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Students' Mathematical Reasoning in Learning Arithmetic Sequences through Contextual Teaching and Learning

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ABSTRACT
This study aims to describe the mathematical reasoning abilities of tenth-grade students at SMA Pusri Palembang in learning arithmetic sequences after the implementation of the Contextual Teaching and Learning (CTL) model. The study was motivated by students' difficulties in presenting mathematical statements, making conjectures, performing manipulations, and drawing logical conclusions. The CTL model was selected because it connects mathematical concepts with real-life contexts and encourages active student participation in the learning process. This research employed a qualitative descriptive method, with data collected through classroom observations, posttests, and interviews. Data analysis was conducted through data reduction, data display, and conclusion drawing. The results indicate that students' mathematical reasoning abilities varied across different levels. Students in the high category were able to fulfill most indicators of mathematical reasoning, those in the moderate category met some indicators, while students in the low category experienced difficulties in understanding arithmetic sequence concepts. The implementation of the CTL model through context-based student worksheets (LKPD) was shown to enhance student engagement and support systematic reasoning in problem-solving processes, despite challenges related to limited time and unequal student participation.

ABSTRAK
Penelitian ini bertujuan untuk mendeskripsikan kemampuan penalaran matematis peserta didik kelas X SMA Pusri Palembang pada materi barisan aritmetika setelah penerapan model *Contextual Teaching and Learning* (CTL). Penelitian ini dilatarbelakangi oleh rendahnya kemampuan peserta didik dalam menyajikan pernyataan matematis, membuat dugaan, melakukan manipulasi, serta menarik kesimpulan secara logis. Model CTL dipilih karena mengaitkan materi pembelajaran dengan konteks kehidupan nyata dan mendorong keaktifan peserta didik dalam proses belajar. Penelitian ini menggunakan metode deskriptif kualitatif dengan teknik pengumpulan data berupa observasi, *posttest*, dan wawancara. Analisis data dilakukan melalui tahap reduksi data, penyajian data, dan penarikan kesimpulan. Hasil penelitian menunjukkan bahwa kemampuan penalaran matematis peserta didik berada pada kategori yang beragam. Peserta didik dengan kategori tinggi mampu memenuhi sebagian besar indikator penalaran matematis, peserta didik kategori sedang memenuhi sebagian indikator, sedangkan peserta didik kategori rendah masih mengalami kesulitan dalam memahami konsep barisan aritmetika. Penerapan model CTL melalui LKPD berbasis konteks kehidupan sehari-hari terbukti meningkatkan keaktifan

peserta didik dan membantu mereka menalar langkah penyelesaian masalah secara sistematis, meskipun masih terdapat kendala berupa keterbatasan waktu dan perbedaan keaktifan.

INTRODUCTION

Mathematics instruction, according to the NCTM, involves five core abilities: problem-solving, reasoning, communication, connection, and representation (Ariati & Juandi, 2022). Students are expected to understand relationships among mathematical facts and concepts, promoting logical thinking. Mathematical reasoning connects data to solve problems, develop ideas, and produce structured solutions (Inayah & Madawistama, 2024). This ability draws conclusions or forms valid statements from proven truths Oktaviana & Aini (2021) also serves as a foundation for understanding and problem-solving in mathematics (Ramdan & Roesdiana, 2022).

Solving arithmetic sequence problems requires strong mathematical reasoning skills and a deep conceptual understanding to obtain logical and justifiable solutions (Wau et al., 2022). Rambe & Afri (2020) said that one important topic frequently taught at various educational levels is the arithmetic sequence. It is defined as a sequence of numbers with a constant difference between consecutive terms. According to the Ministry of Education and Culture Regulation (2018), senior high school students are expected to master the core competency of analyzing arithmetic sequences and solving contextual problems related to them (Hariyomurti et al., 2020).

Despite the urgency of developing mathematical reasoning, students' performance remains low. Indonesia's 2022 PISA mathematics score was 366, down 13 points from 2018, highlighting gaps in reasoning, problem-solving, and argumentation (Ariati & Juandi, 2022). Study from Rismen et al. (2020) shows students' reasoning is often poor, with few able to make conjectures, manipulate mathematics, or draw conclusions correctly (Nababan, 2020). Many struggles with representing statements, recognizing patterns, or forming generalizations by Wau et al. (2022); Fitria et al. (2023) and frequently fail to interpret problems, write correct formulas, or predict solutions by Hariyomurti et al. (2020); Hartati (2021) with logical reasoning errors up to 6.9% (Handayani et al., 2020).

Students' ability to learn mathematics is strongly shaped by the effectiveness of the instructional process (Mayangkara et al., 2025). The findings show that several mathematical reasoning indicators remain unfulfilled due to low student motivation and teacher-centered learning. Teachers focus on formulas rather than understanding, limiting active participation and causing difficulties with non-routine or contextual problems. This supports Syachputra (2023) who states that teacher-dominated instruction weakens students' reasoning skills. To address this, a learning model that emphasizes active student participation is needed one that helps students not only memorize formulas but also apply them meaningfully. One effective model is Contextual Teaching and Learning (CTL), which, according to Mazrur (2020), connects lesson content with students' daily lives, allowing them to construct understanding actively and flexibly. CTL includes seven key components modeling, questioning, learning in community, inquiry, constructing knowledge, reflection, and authentic assessment—which distinguish it from conventional approaches (Septianawati & Abdilah, 2021). With its constructivist foundation, CTL shifts the learning focus from teacher to student, encouraging

active student participation and meaningful concept engagement. Moreover, math problems should relate to students' real life to deepen their understanding (Nisa et al., 2024).

Several studies have demonstrated the effectiveness of the Contextual Teaching and Learning (CTL) model in improving students' mathematical reasoning abilities. Research conducted at SMP Pangkalan Susu reported higher reasoning scores among students taught using CTL compared to those in conventional classrooms (Astriani & Al Dhana, 2024a). Similar findings were reported by Mahmuzah et al. (2024) and Relawati (2024), who found that CTL significantly enhanced students' reasoning performance. Other studies also revealed that students taught using CTL-based instructional materials, such as pop-up books, achieved better reasoning outcomes than those taught through traditional methods (Widya et al., 2020).

However, although CTL has been applied in arithmetic sequence instruction, existing studies remain limited in scope. Khotimah et al. (2023) implemented CTL in teaching arithmetic sequences, but the study primarily focused on improving students' learning outcomes measured quantitatively through test scores, rather than examining specific indicators of mathematical reasoning. Consequently, there is a lack of qualitative studies that describe students' mathematical reasoning abilities in arithmetic sequence topics based on mathematical reasoning indicators. This gap underlies the present study, which aims to describe the mathematical reasoning abilities of tenth-grade students on arithmetic sequence material through the implementation of the Contextual Teaching and Learning (CTL) model.

METHOD

This study employs a descriptive qualitative method to portray phenomena in detail without examining relationships among variables (Ramdhan, 2021; Wijaya, 2020). This descriptive-qualitative study aimed to describe the mathematical reasoning ability of 10th grade students on arithmetic sequence material through the Contextual Teaching and Learning (CTL) model at SMA Pusri Palembang. The sample consisted of one 10th grade class with 33 students, selected based on teacher recommendations due to their heterogeneous academic abilities and the fact that they had not yet studied arithmetic sequences. Interview subjects were selected by categorizing students into high, moderate, and low mathematical reasoning ability groups based on teacher recommendations, initial test results, and classroom observation data. Two students from each category were selected, resulting in six interview participants.

