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An Analysis of Students' Reversible Thinking Mathematical Ability on the Material of Flat Sided Space Geometry

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ABSTRACT

The ability of *reversible* mathematical *thinking* is important for students to support students in the process of learning, thinking and solving various *reversible* mathematical problems. This ability is needed to minimise the possibility of errors in solving mathematical problems. However, the fact is that students are still unable to master the ability of reversible thinking mathematically, so that students are unable to solve the given mathematical problems. The low ability of students' mathematical *reversible thinking* is the background in this study. The purpose of this study was to analyse the mathematical *reversible thinking* ability of students on the material of flat-sided space geometry class VIII at SMPN 8 Bukittinggi. This type of research is a descriptive method that uses a quantitative approach. The subject retrieval technique uses *purposive sampling* technique. The subjects in this study were 29 students of class VIII.3 at SMPN 8 Bukittinggi. The research instruments used were written tests and interviews. The data analysis technique used by researchers is descriptive statistical data analysis technique. The results of this study indicate that the ability of *reversible thinking* mathematical class VIII.3 students at SMPN 8 Bukittinggi is categorised as moderate. Based on the results of the study, it is concluded that most students have not been able to master the ability of *reversible thinking* in flat-sided space geometry material.

***Keywords*:** *Mathematical Reversible Thinking, Flat-Sided Space Geometry*

Analisis Kemampuan *Reversible Thinking* Matematis Peserta Didik Pada Materi Bangun Ruang Sisi Datar

ABSTRAK

Kemampuan *reversible thinking* matematis penting dimiliki peserta didik guna untuk menunjang peserta didik dalam proses belajar, berpikir dan menyelesaikan

berbagai permasalahan matematika yang bersifat *reversible*. Kemampuan ini diperlukan untuk meminimalkan kemungkinan kesalahan dalam menyelesaikan permasalahan matematika. Namun, faktanya peserta didik masih belum mampu menguasai kemampuan reversible thinking matematis, sehingga peserta didik tidak mampu menyelesaikan soal matematika yang diberikan. Rendahnya kemampuan *reversible thinking* matematis peserta didik menjadi latar belakang dalam penelitian ini. Tujuan dari penelitian ini adalah untuk menganalisis kemampuan *reversible thinking* matematis peserta didik pada materi bangun ruang sisi datar kelas VIII di SMPN 8 Bukittinggi. Jenis penelitian ini merupakan penelitian dengan metode deskriptif yang menggunakan pendekatan kuantitatif. Teknik pengambilan subjek menggunakan teknik *purposive sampling* . Subjek pada penelitian ini sebanyak 29 orang peserta didik kelas VIII.3 di SMPN 8 Bukittinggi. Instrumen penelitian yang digunakan adalah tes tertulis dan wawancara. Teknik analisis data yang dilakukan peneliti adalah teknik analisis data statistik deskriptif. Hasil penelitian ini menunjukkan bahwa kemampuan *reversible thinking* matematis peserta didik kelas VIII.3 di SMPN 8 Bukittinggi dikategorikan sedang. Berdasarkan hasil penelitian, diperoleh kesimpulan bahwa sebagian besar peserta didik belum mampu menguasai kemampuan *reversible thinking* pada materi bangun ruang sisi datar.

Kata Kunci**:** *Kemampuan Reversible Thinking Matematis, Bangun Ruang Sisi Datar*

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1. Introduction

Education is one aspect that needs to be considered in the development of quality human resources (Desmawan et al., 2023). Education plays an important role in developing the potential of each individual learner which includes attitudes and skills so that knowledge and broad insights are obtained. One important aspect of education is learning. Learning is a process where information does not only come from educators but can also come from students. Learning involves activities and actions that must be performed to achieve good learning outcomes. Harefa (2020) argued that learning is a learning process that is characterised by the presence of parties who give and receive knowledge, the necessity of formal elements, organised, has a purpose and curriculum toolsOne of them is learning related to everyday problems is learning mathematics.

Mathematics as one of the sciences that is no less important in efforts to improve the quality of education and national life (Khaidir et al., 2022). Mathematics is a discipline that arises because of human thoughts related to ideas, processes and reasoning (Sepriyanti & Nuri, 2017). Lestari in (Purwaningrum & Sutiarso, 2022) argued that mathematics is a discipline that studies how to measure, calculate and compare things. Maths is also called abstract science (D. P. Sari, 2017). Salmina & Nisa (2018) argued that the advantages of mathematics, which is an abstract science, are implicit in enabling humans to think logically and methodically, critically, and creatively. Elder dan Paul in (Kurniawati, 2023) argues that methodical thinking is a systematic and critical thinking process that involves analysing, interpreting, and evaluating information in order to understand problems and achieve a goal. So that mathematics has an important role in shaping a thinking ability to solve a problem properly (Hartati et al., 2017). So it can be concluded that mathematics is not just a subject that we encounter in the world of education.

Furthermore, mathematics is a science that plays a role in improving human abilities in thinking (Rustina, 2013).

Learning mathematics is a process of providing learning experiences to students through a series of planned and structured activities so as to gain knowledge about the mathematics that students learn which aims at the cognitive development of students (Syahra et al., 2022). In addition, mathematics is also referred to as a science that has definite and consistent results, thus making mathematics a science that can be used in proving a truth (Hasratuddin, 2018). In line with this opinion, this was stated by Khaillasiwi in (Purwaningrum & Sutiarso, 2022), in essence learning mathematics at school aims to add problem solving skills to students including the ability to understand concepts, design mathematical models, solve models, and interpret the necessary solutions, Khaillasiwi explained that in one of the indicators in problem solving, namely the fourth indicator is a re-examination that verifies the truth of the answer, in testing the truth of the answer, a thinking ability is needed, namely the ability of *reversible* thinking or the ability to think in reverse.

