his savings will be enough?*

The activity in Issue 1 is specifically designed to stimulate the *Interpretation*. Through the instruction of guiding questions in the LKPD, students are required to identify, sort, and write down what information is known (such as initial savings as a fixed value and daily deposit as an increasing value) as well as what is asked about the problem. This process of writing information trains students to interpret real-world situations into an initial mathematical understanding before getting into the calculation stage. Cognitively, the activation of early knowledge in the first phase is very crucial as an instructional approach so that students are able to interact with learning materials in a more meaningful way (Muhali & Asy'ari, 2026). In order to optimize the introduction stage to the problem, educators can build students' personal attachment by presenting examples of phenomena from their immediate environment before stepping into the group organizing stage (Wijnia et al., 2019).

Syntax 2: Organizing Students to Learn (Stimulation: *Analysis*)

Continuing the success of problem orientation in the previous stage, this phase of student organization is characterized by collaborative activities where students begin to identify new concepts, formulate initial hypotheses, and structure learning plans independently (Alrefaie et al., 2026). Group collaboration in this second phase is crucial because it requires each member to actively communicate with each other, interpret input from peers, and develop a joint strategy to solve these contextual problems (Muhali & Asy'ari, 2026). The main focus of this group interaction is actually to define key concepts through brainstorming (*brainstorming*) so as to make it easier to divide information search tasks among members (Trullàs et al., 2022). Through the dynamics of this directed discussion, learners are trained to openly articulate what they already know while identifying what crucial knowledge gaps they need to learn more (Savery, 2019).

Once students are able to interpret the basic information on the initial problem, the next step is to organize students to work in small groups. At this stage, the LKPD design is directed to stimulate students' Analysis indicators. Students are asked to transform the story data from Syntax 1 into a representation of a sequential pair table. In the LKPD, this activity is presented in the form of instructions to fill in the table as follows:

Activity 2: *Based on Problem 1, discuss with your group to calculate the total money accumulated from day to day, and then complete the savings progress table below!*

Day (x time)	Calculation Process	Total Savings y (Rupiah)	Koordinat (x, y)
0	300.000	300.000	$(0{,}300.000)$
1	$300.000 + 15.000$	315.000	…………………….
2	$300.000 + 15.000 + 15.000$	………….	…………………….
3	………………………………………..	………….	…………………….
x	………………………………………..	………….	…………………….

Guiding Questions:

1. What variables affect the change in total savings?
2. What variable does the value of depend on the number of days of saving?

This table filling and answering question activity is specifically designed to stimulate students' *Analysis* indicators. Through this process, students' critical thinking skills are triggered to:

- Identifying Logical Relationships: Students analyze how each increment of days (x) has a continuous impact on the total nominal addition of money (y).
- Sorting Out the Components of the Problem Structure: Students are trained to separate and determine which acts as an independent variable (number of days/time) and which acts as a bound variable (total amount of savings).

By organizing the data into tabular form, students no longer see the savings problem as a random number, but rather as a structured relationship pattern between two variables. The analysis of the patterns in this table becomes a crucial bridge before students plot the data into the form of the coordinates of the Cartesian graph in the next stage. By setting problem boundaries together, students are directly encouraged to bring together their understanding of the topic and formulate specific learning objectives that the group should achieve (Hussain et al., 2019). This structured organization of tasks from the beginning effectively equips students with essential skills in managing the scope of problems and navigating the dynamics of teamwork before they step into the stage of further investigation (Alsmadi et al., 2024).

Syntax 3: Guiding Individual and Group Investigations (Stimulation: *Analysis* and *Evaluation*)

Entering the third stage, namely individual and group investigation, students are encouraged to be directly involved in the process of observation and discussion intensively in order to practice their independence without always having to rely on direct instruction from the teacher (Safitri et al., 2023). The main focus of this investigation phase is to allow students to actively explore the problem in order to identify learning issues and find the most logical alternative solutions (Nugraha et al., 2023). This active involvement provides hands-on learning experiences, such as collaborating in groups and gathering relevant information, which makes the process of seeking solutions much more focused and meaningful (Sheptia et al., 2026). During the process of information mining, each individual is required to exert their reasoning intelligence and courage in formulating temporary answers to the real-world problems being studied (Qomariyah, 2019). Through facilitative guidance from educators, this stage of problem tracing will effectively hone critical competencies while multiplying students' intrinsic motivation as they feel the immediate benefits of the material being learned (Cahyanti et al., 2024).