Data were collected through written tests, classroom observations, and interviews using validated instruments, including observation sheets, test items, and interview guidelines (Gustiadi et al., 2021). The written test was used to identify students' mathematical reasoning abilities based on predetermined indicators, while observations were conducted to examine students' learning activities during CTL-based instruction. Interviews were carried out to explore students' reasoning processes in greater depth and to support the interpretation of test results.

The study was conducted in three stages: preparation, implementation, and conclusion. The preparation stage involved the development and validation of research instruments. The implementation stage consisted of two learning sessions using the Contextual Teaching and Learning (CTL) model on arithmetic sequence material, followed by a posttest and interviews. The conclusion stage involved data analysis and interpretation. Data analysis followed qualitative analysis procedures, including data reduction, data display, and conclusion drawing or verification (Miles & Huberman, 1994). Data reduction was conducted by selecting and categorizing students' responses according to mathematical reasoning indicators and ability levels (high, moderate, and low). Data display was presented in the form of tables and narrative descriptions to illustrate students' reasoning profiles. Conclusion drawing was carried out by

interpreting patterns and verifying findings through triangulation of test, observation, and interview data to describe students' mathematical reasoning abilities after CTL-based learning.

The indicators of mathematical reasoning used in this study refer to Gustiadi et al. (2021) which are based on Regulation of the Director General of Primary and Secondary Education No. 506/C/Kep/PP/2004. These indicators include (1) presenting mathematical statements in written, oral, or visual form; (2) proposing conjectures; (3) doing mathematical manipulation; (4) constructing proofs or providing justification for the correctness of a solution; and (5) drawing conclusions.

RESULTS AND DISCUSSION

This study was conducted in one of the 10th-grade classes of SMA Pusri Palembang in September 2025 and aimed to describe students' mathematical reasoning abilities through the application of the Contextual Teaching and Learning (CTL) model in learning arithmetic sequences. The learning followed the CTL stages of constructivism, inquiry, questioning, learning community, modelling, reflection, and authentic assessment (Laksana, 2023). It was supported by student worksheets designed with real-life contexts to help learners identify patterns and draw conclusions. The CTL approach was expected to strengthen student engagement and enhance mathematical reasoning skills, in line with findings by (Mazrur, 2020). Data were obtained through observation, written tests, and interviews conducted after two CTL-based learning meetings, followed by one session for administering the written test.

In the first meeting, the Pentas Seni ticket-sale context was introduced through storytelling and the live worksheet, where students analyzed concrete data (150, 195, 240, 290, and 345 tickets). These numbers helped them recognize how the quantities changed each week and connect the situation to familiar real-life experiences. Through this context, students engaged in pattern-based reasoning by identifying essential information, comparing weekly increases, generating the first five terms, and predicting the 12th-week ticket sales without any formulas. This shows that the context provided meaningful data that supported students' mathematical reasoning.

In the second meeting, the context continued naturally as the committee deposited the Pentas Seni ticket profit IDR 10,500,000 into a bank with a 2% simple interest rate. This context shifted students from observing weekly ticket increases to analyzing monthly growth in savings, allowing them to see another real situation modeled by an arithmetic sequence. Students calculated the monthly interest, completed the savings table, and connected the pattern to the structure of an arithmetic sequence before forming the general formula for the n-th month. The simple-interest setting effectively prompted proportional and generalization reasoning because students had to relate percentage, constant increments, and the resulting total savings.

The continuity of the two contexts played an essential role in supporting students' mathematical reasoning. In the first meeting, the ticket-selling scenario helped students notice weekly numerical patterns, extract relevant information, and make early predictions from the observed increases. In the second meeting, the story continued as the profit from ticket sales was deposited in a bank under simple interest, allowing students to identify a similar pattern of constant monthly growth. This connected narrative helped them interpret arithmetic sequences as meaningful representations of real situations. Across both contexts, students demonstrated reasoning such as comparing changes, determining the first term and common difference, and generalizing these observations into the n-th term formula. Thus, the contexts served not merely as illustrations but as cognitive scaffolds that supported students in constructing and justifying mathematical ideas. These reasoning processes emerged as a direct result of the CTL approach,

where contextual storytelling, inquiry-driven activities, and guided abstraction enabled students to build understanding from meaningful real-life situations.

To analyze the emergence of these reasoning indicators in students' work, their written responses were examined and categorized using color-coded markers. These color codes are consistently used in the analysis of responses to Question 1 and Question 2. The red box represents an indicator presenting mathematical statements in written, oral, or visual form; the green box represents an indicator proposing conjectures; the blue box represents an indicator doing mathematical manipulation; the yellow box represents an indicator constructing proofs or providing justification for the correctness of a solution; and the purple box represents an indicator drawing conclusions.

Question 1 focuses on simple interest calculations using an arithmetic sequence and includes five sub-questions (a)–(e) representing different reasoning indicators: presenting statements through tables, proposing conjectures, applying formulas, justifying interest patterns, and drawing conclusions about the time needed to reach the target. The questions are shown by **Figure 1** in the below.

Original Version:	English Version:
1. Dina menabung Rp5.000.000 di sebuah bank dengan bunga tunggal 2% per bulan. Ia berencana menabung selama beberapa bulan ke depan. Jawablah: a. Sajikan tabel jumlah tabungan Dina (kolom modal dan bunga dipisahkan) dari bulan 1 sampai bulan 6. b. Berdasarkan tabel, ajukan dugaan jumlah tabungan Dina pada bulan ke-10. c. Gunakan rumus barisan aritmetika untuk menghitung jumlah tabungan Dina pada bulan ke-10. Apakah hasilnya sama dengan dugaanmu? d. Jelaskan secara logis mengapa bunga yang diterima Dina selalu bertambah dengan pola yang teratur setiap bulan. e. Berdasarkan perhitunganmu, tarik kesimpulan berapa lama waktu yang dibutuhkan Dina agar tabungannya mencapai Rp7.000.000.	1. Dina saves IDR 5,000,000 in a bank with a simple interest rate of 2% per month. She plans to save for several months ahead. Answer the following questions: a. Present a table showing Dina's total savings (with separate columns for principal and interest) from month 1 to month 6. b. Based on the table, make a conjecture about the total savings Dina will have in the 10th month. c. Use the arithmetic sequence formula to calculate Dina's total savings in the 10th month. Is the result the same as your conjecture? d. Explain logically why the interest Dina receives keeps increasing in a regular pattern each month. e. Based on your calculation, draw a conclusion about how long it will take for Dina's total savings to reach IDR 7,000,000.

Figure 1. Question Number 1

The following is an analysis of the research subjects' responses in solving question number 1. The following **Figure 2** is answers of Subject AA (high) in number 1.