Reversible thinking is the ability to think in reverse (Sutiarso, 2020). KBBI the meaning of the word *reversible* is back and forth (Irma Sulastri, Leni Marlina, 2019). A person's ability to think *reversibly* can also be called reversibility. Reversibility arises from the theory of a person's cognitive development in the world of education by Jean Piaget. Muzaini in (Azhari, 2023), *revesible* refers to the capacity of individuals to return their cognitive processes back to the initial state. The ability of *reversible thinking* mathematically is included in one of the cognitive abilities that are important to develop students' problem solving skills (Purwaningrum, 2023). Ramful (2009) argued that *reversibility* can be viewed into a pair of aspects, namely the first aspect of *reversibiliy* as an idea from Piaget, the second *reversibility* is related in the field of mathematics itself.

Piaget in (Purwaningrum, 2023) *reversible thinking* mathematics is a person's mental ability to reverse his thinking back to the original point/place. In line with the opinion of Flanders (2014), argued that mathematical or *reversible* thinking is a mental activity that makes individuals think logically in two ways that can be reversed, making two-way relationships between concepts, principles, and procedures to create schemes. Meanwhile, Maf'ulah et al (2019) argued that in using *reversible* thinking, students are required to think twice with the opposite point of view to minimise errors in every decision they make. R*eversible thinking* ability is the ability of reverse (Bharata et al., 2022). Kurniawati & Sutiarso (2022) that the ability of *reversible thinking* is needed when learning mathematical concepts that have *reversible* properties themselves. Mathematics has several disciplines such as arithmetic, geometry, algebra, trigonometry, statistics, and calculus (including sequence, limit, derivative, differential, and integral), some of which have *reversible* characteristics (Kurniawati & Sutiarso, 2022). Kang dan Lee in (Saparwadi et al., 2017) that reversibility is the ability to think back to the original point as a way of finding when working on mathematical problems.

Reversibility is an ability or skill that is understood in two directions or the ability of students to restore their thinking to return to the starting point (Nur, 2014). *Reversible* thinking is the mental activity of a person in establishing two-way relationships that are mutually opposite in solving mathematical problems. *Reversible thinking* is also usually associated with mathematical operations (Bharata et al., 2022). For example, when learners solve geometry problems where a surface area of a flat-sided cube-shaped space is known to be equal to $24\ cm^2$, then learners are asked how long the side of the flat-sided space is. The question can be expressed in the form $24 = 6 \times s^2$ to $s^2 = \frac{24}{6}$ then obtained the results $s^2 = 4$, then the length of the side of the cube is $s = \sqrt{4} = 2$. This applies to any reversal of the position of the equation, or what is often referred to as moving segments. This is in line with the aspects of *reversible thinking*, namely negation or *inverse*, *reciprocity*, and the ability to return to the initial data after getting the result.

Kurniawati (2023), argued that negation is when there is an activity of reversing the related operations and reversing the equation, *reciprocity* is the use of other equivalent relationships in making an equation model, the last aspect is returning to the initial data after getting the result is when students return to the starting point after finding the solution using the correct systematic or procedure. Hackenberg (2010) argued that *reversible thinking* is related to inverting schemas. One may not only involve the *inverse* to the initial state, but also involve compensatory or other relationships in reversing the schema as well as taking action to reverse the state equivalent to the initial state. according to Maf'ulah & Juniati, (2020) stated that *reversible* problems are opposite problems or problems that are the opposite (can go back and forth). In the theory developed by Piaget in (Purwaningrum, 2023), The concept of *reversible thinking* mathematically is classified into three types, namely *negation, reciprocity* and action to reverse the state of the condition equivalent to the initial state (returning to the initial data after obtaining the result). *Negation* involves understanding that a one-way movement might be lost with a reversal step. *Reciprocity* relates to compensation or an equal relationship. While returning to the initial data after getting the results is an action to reverse the state of conditions that are equivalent to the initial state. This statement is in line with the opinion of Hackenberg (2010) It is argued that there are two ways to do *reversible thinking* mathematically: *negation or inversion* and *reciprocity.* Using *negation or inversion* about handling position reversal (in terms of problems related to algebra), on the other hand *reciprocity* is characterised by a *reciprocal* or equivalent relationship.

Based on the review of previous research on *reversible thinking* ability, it is found that the low *reversible thinking* ability of students is caused by weak mathematical reasoning ability and lack of courage in doing activities during learning (Sutiarso, 2020). Furthermore, students are not able to solve *inverse* or reciprocal problems because students' *reversible* thinking in solving mathematical insurance problems is found in difficulty (Maf'ulah et al., 2017). Next, learning with a *reversible* problem solving approach can affect the *reversible* thinking ability of prospective mathematics teachers and the effect is significant and positive (Maf'ulah & Juniati, 2020). Based on the description above, it can be said that the ability to *reversible* thinking mathematically is the ability to think back and forth in solving mathematical problems where students are required to think twice with the opposite point of view to minimise the possibility of error in every decision they make against an obstacle or failure then he returns to the starting point to start using a new idea*(inverse*) and if you continue it then there is such a thing as compensation (*reciprocity*) in the sense of producing an equivalent value / equal / equivalent then after getting the correct result if it is reversed it is still correct.

In this study, what will be considered is the ability of *reversible thinking* mathematical students in solving mathematical problems with aspects of indicators adopted from opinion Purwaningrum (2023) namely negation, *reciprocity,* and the ability to return to the initial data after getting results, so researchers are interested in conducting this study with the aim of analysing and describing the *reversible thinking* ability of students on flat-sided space geometry material.