Once the data is organized in the form of a table, students are guided to conduct in-depth mathematical investigations. At this stage, the design of LKPD activities is directed to stimulate the combination of *students' Analysis* and *Evaluation indicators* through visual representation of graphs and calculation of the rate of change in grades. In the LKPD, these investigation activities are presented as follows:

Activity 3:

1. Move the coordinate points you found in Activity Table 2 into the Cartesian plane below, then connect them to form a line! (x, y)*(Provide a blank Cartesian Plane Grid/Grid with an x-axis that says "Day" and a y-axis that says "Total Savings")*
2. Pay attention to the slant of the lines formed from your chart. Let's investigate the rate at which total savings change from day to day by completing the following comparison:
   - Total savings change from day 1 to day 2 $\Delta y = \cdots$
   - Change in length from day 1 to day 2 $\Delta x = \cdots$
   - Value change ratio $= \frac{\Delta y}{\Delta x} = \frac{\cdots}{\cdots} = \cdots$
   - Try to do the same for day 2 to day 3

3. Guiding Question: Is the ratio value () you get from each change in the day always the same (constant)? Connect this ratio value to the inclination direction of your straight line graph!$\frac{\Delta y}{\Delta x}$

This guided inquiry activity is designed to stimulate students' critical thinking components in the following aspects:

- Visual and Numerical Analysis: Students analyze the relationship between the direction of the skew of a straight line graph (whether the line is steadily ascending) and the value of the rate at which their daily savings are replenished. Students are directed to see that the speed of money change every day is represented by the slope of the chart.
- Evaluation of Procedural Accuracy: The evaluation indicator is triggered when students *cross-check* whether the position of the coordinate points they draw on the Cartesian plane is completely accurate to form a linear straight line. If there are deviating points, students are required to evaluate the calculation errors in the previous step.

Through Research Pure to ratio ($\frac{\Delta y}{\Delta x}$) in this way, students construct an understanding that gradients are not just memorized formulas, but real representations of the constant rate of change in values on a graph. Cognitively, the continuous involvement of students in scientific investigation activities has been proven to be able to bring substantive changes to the way they interpret, analyze, and infer mathematical information (Muhali & Asy'ari, 2026). At its peak, the completeness of the data and the complete understanding gained by students through this directed independent study will be a very vital cognitive foundation before they step into the stage of designing and presenting the work (Alrefaie et al., 2026).

Syntax 4: Developing and Presenting Works (Stimulation: *Inference*)

Entering the fourth stage, which is developing and presenting the work, the main focus of learning shifts to the preparation of the final product or report, where the public presentation nature of this stage directly stimulates students to display their best thoughts on the solutions offered (Savery, 2019). The demand to formulate and present this real work plays a crucial role in bridging the gap between the theoretical understanding that has been learned and its practical application in the context of the real world (Alsmadi et al., 2024). Through the collaborative process of compiling the broadcast materials, students gained a very diverse learning experience because they were challenged to formulate conclusions, discuss findings, and comprehensively assemble reports (Nugraha et al., 2023). Empirically, the obligation to present and defend the results of the group work in front of the class has been proven to significantly increase the courage to perform and the confidence of students (Marpaung, 2021).

After conducting an investigation of the graph and the ratio of the change in values in the previous stage, students entered the formalization phase of the group's work results. At this stage, instructional activities are designed to stimulate *Inference* indicators. Students are required to draw logical mathematical conclusions about the essential meaning of the gradient based on all the data they have processed. In the LKPD, this conclusion drawing activity is directed through the following instructions:

Activity 4:

1. Based on the results of the comparison you have calculated in Activity 3, discuss with your group to fill in the blanks below:$\frac{\Delta y}{\Delta x}$
   - The constant ratio value we obtain is …
   - This number turns out to be the same as the nominal value (choose: …*initial savings / daily deposit*) in the story of Problem 1.
2. In mathematics, the value of the slope or the constant rate of change on a straight line graph is referred to as a Gradient (symbolized by m). Write your group's conclusions about how to determine the gradient value (m) of a graph:
$$m = \frac{Perubahan\ komponen\ ...}{Perubahan\ komponen\ ...} = \frac{\Delta\ ...}{\Delta\ ...}$$
3. Prepare a report of the results of your group discussion on plano/cardboard (or LKPD sheet) and appoint a group representative to present the findings of this gradient concept in front of the class!

This activity of drawing conclusions and presenting the results of this work is specifically designed to trigger the student's *Inference indicators* through the following processes:

- Drawing Deductive Conclusions: Students take a leap of critical thinking by concluding in general that the value of the graph slope (gradient) is obtained from the ratio of the difference of the component-y (total money) to the difference of the component- x (time/day).
- Relating Abstract Concepts to Real Context: Students are able to logically infer that the gradient function (m) in real situations acts as a constant speed of change (in this case, the nominal daily deposit of Rp15,000).

The presentation and inter-group Q&A session on this syntax further strengthened students' inferences. They were required to defend their mathematical arguments in front of the class, as well as convince the audience why the gradient value on the savings graph was positive (the slanted line to the upper right) associated with the condition of savings that were increasing day by day. Active involvement in communicating ideas orally is inherently very effective in training students to be more courageous and skilled in speaking and expressing their academic opinions (Safitri et al., 2023). In the end, the dynamics of the lively question and answer session during the presentation of this work were proven to be able to trigger students' critical thinking sharpness, which at the same time led them to full readiness to enter the final phase of learning, namely the analysis and evaluation of the problem-solving process (Hussain et al., 2019).