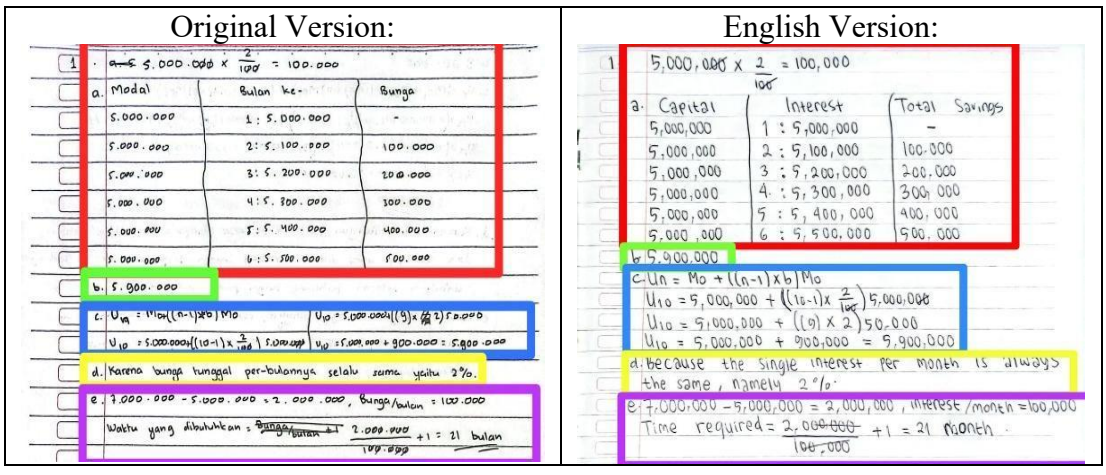


Figure 2. AA's Answers of Number 1

Based on **Figure 2**, subject AA has fulfilled the first indicator in the red box, presenting mathematical statements, by correctly calculating interest and creating a table showing consistent monthly increases, resulting in total savings from IDR 5,000,000 to IDR 5,500,000

in the sixth month. In the green box, which represents the indicator of proposing conjectures, AA initially did not fulfill it because only IDR 5,900,000 was written without showing a pattern, but the interview revealed that the subject understood the process of adding IDR 100,000 each month, so the indicator was considered fulfilled. In the blue box, corresponding to the indicator of doing mathematical manipulation, AA successfully applied the simple interest formula to determine Dina's total savings, obtaining IDR 5,900,000. However, the subject did not initially compare this result with the earlier estimation and only realized during the interview that both results were consistent. This showed that AA's written explanation did not fully reflect the reasoning actually possessed. Nonetheless, the clarification during the interview confirmed that AA understood the connection between the estimated pattern and the formula-based result.

Subject AA initially did not meet the indicator of providing justification in yellow box because only "2% interest per month" was written without any explanation. During the interview, AA clarified that the 2% was calculated from the initial capital, resulting in IDR 100,000 per month, which showed logical reasoning. AA further added that this percentage was consistently applied each month because the interest in simple interest problems always refers to the principal, not the accumulated amount. In purple box, AA fulfilled the indicator of drawing conclusions by subtracting the initial savings from the target, dividing it by the monthly interest, and adding 1 to obtain 21 months. AA also explained that adding 1 corresponds to the $n-1$ structure in the simple interest formula, showing that the steps taken were not just procedural but based on an understanding of the underlying concept. The following **Figure 3** is answers of Subject FM (high) in number 1.

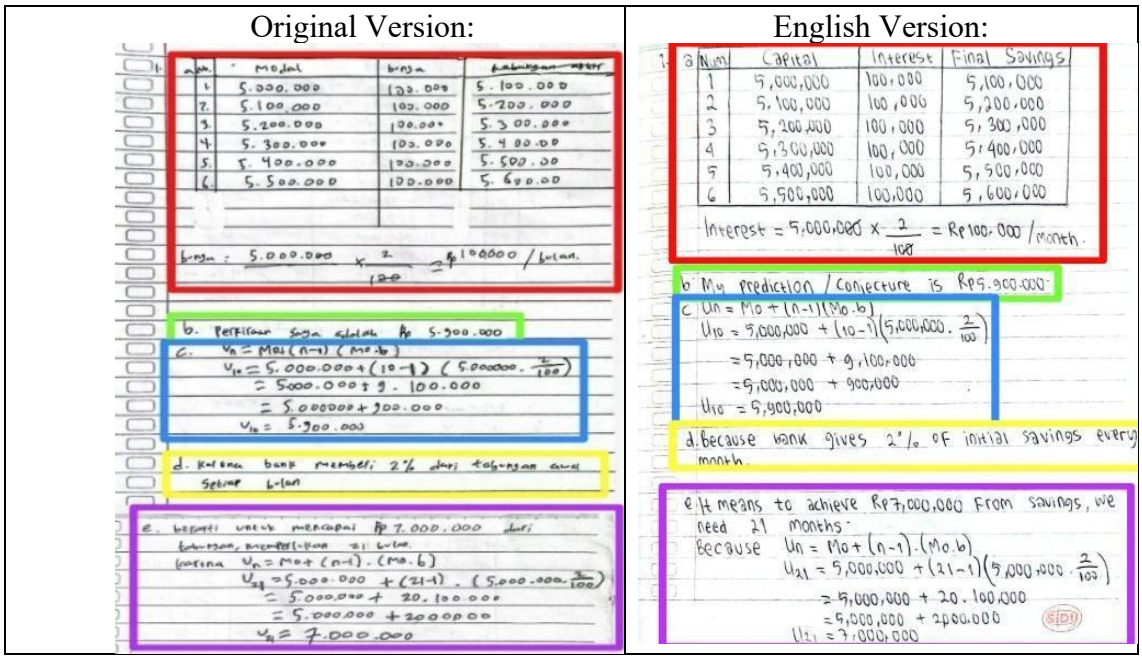


Figure 3. FM's Answers of Number 1

Based on **Figure 3**, in the red box, Subject FM has fulfilled the indicator of presenting mathematical statements by creating a clear table with columns for Month, Capital, Interest, and Final Savings. The capital increased by IDR 100,000 each month from IDR 5,000,000 to IDR 5,500,000 showing consistent interest and correct total savings, with the interest calculation also written below the table. In the green box, FM initially did not fulfill the indicator of proposing conjectures, as only IDR 5,900,000 was written for the 10th month

without showing the pattern. However, during the interview, FM explained that the total interest increased by IDR 100,000 each month, one less than the month number, leading to IDR 900,000 in the 10th month and total savings of IDR 5,900,000, showing logical reasoning. In the blue box, FM fulfilled the indicator of doing mathematical manipulation by accurately applying the U_n formula to calculate Dina's savings, obtaining IDR 5,900,000, and later confirmed through the interview that this result matched the earlier estimation.

Subject FM has fulfilled the indicator of providing justification in the yellow box by logically explaining that the 2% interest was calculated from the initial savings of IDR 5,000,000, giving a fixed monthly increase of IDR 100,000. In purple box, FM did not fully fulfill the indicator of drawing conclusions. The subject correctly applied the U_n formula but used $n = 21$ without solving for it, estimating the value mentally by adding IDR 100,000 each month until reaching IDR 7,000,000, then verifying it with the formula. This indicates intuitive rather than systematic reasoning. The interview also showed that FM relied more on repeated addition than on formal manipulation of the formula. Although the final answer was correct, the reasoning process lacked explicit steps that demonstrate structured mathematical thinking. The following **Figure 4** is answers of Subject NP (moderate) in number 1.

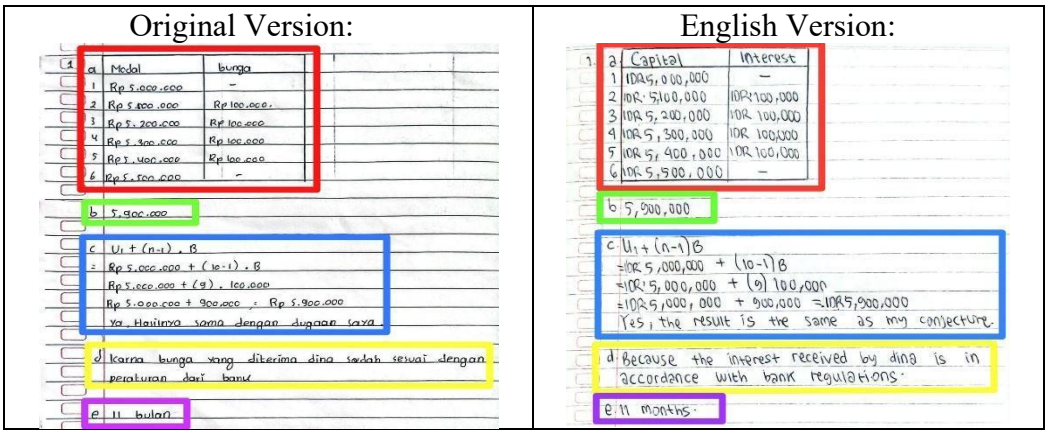


Figure 4. NP's Answers of Number 1

Based on **Figure 4**, in the red box, Subject NP has not fulfilled the indicator of presenting mathematical statements. The table only included "Principal" and "Interest," and the "Principal" values actually showed total savings. NP admitted forgetting to add the "Total Savings" column and often confusing "principal" with "total savings," indicating limited understanding. In the green box, NP initially wrote only IDR 5,900,000 without any pattern but later explained that the amount came from adding IDR 100,000 each month, so the indicator of proposing conjectures was considered fulfilled. In the blue box, NP has fulfilled the indicator of doing mathematical manipulation by correctly applying the Un formula to calculate Dina's savings, obtaining IDR 5,900,000, and confirming that the result matched the earlier estimation.