2. Method

This research uses descriptive quantitative research. This is in accordance with the purpose of this study which is to analyse and describe how the ability of *reversible thinking* mathematical students on the material of flat-sided space geometry. The subjects in this study were students of class VIII.3 SMPN 8 Bukittinggi located in Bukittinggi City, West Sumatra. The subjects are 29 students, who will be selected 6 people to be interviewed and analysed which are divided from 2 representatives of the high group, medium group and low group.

The subjects were selected by *purposive sampling.* According to Sugiyono (2015) *purposive sampling* is a sampling technique with certain considerations. Subjects with *purposive sampling* are subjects who are chosen with full consideration by asking the opinion of class teachers who understand the cognitive and affective conditions of students (Novianti & Zanthy, 2019). The research instruments used by researchers are written tests and interviews. Learners are given a test question on the ability of mathematical *reversible thinking* , then after obtaining the test results the students are grouped into three groups, namely the high group, medium group, and low group. Furthermore, each group selected two learners as research subjects who will be analysed through interviews to find out how their mathematical reversible *thinking* ability. The object in this study is the ability of *reversible thinking* mathematical learners on the material of flat-sided space geometry.

The data were analysed through three stages, namely the data reduction stage, data presentation, and conclusion drawing (Apriliyani et al., 2022). In this study, researchers used descriptive statistical data analysis techniques. Descriptive statistics are part of statistics that function to collect data, determine statistical values about something so that it is easy to read and understand (E. W. Sari, 2020). Descriptive statistical data analysis technique is a statistical data analysis technique that is used only to describe and analyse a research result without making generalisations/inferences (Gunawan, 2015). According to Gunawan (2015) suggests that descriptive statistical data analysis techniques can use the following steps including calculating the average*(mean*), mode (Mo), median (Me), frequency distribution*(range)*, class interval, class length), *variance*, and*standard deviation (SD*). So this research only explains, describes and describes objectively the data obtained without aiming to test the hypothesis.

3. Result and Discussion

The test results of students' mathematical *reversible thinking* ability are presented in Table 1.

TABLE 1 Test Results of *Reversible Thinking* Mathematical Ability of Students

Group	Research Subject	Score
High group	SP1	95,59
	SP2	91,18
Medium group	SP6	73,53
	SP7	72,06
Low group	SP28	17,65
	SP29	14,71

Furthermore, from each group, two research subjects were selected, coded SP1, SP2, SP6, SP7, SP28, and SP29, who were interviewed and then analysed the answers obtained by them.

3.1 *Reversible Thinking* Mathematical Ability

The following is presented the test results of students' mathematical *reversible thinking* abilities and their analysis.

3.1.1 *Reversible Thinking* Mathematical Ability of High Group Subjects

In this group, the researcher looked at three aspects, namely *negation or inverse*, *reciprocity*, and returning to the initial data after obtaining results.

3.1.1.1 *Negation or Invers*

The snippet of SP1's mathematical *reversible thinking* test results related to the *negation or inverse* aspect is presented in Figure 1.

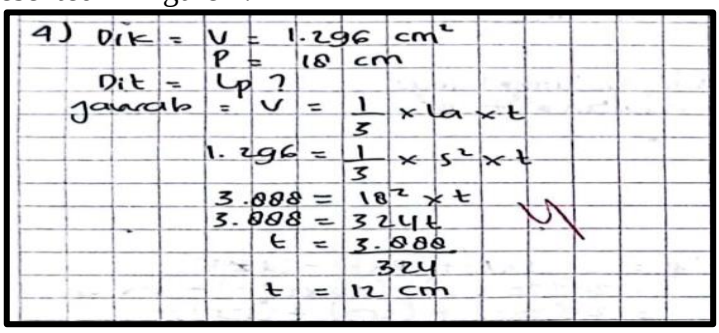


Figure 1 SP1 work in the aspect of *negation or inverse*

Figure 1 shows that SP1 was able to reverse the given problem (reversal of mathematical operations) correctly. SP1 was able to explain the process of moving segments from $1.296 = \frac{1}{3} \times s^2 \times t$ to $3.888 = 18^2 \times t$ then $3.888 = 324\,t$ to $t = \frac{3.888}{324}$ results obtained $t = 12\ cm$. This shows that SP1 has fulfilled the *negation or inverse* aspect. Reinforced by the results of the interview as follows.

Researcher : What is known in this question?
SP1 : The volume of the pyramid is 1.296 cm^2, and the length of the base rib is 18cm.
Researcher : What is asked in this item?
SP1 : The surface area of the pyramid
Researcher : Explain how do you do this problem?
SP1 : First, I look for the height of the pyramid by using the volume formula of the pyramid known in the question, secondly after getting the height I use it to find the value of the hypotenuse on the base of the pyramid which is triangular with the phytagorean formula, then after getting the results I use it to find the surface of the pyramid.
Researcher : Is there a process of reversing the problem in working on this problem? Explain?
SP1 : There is, I think when looking for the value of the height of the pyramid in the volume of the pyramid there is a process of moving segments.

The snippet of SP2 mathematical *reversible thinking* test results related to the *negation or inverse* aspect is presented in Figure 2.