Syntax 5: Analyzing and Evaluating the Problem-Solving Process (Stimulation: *Evaluation*)

As the peak stage of the entire instructional series, the fifth phase, which is analyzing and evaluating the problem-solving process, aims to consolidate knowledge while facilitating comprehensive reflection so that students truly understand the extent of the level of performance and learning outcomes they have achieved (Savery, 2019). The reflective evaluation process in this phase does not simply demand memory of the content of the material, but forces students to critically re-examine their reasoning strategies, identify misconceptions, and plan future improvement steps (Muhali & Asy'ari, 2026). The encouragement to constantly review the stages of problem solving directly enables students to refine conceptual understanding while honing their practical skills in a repetitive and targeted manner (Alsmadi et al., 2024). At this point, the cognitive demands that are given fundamentally require each individual to exert his or her critical reasoning to ensure that the learning objectives have been met before they draw a mutually validated final conclusion(Hussain et al., 2019).

The final stage of this PBL model is geared towards consolidating students' understanding and expanding their cognitive structure. In this closing function, the design of learning activities is focused on stimulating *Evaluation* indicators. Students are invited to review the strengths or weaknesses of their solution strategies, as well as to be tested using new mathematical situations that are visually different. The activities in the LKPD or final evaluation sheet are designed as follows:

Activity 5 (Challenge Questions):

Pay attention to the chart of the progress of savings belonging to two students, namely Andi (Red Line) and Budi (Blue Line) in the Cartesian field below! *(Present a picture* *of two straight lines in one plane of Cartesian: The Andi Line looks very steep/steep, while the Budi Line looks more sloping)*

1. Without calculating the numbers in detail, do a visual analysis: who among Andi and Budi saves with a larger daily deposit? Give your reasons by associating it with the concept of graph tilt (gradient)!
2. Calculate the gradient value (m) of each of these lines using the comparison ratio formula $\frac{\Delta y}{\Delta x}$ that you have found in Syntax 4 to prove your visual analysis!

This new reflection and challenge activity in Syntax 5 is designed to trigger students' *Evaluation* indicators through two crucial aspects:

- Evaluating Qualitative and Quantitative Relevance: Students are trained to independently assess and test the correctness of their arguments. They must critically evaluate that the steeper a straight line graph is, the greater the gradient value () will be, which means that the rate of money addition will also be faster.m
- Detecting Procedural Errors: When calculating the gradient values of the two new graphs, students are required to be careful in determining the difference between the coordinate points so as not to be inverted between the component-Δy and component-Δx. This process of rechecking the results of this count trains their critical thinking evaluation acuity.

Through this concluding syntax, the teacher and the students conclude the whole essence of learning that a gradient is a measure of the slope of a line that reflects the constant rate of change in real-life problems. Empirically, the obligation to conduct a review at the end of this session has been proven to significantly increase the activeness and accuracy of students in summarizing and concluding the essence of a learning material (Marpaung, 2021). With the completion of the application of this scientific method evaluation phase, the entire problem-based learning syntax will ultimately lead to the formation of students who not only master substantial theories, but also have permanent skill toughness in solving various complexities of problems in real life (Nugraha et al., 2023)

CONCLUSION

Based on the results and discussion, this study has succeeded in answering the research objectives by producing a draft of the Straight Line Equation (PGL) learning design for grade VIII junior high school based *on Problem-Based Learning* (PBL) which is validly designed to stimulate students' critical thinking skills. The integration of the five PBL syntaxes with Facione's four critical thinking indicators is focused purely on constructing the concept of gradient through the financial context of "Future Savings". Through this design, *the interpretation* indicator was successfully stimulated in the orientation phase when students identified initial savings information and daily deposits. Furthermore, *the analysis* indicator is triggered in the organizing phase through the transformation of story data into tables to sort out free and bound variables. Meanwhile, the combination of *analysis* and *evaluation indicators* was obtained in the investigation guidance phase through the activity of plotting a graph and testing its speed based on the ratio of value changes $\frac{\Delta y}{\Delta x}$.

In the final phase, *the inference* indicator was stimulated through group discussions and presentation of the work to draw formal conclusions about the gradient value (m), which was then strengthened by *the evaluation* indicator in the closing phase through the completion of the visual comparison challenge of the two graphs. Thus, this initial instructional design draft offers a theoretical pedagogical solution designed to address learning obstacles and bridge students' reasoning from the concrete-arithmetic level to formal algebraic reasoning, serving as a prototype prepared for future expert validation. As a suggestion, given that this research is limited to the stage of producing a valid draft based on student needs analysis and analysis, subsequent researchers or education practitioners are expected to be able to implement this design in real classrooms to test its empirical effectiveness quantitatively.

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