In the yellow box, Subject NP has not fulfilled the indicator of providing justification, as the answer only mentioned that the interest followed the bank's rules without a mathematical explanation of why it increased equally each month, showing a weak grasp of the simple interest concept. In the purple box, NP also has not fulfilled the indicator of drawing conclusions, stating that Dina would reach IDR 7,000,000 in 11 months without clear reasoning or calculation steps. The interview confirmed errors and unclear logic, indicating that the conclusion was not based on proper analysis. The following **Figure 5** is the answer of Subject RC (moderate) in number 1.

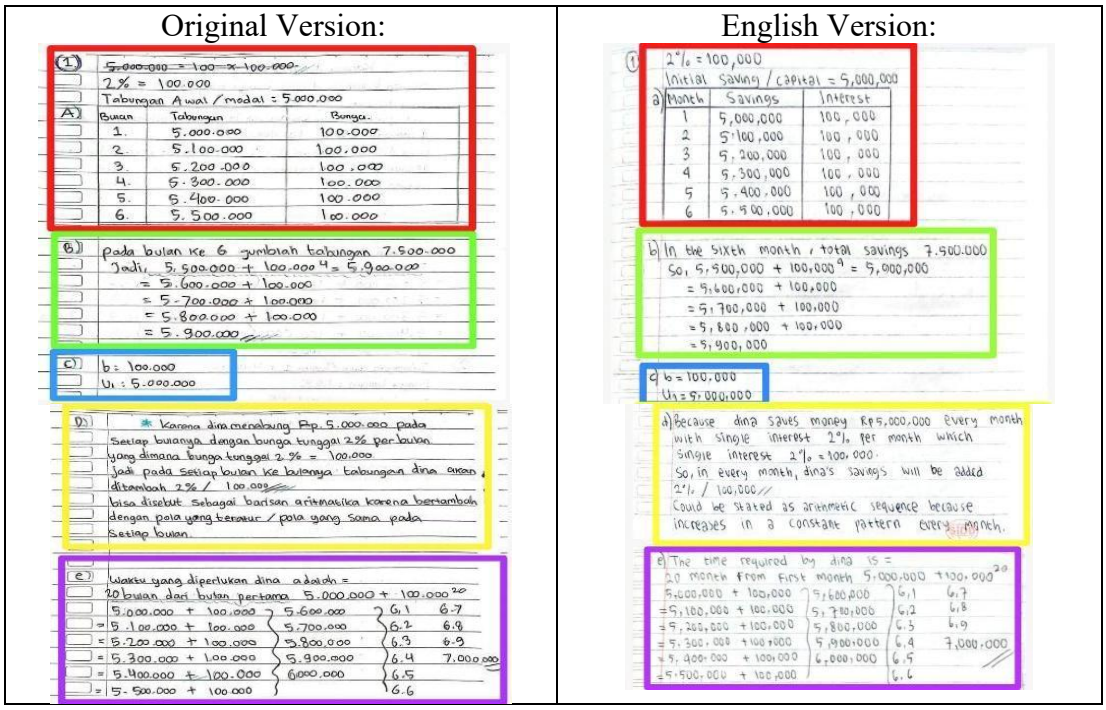


Figure 5. RC's Answers of Number 1

Based on **Figure 5**, in the red box, Subject RC has not fulfilled the indicator of presenting mathematical statements. Although RC correctly calculated 2% of IDR 5,000,000 as IDR 100,000 and made a table with columns for Month, Savings, and Interest, the omission of the Capital column meant the response did not fully follow the instructions. In green box, RC fulfilled the indicator of proposing conjectures by estimating Dina's total savings in the 10th month as IDR 5,900,000 based on the pattern of adding IDR 100,000 each month. The exponent symbol error found in the written answer was only a notation mistake, as clarified in the interview. In blue box, RC has not fulfilled the indicator of doing mathematical manipulation, since only b = 100,000 and U_1= 5,000,000 were identified without using the U_n formula or doing calculations, showing that the concept of arithmetic sequences was not yet applied correctly.

In the yellow box, Subject RC has fulfilled the indicator of providing justification by correctly identifying the initial capital and 2% monthly interest, calculating IDR 100,000, and explaining that Dina's savings increased by a fixed amount each month, consistent with an arithmetic sequence. In the purple box, RC has not fulfilled the indicator of drawing conclusions, as the subject began with an unsupported guess of "20 months from the first month" and then added 5,000,000 and $100{,}000^{20}$ instead of multiplying by 20. Although the final result was IDR 7,000,000, it was reached by coincidence rather than through logical reasoning. The following **Figure 6** is answer of Subject SS (low) in number 1.

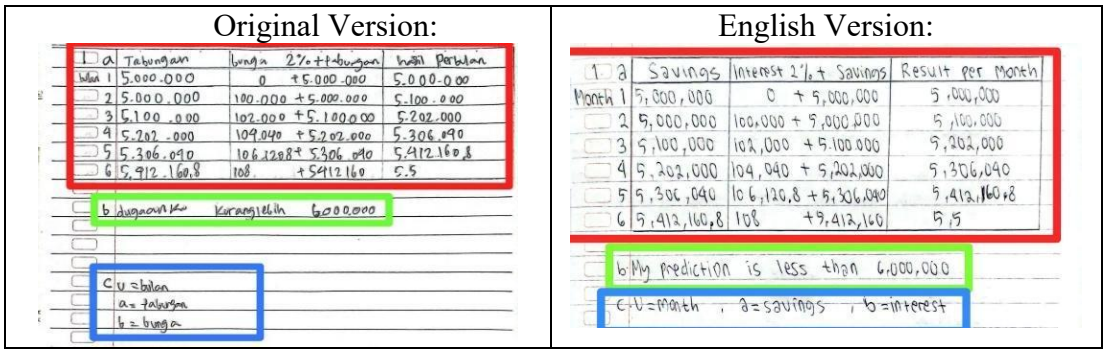


Figure 6. SS's Answers of Number 1

Based on **Figure 6**, subject SS did not fulfill the indicator of presenting mathematical statements in written, oral, or visual form. In the red box, although SS created a table with the correct columns, the interest was incorrectly calculated from the previous month's total, leading to a compound interest pattern instead of a simple one. SS admitted feeling confused about the concept. The subject also did not fulfill the indicator of proposing conjectures, as the answer in the green box was only a rough estimate of IDR 6,000,000 without showing any analyzed pattern. Lastly, SS failed to do mathematical manipulation in the blue box, writing only variable symbols without applying formulas or calculations, indicating limited understanding of the arithmetic sequence, particularly the U_n formula.