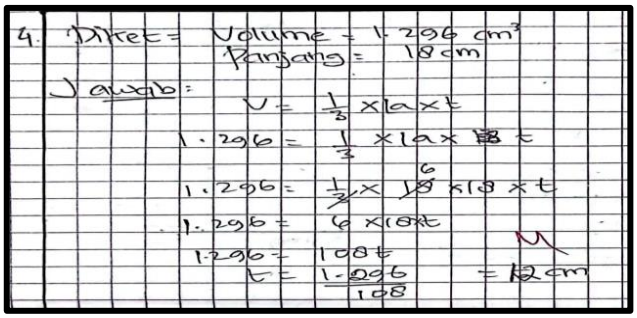


Figure 2 SP2 work in the aspect of *negation or inverse*

Figure 2 shows that SP2 was able to reverse the given problem (reversal of mathematical operations) correctly. SP2 was able to explain the process of moving segments from $1.296 = \frac{1}{3} \times 18 \times 18 \times t$ to $1.296 = 6 \times 18 \times t$ then $1.296 = 108\,t$ to $t = \frac{1.296}{108}$ results obtained $t = 12\ cm$. This shows that SP2 has fulfilled the aspect of *negation or inverse* ability. Reinforced by the results of the interview as follows.

Researcher : What is known in this question?
SP2 : The volume of the pyramid is 1.296 cm^2, and the length of the base rib is 18cm.
Researcher : What is asked in this question?
SP2 : The surface area of the pyramid
Researcher : Explain how do you do this problem?
SP2 : First, I look for the height of the pyramid first, second after getting the height I look for the value of the hypotenuse on the base of the pyramid, then after getting the results I use it to find the surface of the pyramid.
Researcher : Is there a process of reversing the problem in working on this problem? Explain?
SP2 : There is, I think when looking for the height value of the pyramid by using the description of the volume formula of the pyramid, there is a process of moving segments.

3.1.1.2 *Reciprocity*

The snippet of SP1's mathematical *reversible thinking* test results related to the *reciprocity* aspect is presented in Figure 3.

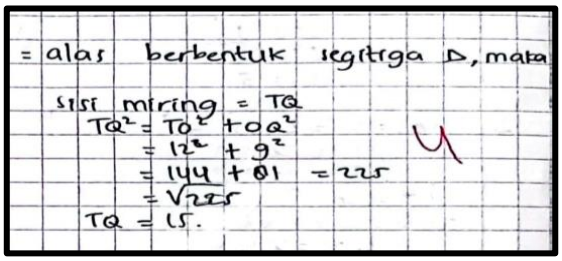


Figure 3 SP1 work in the aspect *reciprocity*

Figure 3 shows that SP1 is able to use compensation or other relationships that are equivalent to the given problem. SP1 was able to explain the use of any formula related to the problem, namely the use of the pyhtagorean theorem formula in finding the value of the hypotenuse on the base of a triangular pyramid. This shows that SP1 already has the *reciprocity* aspect. Strengthened by the results of the interview as follows.

Researcher : How do you use the formula you want to use?
SP1 : I used volume of pyramid formula, phytagoras theorem formula and surface area of pyramid formula.
Researcher : Can you use other formulas or equivalent formulas in doing this problem? Explain?
SP1 : Yes, like using the pythagorean theorem formula to find the hypotenuse of the base of the triangular pyramid.

A snapshot of SP2's mathematical *reversible thinking* test results related to the *reciprocity* aspect is presented in Figure 4.

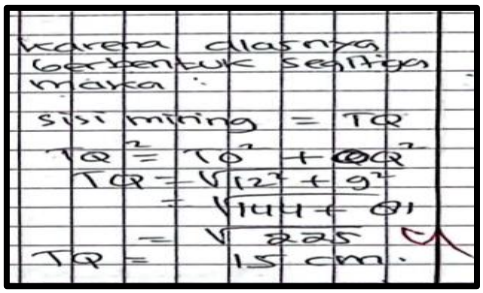


Figure 4 SP2's work on *reciprocity* aspect

Figure 4 shows that SP2 is able to use compensation or other relationships that are equivalent to the given problem. SP2 was able to explain the use of any formula related to the problem, namely the use of the pyhtagorean theorem formula in finding the value of the hypotenuse on the base of a triangular pyramid. This shows that SP2 already has the *reciprocity* aspect. Strengthened by the results of the interview as follows.

Researcher : How do you use the formula you want to use?
SP2 : I used pyramid volume formula, phytagoras theorem formula and pyramid surface area formula.
Researcher : Can you use other formulas or equivalent in doing this problem? Explain?
SP2 : Yes, when looking for the size of the hypotenuse of the base of the triangular pyramid, you can use the phythagorean formula.

3.1.1.3 Return to Initial Data After Getting Result

The snippet of SP1's mathematical *reversible thinking* test results related to the aspect of returning to the initial data after getting the results is presented in Figure 3.

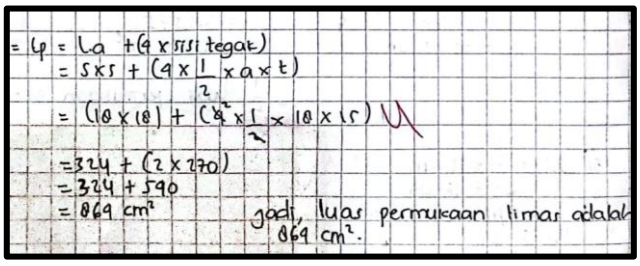


Figure 5 SP1's work
the aspect of returning to the initial data after getting the result

Figure 5 shows that SP1 was able to return the problem made to the beginning after getting the results using the correct procedure according to what was instructed in the problem. SP1 was able to explain how to find the surface area of the pyramid correctly and according to what was asked in the problem. This fulfils the aspect of the ability to return to the initial data after getting the results. Strengthened by the results of the interview as follows.