Since SS did not answer sub-questions (d) and (e), they did not fulfill the indicators of constructing proof or providing justification for the correctness of a solution and drawing conclusions. The interview revealed that SS had not yet understood the arithmetic sequence formula or its application in simple interest. Errors in the red box indicate a misconception in interpreting the concept of simple interest. The following **Figure 7** is the answer of Subject KW (low) in number 1.

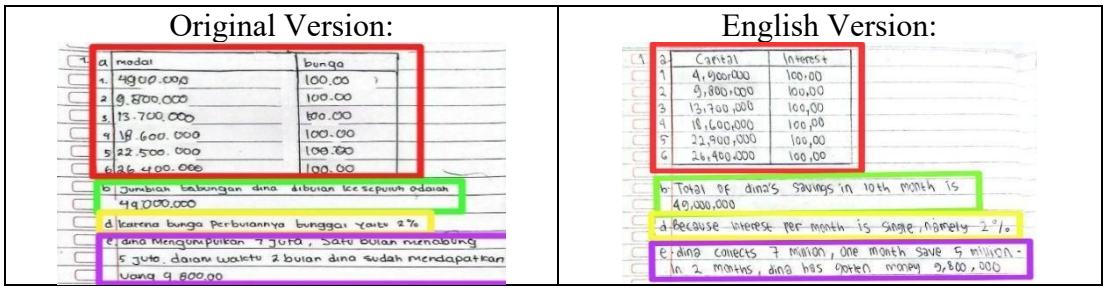


Figure 7. KW's Answers of Number 1

Based on **Figure 7**, in the red box, Subject KW has not fulfilled the indicator of presenting mathematical statements in written, oral, or visual form. The subject created a table with only two columns, Capital and Interest, without including the Total Savings column. They also wrote the initial capital as IDR 4,900,000 instead of IDR 5,000,000, assuming that interest had already been deducted. The interview showed that KW misunderstood the concept of interest.

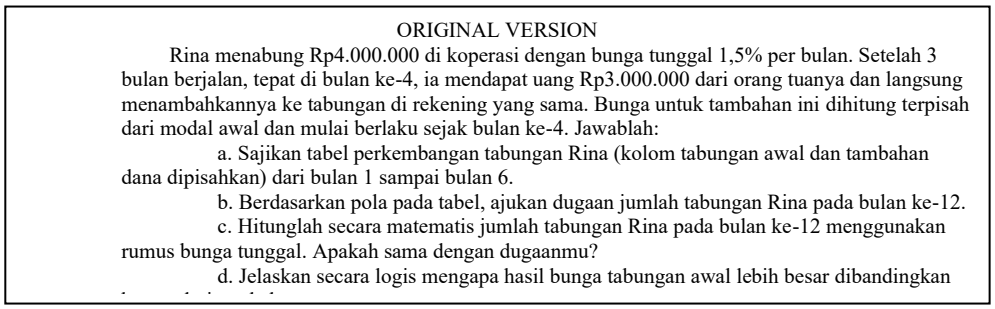
In the green box, under the indicator of proposing conjectures, KW only stated that Dina's savings in the tenth month was IDR 49,000,000, simply adding IDR 100,000 each month without analyzing any pattern or providing reasoning. In the blue box, under the indicator of

doing mathematical manipulation, KW gave no written answer, and the interview revealed KW was confused about which formula to use in applying the arithmetic sequence.

Subject KW has not fulfilled the indicator of constructing evidence or providing justification for the solution. In the yellow box, the subject wrote only "2% simple interest" without explanation, showing a lack of understanding that a fixed interest rate causes a constant increase in savings. In the purple box, KW has not fulfilled the indicator of drawing conclusions, incorrectly stating that Dina would reach IDR 7,000,000 in 2 months based on a previous miscalculation of IDR 9,800,000 in the second month, stemming from an error in the red box.

These patterns of achievement and difficulty across the five indicators in question number 1 are in line with previous studies. High-ability students' consistency in recognizing patterns and manipulating formulas is similar to findings by Wau et al. (2022); Astriani & Al Dhana (2024). Meanwhile, the errors made by medium- and low-ability students, such as misrepresenting data, miscalculating interest, and failing to justify solutions, also reflect the difficulties reported by Fitria et al. (2023); Handayani et al. (2020) regarding students' reasoning on arithmetic sequence problems.

Question 2 involves Rina's savings with a 1.5% simple interest rate per month and an additional savings in the fourth month, calculated separately using simple interest. It includes five sub-questions (a–e) covering indicators of reasoning ability: presenting statements through tables, proposing conjectures, applying formulas, justifying interest differences, and concluding the relationship between saving duration and total interest, which is shown by **Figure 8**.


ORIGINAL VERSION

Rina menabung Rp4.000.000 di koperasi dengan bunga tunggal 1,5% per bulan. Setelah 3 bulan berjalan, tepat di bulan ke-4, ia mendapat uang Rp3.000.000 dari orang tuanya dan langsung menambahkannya ke tabungan di rekening yang sama. Bunga untuk tambahan ini dihitung terpisah dari modal awal dan mulai berlaku sejak bulan ke-4. Jawablah:

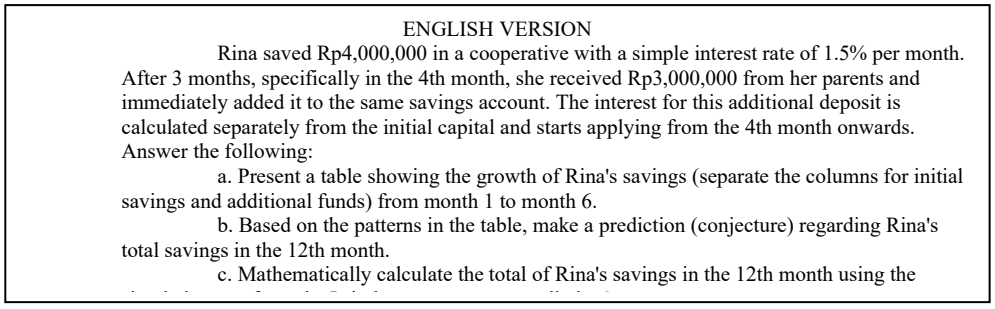
a. Sajikan tabel perkembangan tabungan Rina (kolom tabungan awal dan tambahan dana dipisahkan) dari bulan 1 sampai bulan 6.

b. Berdasarkan pola pada tabel, ajukan dugaan jumlah tabungan Rina pada bulan ke-12.

c. Hitunglah secara matematis jumlah tabungan Rina pada bulan ke-12 menggunakan rumus bunga tunggal. Apakah sama dengan dugaanmu?

d. Jelaskan secara logis mengapa hasil bunga tabungan awal lebih besar dibandingkan

Figure 8. Question Number 2


ENGLISH VERSION

Rina saved Rp4,000,000 in a cooperative with a simple interest rate of 1.5% per month. After 3 months, specifically in the 4th month, she received Rp3,000,000 from her parents and immediately added it to the same savings account. The interest for this additional deposit is calculated separately from the initial capital and starts applying from the 4th month onwards. Answer the following:

a. Present a table showing the growth of Rina's savings (separate the columns for initial savings and additional funds) from month 1 to month 6.

b. Based on the patterns in the table, make a prediction (conjecture) regarding Rina's total savings in the 12th month.

c. Mathematically calculate the total of Rina's savings in the 12th month using the

The following is an analysis of the research subjects' responses in solving question number 2. The following **Figure 9** is the answer of Subject AA (high) in number 2.

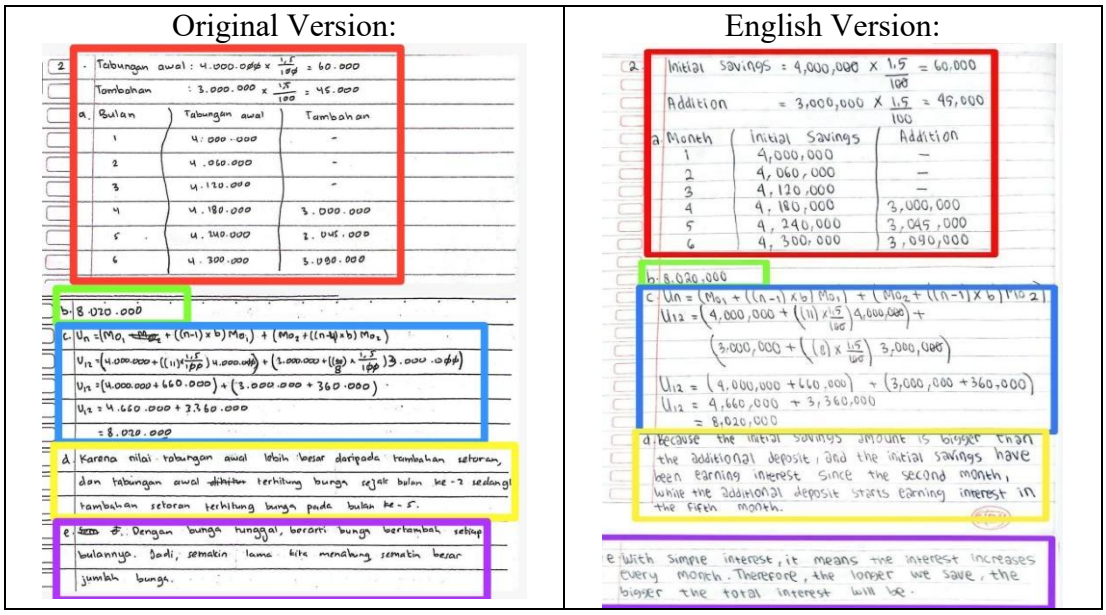


Figure 9. AA's Answers of Number 2

Based on **Figure 9**, Subject AA has not fully fulfilled the first indicator of presenting mathematical statements in written, oral, or visual form. In red box, the subject correctly calculated the monthly interest for the initial savings of IDR 4,000,000 and the additional savings of IDR 3,000,000, organizing them into a table with the columns Month, Initial Savings, and Additional Savings. However, the Total Savings column was missing, and the interview revealed that AA forgot to include it, making the presentation incomplete. In green box, AA has not fulfilled the indicator of proposing conjectures, as the subject only wrote IDR 8,020,000 as Rina's total savings in month 12 without showing patterns or relationships from the table. The interview revealed that AA calculated this by continuing from month 6, showing logical but incomplete reasoning. In blue box, AA has fulfilled the indicator of doing mathematical manipulation, correctly applying the simple interest formula for both the initial savings and the additional savings, using the adjustment (n-4) for the fourth-month savings, and obtaining IDR 8,020,000, though no comparison was made with the earlier conjecture.

Subject AA has not fulfilled the indicator of constructing proof or providing justification for the correctness of the solution. In the yellow box, AA provided only a qualitative statement that the initial savings produced more interest because they were larger and saved earlier but did not strengthen this reasoning with quantitative evidence, such as showing the monthly interest amounts of IDR 60,000 and IDR 45,000 or comparing how they accumulated. However, in the purple box, AA fulfilled the drawing conclusions indicator by explaining that a longer saving duration yields greater total interest, demonstrating an understanding of the direct proportional relationship between time and accumulated interest within simple interest calculations. The following **Figure 10** is answers of Subject FM (high) in number 2.

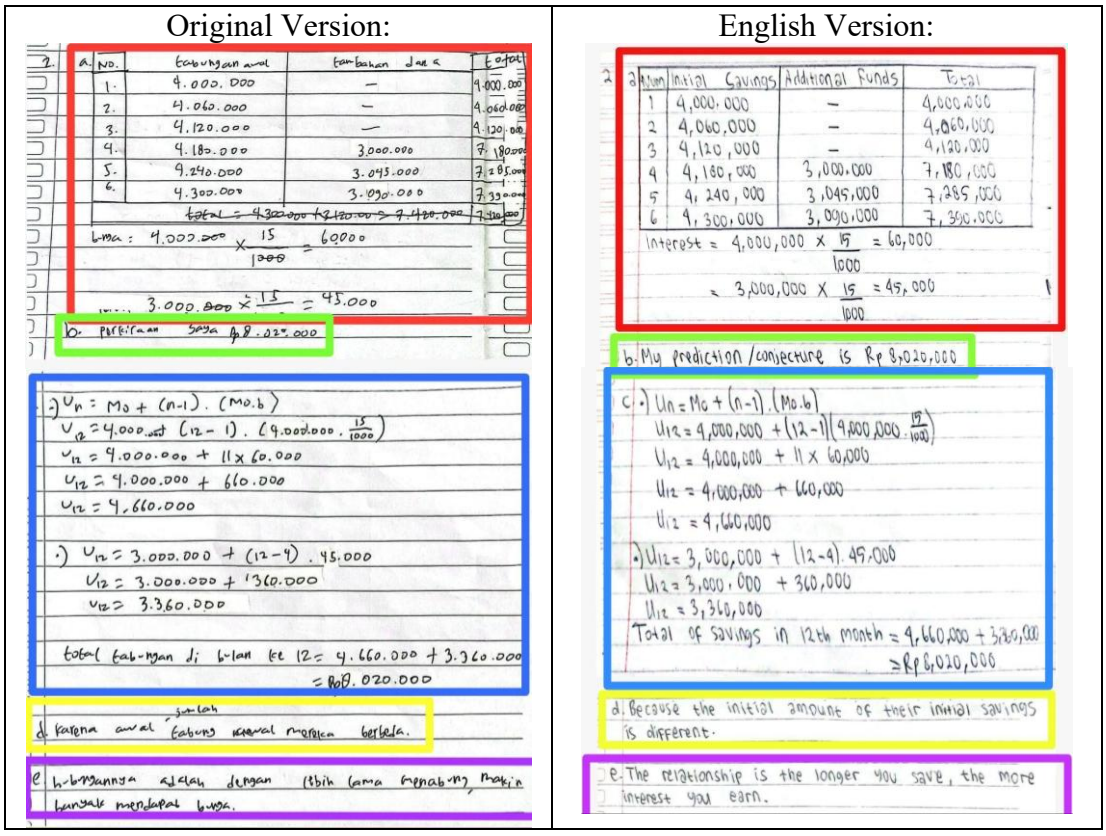


Figure 10. FM's Answers of Number 2

Based on **Figure 10**, subject FM has fulfilled the indicator of presenting mathematical statements in written, oral, or visual form. In red box, the subject correctly calculated the interest for the initial and additional savings (IDR 60,000 and IDR 45,000) and organized them into a table with four columns: No (Month), Initial Savings, Additional Savings, and Total. The interest accumulation was accurately shown, starting from the second month for the initial savings and the fifth month for the additional savings. In green box, FM has not fulfilled the indicator of proposing conjectures, as the subject only wrote IDR 8,020,000 as the estimated total savings in month 12 without showing patterns or relationships from the table, relying on the calculation in blue box and unsure how to derive it independently. In blue box, FM has fulfilled the indicator of doing mathematical manipulation, correctly applying the simple interest formula for both initial and additional savings, obtaining IDR 4,660,000 and IDR 3,360,000, totaling IDR 8,020,000, though no comparison was made with earlier conjecture.