Researcher : Explain how you can prove that your answer is correct?
SP1 : I think my answer is correct. From the results obtained by its height 12 cm with the volume of the pyramid known to be 1.296 cm^3 by moving the segment from:
$v = \frac{1}{3} \times luas\ alas \times tinggi$
$1.296 = \frac{1}{3} \times s^2 \times t$
$3.888 = 18^2 \times t$

$3.888 = 324\ t$
$t = \frac{3.888}{324} = 12\ cm$
Then the height is 12 cm, if I return to the beginning of the question then my answer is correct. Then the next step I looked for the hypotenuse of the base of the triangular pyramid, using the pythagorean theorem formula to get the hypotenuse, then obtained:
Hypotenuse = TQ
$TQ^2 = TO^2 + OQ^2$
$= 12^2 + 9^2$
$= 144 + 81$
$= \sqrt{225}$
$TQ^2 = 15$
After obtaining the height and hypotenuse of the base of the pyramid, the last step I did was to find the surface area of the pyramid as asked in the question, namely:
$Lp = La + (4 \times sisi\ tegak)$
$= s \times s + (4 \times \frac{1}{2} \times a \times t)$
$= (18 \times 18) + \left(4 \times \left(\frac{1}{2} \times 18 \times 15\right)\right)$
$= 324 + (2 \times 270)$
$= 324 + 540$
$= 864\ cm^2$
So, the surface area of the pyramid is 864 cm^2.

Researcher : Have you checked your answer again?
SP1 : Yes, I have.

The snippet of SP2's *reversible thinking* mathematical test results related to the aspect of returning to the initial data after getting the results is presented in Figure 6.

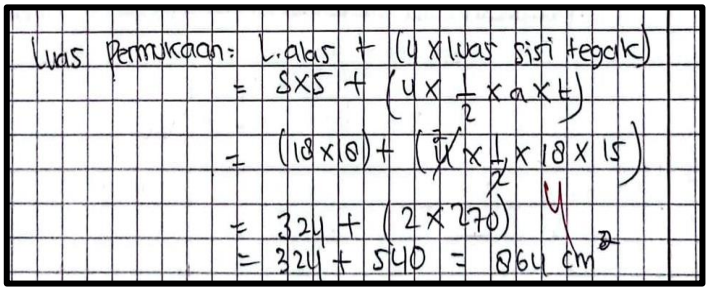


Figure 6 SP2 work
the aspect of returning to the initial data after getting the result

Figure 6 shows that SP2 was able to return the problem made to the beginning after getting the results using the correct procedure according to what was instructed in the problem. SP2 was able to explain how to find the surface area of the pyramid correctly and according to what was asked in the problem. This fulfils the aspect of the ability to return to the initial data after getting the results. Strengthened by the results of the interview as follows.

Researcher : Explain how you can prove that your answer is correct?
SP2 : I think the answer I did is correct. The first step I did was to find the height of the base of the pyramid, by using the description of the pyramid volume formula known in the problem. Where it is known that the volume is 1.296 cm^3, then the length of the base is 18 cm. The result of the formula is obtained:

$v = \frac{1}{3} \times La \times t$
$1.296 = \frac{1}{3} \times La \times t$
$1.296 = \frac{1}{3} \times 18 \times 18 \times t$
$1.296 = 6 \times 18 \times t$
$1.296 = 108\ t$
$t = \frac{1.296}{108} = 12\ cm$

The second step I did was to use the height value obtained earlier to find the size of the hypotenuse on the base of the pyramid. I used the pythagorean theorem formula because the base is triangular:

Hypotenuse = TQ
$TQ^2 = TO^2 + OQ^2$
$TQ = \sqrt{12^2 + 9^2}$
$TQ = \sqrt{144 + 81} = \sqrt{225}$
$TQ = 15$

After getting the height and hypotenuse of the base of the pyramid, the last step I did was to find the surface area of the pyramid as asked in the question, using the formula:

$Lp = L\ alas + (4 \times Luas\ sisi\ tegak)$
$= s \times s + (4 \times \frac{1}{2} \times a \times t)$
$= (18 \times 18) + \left(4 \times \left(\frac{1}{2} \times 18 \times 15\right)\right)$
$= 324 + (2 \times 270) = 324 + 540 = 864\ cm^2$

So, the surface area of the pyramid is obtained. $864\ cm^2$.

Researcher : Have you checked your answer again?
SP2 : Already mam.

3.1.1.4 Discussion

Based on snippets of test results and interviews with SP1 and SP2 subjects, a summary of the analysis is presented in Table 2.

TABLE 2 Analysis of Reversible Thinking Mathematical Ability of High Subjects

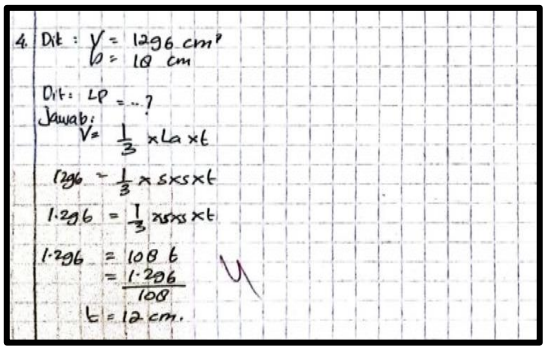
Subject	Aspect	Test Result	Result Interview	Conclusion	Category
SP1	*Negation or Invers*	Meet	Meet	Meet	Able
SP2		Meet	Meet	Meet	
SP1	*Reciprocity*	Meet	Meet	Meet	Able
SP2		Meet	Meet	Meet	
SP1	Return To Initial Data After Getting Result	Meet	Meet	Meet	Able
SP2		Meet	Meet	Meet	

3.1.2 *Reversible Thinking* Mathematical Group Medium Subject Group

In this group, researchers looked at three aspects, namely negation or inverse, reciprocity, and returning to the initial data after obtaining results.