Subject FM has not fulfilled the indicator of constructing proof or providing justification. In yellow box, the subject gave a general explanation without showing interest calculations and did not clarify that the greater increase after the fourth month was due to the additional IDR 3,000,000 generating interest. In purple box, FM has fulfilled the indicator of drawing conclusions, stating that the longer one saves, the more interest is earned, demonstrating an understanding that saving duration is directly proportional to the total interest gained. The following **Figure 11** is answers of Subject NP (moderate) in number 2.

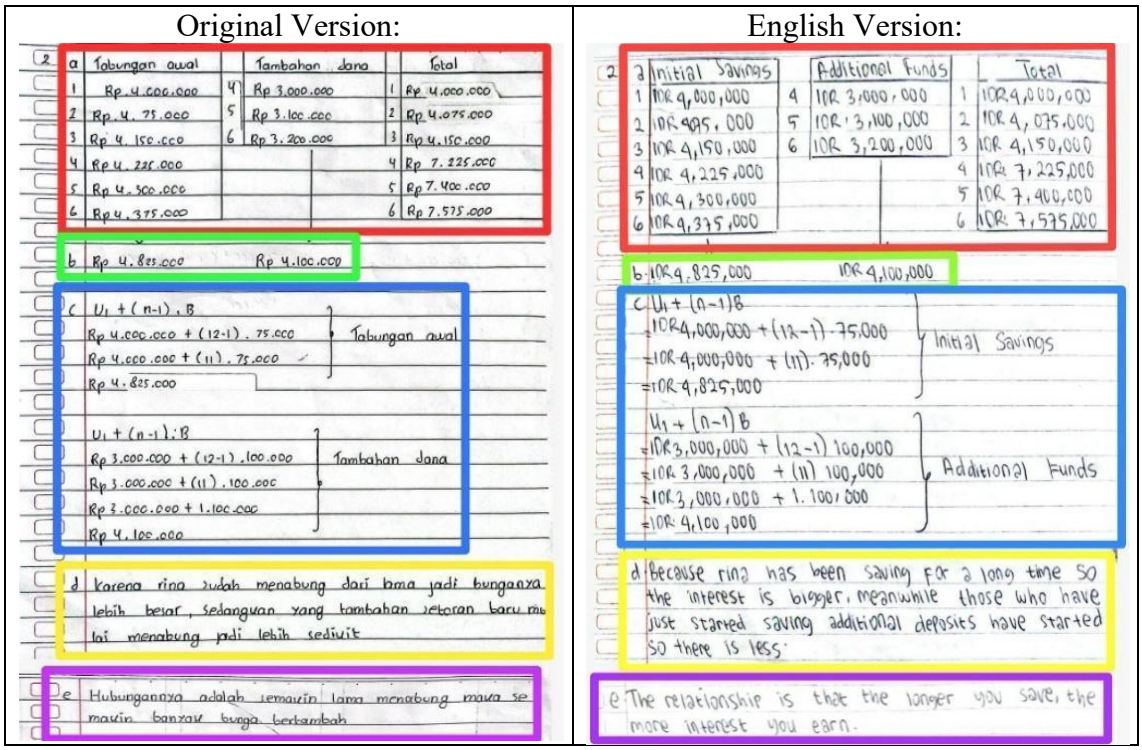


Figure 11. NP's Answers of Number 2

Based on **Figure 11**, subject NP has not fulfilled the indicator of presenting mathematical statements in written, oral, or visual form. In red box, the subject created three columns—Initial Savings, Additional Funds, and Total—but made errors in calculating the interest (e.g., IDR 4,075,000 and IDR 3,100,000). The interview revealed that NP did not fully understand the computation process. In green box, NP has not fully fulfilled the indicator of proposing conjectures, as only totals (IDR 4,825,000 and IDR 4,100,000) were shown without explanation. Manual addition of IDR 75,000 each month reflected a logical but unclear conjecture. In blue box, NP has fulfilled the indicator of doing mathematical manipulation by applying the arithmetic sequence formula, though errors in determining the difference and substituting values indicate that formula manipulation was possible but the application remained inaccurate.

Subject NP has not fulfilled the indicator of constructing proof or providing justification for the solution. In the yellow box, NP only stated that the interest on the main savings was greater than on the additional funds without including detailed calculations like IDR 60,000 and IDR 45,000, giving a qualitative reason without quantitative proof. In the purple box, NP has fulfilled the indicator of drawing conclusions, stating that the longer one saves, the more interest is earned, showing an understanding that saving duration is directly proportional to the total interest gained. The following **Figure 12** is answers of Subject RC (moderate) in number 2.

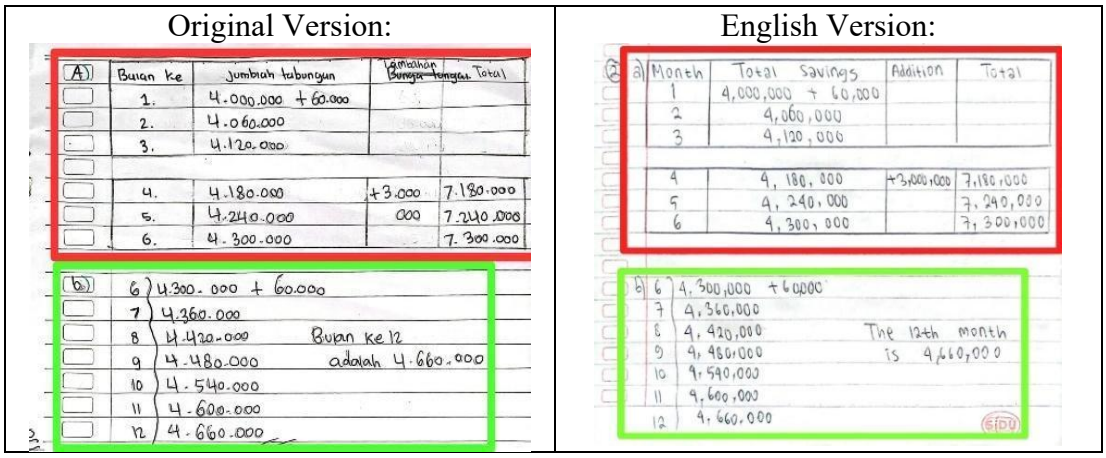


Figure 12. RC's Answers of Number 2

Based on **Figure 12**, subject NP has not fulfilled the first indicator of presenting mathematical statements in written, oral, or visual form. In the red box, NP made four columns and added IDR 60,000 interest to the initial savings but did not apply interest to the additional funds. The interview showed NP misunderstood how interest should be applied. Subject NP has not fulfilled the indicator of making conjectures. In the green box, NP used only the initial savings as the pattern basis without including the IDR 3,000,000 additional funds starting from month 4. Thus, NP's conjecture was incomplete, relying only on partial data. This also shows that NP focused more on what was remembered rather than the full conditions in the problem. NP mentioned needing clearer steps and more examples to better recognize how patterns should be formed.

In sub-questions (c), (d), and (e), subject NP did not answer any of the questions, so the indicators of doing mathematical manipulation, giving justification, and drawing conclusions were not met. From the interview, NP admitted forgetting the formulas and finding the tasks quite challenging. Even so, NP said the contextual learning made the material feel more relatable and slowly helped with understanding. NP also mentioned feeling a bit more confident when the problems were linked to everyday situations, although still unsure about the steps. This shows that NP is starting to grasp the ideas but hasn't been able to put them into written answers yet. NP also felt that with more practice and clearer examples, the material would be easier to handle. The following **Figure 13** is the answer of Subject SS (low) in number 2.

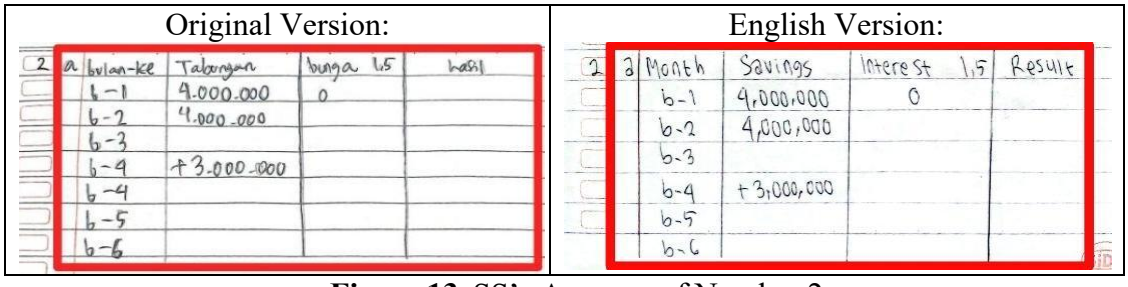


Figure 13. SS's Answers of Number 2

Based on **Figure 13**, subject SS has not fulfilled the first indicator, which is presenting mathematical statements in written, oral, or visual form. In the red box, SS created four columns Month, Savings, 1.5% Interest, and Result but could not calculate the interest in rupiah, leaving

'0' in the Interest column and incomplete entries in others. The interview showed SS did not understand how to convert percentages into rupiah, leading to errors in subsequent calculations.

In sub-questions (b)–(e), subject SS did not answer any of the questions, so the indicators of proposing conjectures, doing mathematical manipulation, constructing proof or justification, and drawing conclusions were not fulfilled. The interview showed SS still struggled to make conjectures, give reasons, and relate savings patterns to interest. However, with guidance, SS began to show partial understanding, though not yet consistent. The following **Figure 14** is answers of Subject KW (low) in number 2.

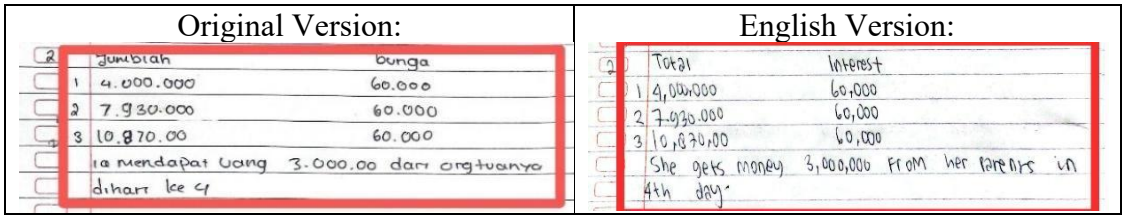


Figure 14. KW's Answers of Number 2

Based on **Figure 14**, subject KW has not fulfilled the first indicator, which is presenting mathematical statements in written, oral, or visual form. In the red box, KW separated the components into Amount and Interest without making a table or including Additional Funds. Although KW correctly calculated the IDR 60,000 interest for the initial savings, the following totals were illogical, and some details showed misunderstanding of the problem context.

In sub-questions (b)–(e), subject KW did not answer any of the questions, so the indicators of proposing conjectures, doing mathematical manipulation, constructing proof or justification, and drawing conclusions were not fulfilled. The interview revealed that KW faced time constraints and limited understanding of the concepts. However, group interaction helped improve comprehension, showing that collaborative learning supported KW's gradual understanding despite remaining difficulties.

The results in question number 2 also show a similar trend to earlier studies. Students who understood the concept of simple interest could present information, manipulate formulas, and conclude logically, aligning with findings by Relawati (2024); Khotimah et al. (2023). On the other hand, the incomplete tables, incorrect conjectures, and inability to justify solutions among medium-and low-ability students are consistent with obstacles noted by Rahmah & Maarif (2021); Suhendra et al. (2025), particularly regarding students' difficulty connecting contextual information with structured mathematical reasoning.

In the indicator of presenting mathematical statements, high-ability subjects could organize information systematically using tables, though they varied in recording monthly capital. Medium-ability subjects understood the basics but were less precise, while low-ability subjects made fundamental errors, such as using the wrong interest type or miswriting initial capital, showing misconceptions about simple interest. These findings align with Agusfianuddin et al. (2024); Rahmah & Maarif (2021) who note that low-achieving students often struggle to represent problems correctly due to difficulties connecting symbols, concepts, and context.

In the indicator of making conjectures, high-ability subjects could logically estimate 10^{th}-month savings, though only showing the final result. Medium-ability subjects began finding patterns but made errors in symbols and calculations, showing partial understanding. Low-ability subjects mostly guessed without a mathematical basis, producing answers far from the problem's concept. This shows that conjecture ability is closely linked to mastery of

arithmetic sequences. Such random-like answers stem from difficulty in recognizing patterns and forming logical relationships between data (Fatikhah & Kusno, 2025).

In the indicator of doing mathematical manipulation, high-ability subjects correctly used arithmetic sequence or simple interest formulas and substituted values, though sometimes forgetting to compare with initial conjectures. Medium-ability subjects had mixed results; NP followed the procedure with minor errors, while RC only wrote symbols without clear steps. Low-ability subjects struggled: SS forgot the formula and wrote only symbols, and KW left answers blank. This shows that manipulation depends on conceptual understanding and procedural accuracy, as many students make errors in operations, substitution, or procedural steps due to weak understanding or lack of attention to detail Syahrir et al. (2023); Suhendra et al. (2025).

In the indicator of constructing proof or providing justification, high-ability subjects could explain the correctness of solutions. AA clarified that interest was calculated from the initial capital, keeping it constant, and FM gave a similar simple explanation. Medium-ability subjects showed limited reasoning; NP mentioned bank rules without elaboration, and RC referred only generally to arithmetic sequences. Low-ability subjects could not provide logical proof, often writing only keywords. This aligns with Wau et al. (2022); Lubis (2024) showing that mathematical reasoning depends on conceptual understanding and communication skills.

In drawing conclusions, high-ability subjects concluded accurately, like AA calculating 21 months logically, while FM estimated mentally without clear steps. Medium-ability subjects struggled; NP wrote 11 months without reasoning, and RC guessed 20 months. Low-ability subjects could not conclude correctly due to earlier errors. This shows concluding ability relies on consistent logical thinking (Sipakkar & Anim, 2024).

The implementation of the Contextual Teaching and Learning (CTL) model in arithmetic sequence instruction contributes to the development of students' mathematical reasoning abilities, particularly in presenting mathematical statements, doing mathematical manipulations, and drawing conclusions. Despite challenges such as time constraints, variations in student participation, and difficulties in relating contextual problems to mathematical concepts, the use of context-based student worksheets (LKPD) within the CTL framework promotes active learning and supports students in systematically reasoning through problem-solving processes.

CONCLUSION

Based on research in class X.A at SMA Pusri Palembang, students' mathematical reasoning skills on arithmetic sequences through the Contextual Teaching and Learning (CTL) model show varied development across each indicator. High-category students can present statements, do mathematical manipulation, and draw conclusions logically and systematically. Medium-category students begin to show ability in presenting statements, proposing conjectures, and drawing conclusions, but still make errors in symbols, calculations, and reasoning. Low-category students struggle with understanding the problem, applying mathematical concepts, and drawing conclusions, leading to incomplete solutions. CTL learning with contextual worksheets encourages discussion, pattern recognition, and conclusion drawing from real situations. Main challenges include limited time due to long group discussions and differing participation levels. Nonetheless, CTL fosters logical thinking habits and enhances engagement in mathematical reasoning.

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