3.1.2.1 *Negation or Invers*

A Snapshot of SP6 mathematical reversible thinking test results related to the negation or inverse aspect is presented in Figure 7.

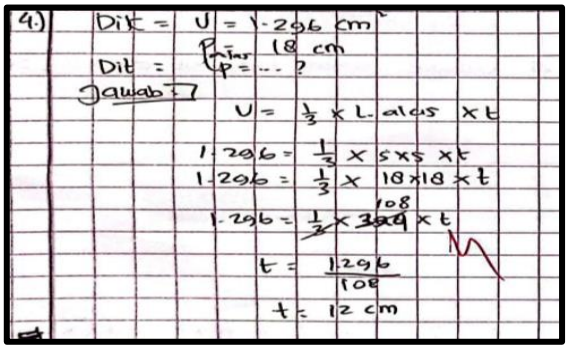


Gambar 7 Hasil pekerjaan SP6 *negation or invers*

Figure 7 shows that SP6 was able to reverse the given problem (reversal of mathematical operations) correctly. SP6 was able to explain the process of moving the segment from $1.296 = \frac{1}{3} \times 18 \times 18 \times t$ to $1.296 = 6 \times 18 \times t$ then $1.296 = 108\ t$ to $t = \frac{1.296}{108}$ the result is obtained $t = 12\ cm$. his shows that SP6 has fulfilled the negation or inverse aspect. Strengthened by the results of the interview as follows.

Researcher : What is known in this problem?
SP6 : The volume of the pyramid is 1.296 cm^2, and the length of the base rib is 18cm mam.
Researcher : What is asked in this problem?
SP6 : The surface area of the pyramid
Researcher : Explain how do you do this problem?
SP6 : First I look for the height of the pyramid, secondly after getting the height I use it to find the value of the hypotenuse of the base of the pyramid, then the last step I look for the surface area of the pyramid.
Researcher : Is there a process of reversing the problem in working on this problem? Explain?
SP6 : There is, when I look for the height of the pyramid with the pyramid volume formula, I move the segments to get the result.

A snapshot of SP7 reversible thinking mathematical test results related to the negation or inverse aspect is presented in Figure 8.



Gambar 8 Hasil pekerjaan SP7 *negation or invers*

Figure 8 shows that SP7 was able to reverse the given problem (reversal of math operations) correctly. SP6 has not been able to explain the process of moving segments from $1.296 = \frac{1}{3} \times 18 \times 18 \times t$ to $1.296 = 6 \times 18 \times t$ then $1.296 = 108\ t$ to $t = \frac{1.296}{108}$ o obtain the result $t = 12\ cm$. This shows that SP7 has fulfilled the negation or inverse aspect. Strengthened by the results of the interview as follows.

Researcher : What is known in this problem?
SP7 : The volume of the pyramid is 1.296 cm^2, and the length of the base rib is 18cm mam.
Researcher : What is asked in this problem?
SP7 : The surface area of the pyramid
Researcher : Explain how do you do this problem?
SP7 : First, I find the height of the pyramid first, then I find the surface of the pyramid as asked in the question.
Researcher : Is there a process of reversing the problem in working on this problem? Explain?
SP7 : There is, I think when looking for the height value of the pyramid by using the description of the pyramid volume formula, there is a process of moving the segments.

3.1.2.2 *Reciprocity*

The snippet of SP6 mathematical reversible thinking test results related to the reciprocity aspect is presented in Figure 9.

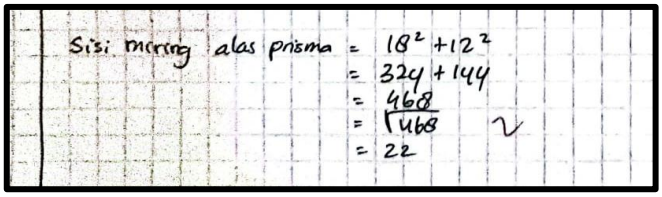


Figure 9 SP6 work on reciprocity aspect

Figure 9 shows that SP6 has not been able to explain the use of any formula related to the problem correctly, namely the use of the pyhtagorean theorem formula in finding the value of the hypotenuse on the base of the triangular pyramid correctly. This shows that SP6 does not have reciprocity which can be seen when SP6 has not been able to use compensation or other relationships that are equivalent to the problem given. Reinforced by the results of the interview as follows.

Researcher : How do you use the formula you want to use?
SP6 : I used the volume formula of the pyramid, the phytagoras theorem formula and the surface area formula of the pyramid.
Researcher : Can you use other formulas or equivalent in doing this problem? Explain?
SP6 : Yes, to find the hypotenuse of the base of the triangular pyramid.

A snapshot of SP7's mathematical reversible thinking test results related to the reciprocity aspect is presented in Figure 10.

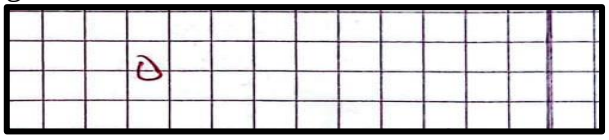


Figure 10 SP7 is work on reciprocity aspect

Figure 10 shows that SP7 is unable to use compensation or other relationships that are equivalent to the problem given. SP7 was unable to explain the use of any formulas related to the problem, namely the use of the pyhtagorean theorem formula in finding the value of the

hypotenuse on the base of a triangular pyramid. This shows that SP7 does not have the reciprocity aspect which can be seen when SP7 is unable to use compensation or other relationships that are equivalent to the problem given. Strengthened by the results of the interview as follows.

Researcher : How do you use the formula you want to use?
SP7 : I use the volume formula of the pyramid and the surface area formula of the pyramid.
Researcher : Can you use other formulas or equivalent in doing this problem? Explain?
SP7 : I don't know.

3.1.2.3 Returning To The Initial Data After Getting The Result

The snippet of SP6 reversible thinking mathematical test results related to the aspect of returning to the initial data after getting the results is presented in Figure 11.

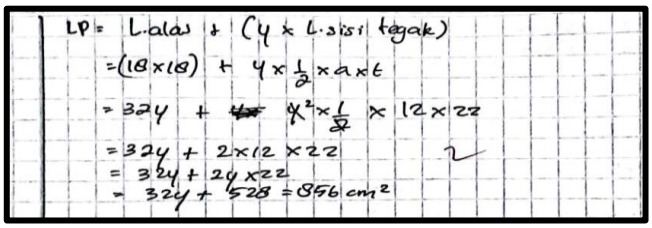


Figure 11 SP6 work result
aspects of returning to the initial data after getting the result

Figure 11 shows that SP6 has not been able to return the problem made to the beginning after getting the results using the correct procedure according to what is instructed in the problem. SP6 has not been able to explain how to find the surface area of the pyramid correctly and according to what is asked in the problem. This does not fulfill the aspect of the ability to return to the initial data after getting the results. Strengthened by the results of the interview as follows.

Researcher : Explain how do you prove that the answer you did is correct?
SP6 : I think my answer is correct. The step that I did first was to find the height of the prism with the description of the volume formula of the pyramid, in the process of working on it I moved the segment to get the height of 12 cm.

$v = \frac{1}{3} \times La \times t$
$1.296 = \frac{1}{3} \times La \times t$
$1.296 = \frac{1}{3} \times 18 \times 18 \times t$
$1.296 = 6 \times 18 \times t$
$1.296 = 108\, t$
$t = \frac{1.296}{108}$
$t = 12\ cm$

Then, the next step I looked for the hypotenuse of the base of the pyramid which is triangular using the concept of the pyhtagorean formula:

$sisi\ miring\ alas\ prisma = 18^2 + 12^2$
$= 18^2 + 12^2$
$= 324 + 144$
$= \sqrt{466} = 22$

The last step is then I look for how much the surface area of the pyramid is as asked in the question, using the formula:

$Lp = La + (4 \times L.sisi\ tegak)$
$= (18 \times 18) + \left(4 \times \left(\frac{1}{2} \times a \times t\right)\right)$
$= (18 \times 18) + \left(4 \times \left(\frac{1}{2} \times 12 \times 22\right)\right)$
$= 324 + (2 \times 12 \times 22)$
$= 324 + 528 = 856\ cm^2$
So, the surface area of the pyramid is $856\ cm^2$.

Researcher : Have you checked your answer again?
SP6 : Already mam.

The snippet of SP7's reversible thinking mathematical test results related to the aspect of returning to the initial data after getting the results is presented in Figure 12.

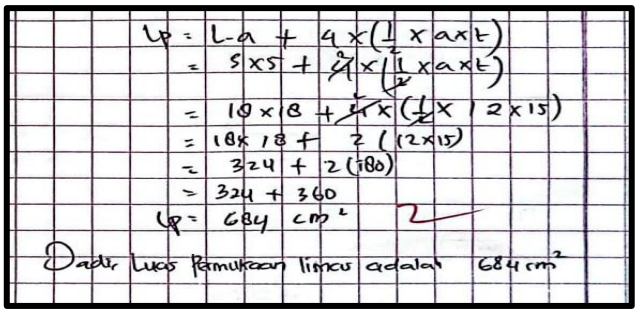


Figure 12 SP7 work
aspect of returning to the initial data after getting the result

Figure 12 shows that SP7 has not been able to return the problem made to the beginning after getting the results using the correct procedure according to what is instructed in the problem. SP7 has not been able to explain how to find the surface area of the pyramid correctly and according to what is asked in the problem. This does not fulfill the aspect of the ability to return to the initial data after getting the results Reinforced by the interview results as follows.

Researcher : Explain how do you prove that the answer you did is correct?
SP6 : I think the answer I did is correct. The first step I did was to find the height of the base of the pyramid, using the description of the pyramid volume formula known in the problem. Where it is known that the volume is 1.296 cm^3, then the length of the base is 18 cm. The result of the formula is obtained:

$v = \frac{1}{3} \times La \times t$
$1.296 = \frac{1}{3} \times La \times t$
$1.296 = \frac{1}{3} \times 18 \times 18 \times t$
$1.296 = 6 \times 18 \times t$
$1.296 = 108\ t$
$t = \frac{1.296}{108} = 12\ cm$

After getting the height, the last step I did was to find the surface area of the pyramid as asked in the problem, with the formula:

$Lp = L.alas + (4 \times \frac{1}{2} \times a \times t)$
$= s \times s + (4 \times \frac{1}{2} \times a \times t)$
$= (18 \times 18) + \left(4 \times \left(\frac{1}{2} \times 12 \times 15\right)\right)$
$= 324 + (2 \times 180) = 324 + 360 = 684\ cm^2$

Then, the surface area of the pyramid is $684\ cm^2$.

Researcher : Have you checked your answer again?

SP6 : Yes, I have.

3.1.2.4 Discussion

Based on snippets of test results and interviews with SP6 and SP7 subjects, a summary of the analysis is presented in Table 2.

TABLE 2 Analysis of Reversible Thinking Mathematical Ability of Medium Subjects

Subject	Aspect	Test Result	Result Interview	Conclusion	Category
SP6	*Negation or Invers*	Meet	Meet	Meet	Able
SP7		Meet	Meet	Meet	
SP6	*Reciprocity*	Not Meet	Not Meet	Not Meet	Not Able
SP7		Not Meet	Not Meet	Not Meet	
SP6	Return To Initial Data After Getting Result	Not Meet	Not Meet	Not Meet	Not Able
SP7		Not Meet	Not Meet	Not Meet	

3.1.3 *Reversible Thinking* Mathematical Group of Low Group Subjects

In this group, researchers looked at three aspects, namely negation or inverse, reciprocity, and returning to the initial data after getting results.

3.1.3.1 *Negation or Invers*

A snapshot of SP28 reversible thinking mathematical test results related to the negation or inverse aspect is presented in Figure 13.

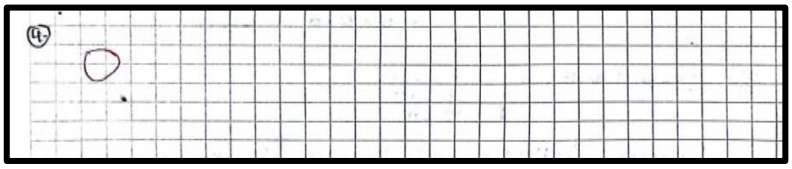


Figure 13 work on SP28 aspect *negation or invers*

Figure 13 shows that SP28 was unable to reverse the given problem (reversal of mathematical operations). SP28 was not able to explain the process of moving the segment from $1.296 = \frac{1}{3} \times 18 \times 18 \times t$ to $1.296 = 6 \times 18 \times t$ then $1.296 = 108\,t$ to $t = \frac{1.296}{108}$ the result is obtained $t = 12\,cm$. Hal ini menunjukkan bahwa SP28 tidak memenuhi aspek *negation or invers.* Strengthened by the results of the interview as follows.

Researcher : What is known in this problem?
SP28 : Sorry, I can't work on this problem, because I don't know how to solve it.

The snippet of SP29's mathematical reversible thinking test results related to the negation or inverse aspect is presented in Figure14.

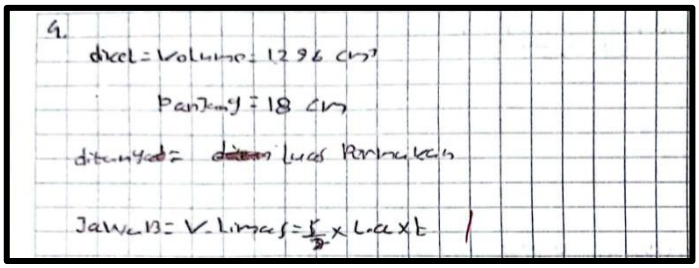


Figure 14 work result on SP7 aspect *negation or invers*

Figure 14 shows that SP29 was unable to reverse the given problem (reversal of mathematical operations). SP29 was not able to explain the process of moving the segment from $1.296 = \frac{1}{3} \times 18 \times 18 \times t$ to $1.296 = 6 \times 18 \times t$ then $1.296 = 108\,t$ to $t = \frac{1.296}{108}$ the result is $t = 12\,cm$. This shows that SP29 did not fulfill the negation or inverse aspect. Strengthened by the results of the interview as follows.

Researcher : What is known in this problem?
SP29 : The volume of the pyramid and the length of the base of the pyramid.
Researcher : What is asked in this question?
SP29 : The surface area of the pyramid
Researcher : Explain how do you do this problem?
SP29 : Sorry, I don't understand. I just answered with the formula is: $v = \frac{1}{2} \times La \times t$.

3.1.3.2 *Reciprocity*

The snippets of SP28 and SP29 mathematical reversible thinking test results related to the reciprocity aspect are presented in Figure15.

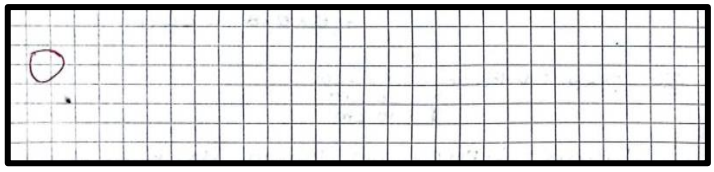


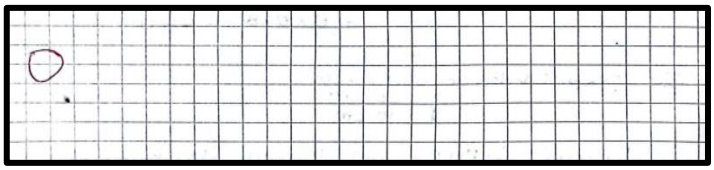
Figure 15 SP28 and SP29 reciprocity results

Figure 15 shows that SP28 and SP29 are unable to use compensation or other relationships that are equivalent to the problem given. This shows that SP28 did not fulfill the reciprocity aspect where SP28 was not able to use compensation or other relationships equivalent to the given problem correctly. Strengthened by the results of the interview as follows.

Researcher : What is known in this problem?
SP28 dan SP29 : Sorry, I can't do this problem, because I don't know how to solve it.

3.1.3.3 Returning To The Initial Data After Getting The Results

The snippets of SP28 and SP29 reversible thinking mathematical test results related to the aspect of returning to the initial data after getting the results are presented in Figure16.



Gambar 16 The work SP28 dan SP29
aspects of returning to the initial data after getting the results

Figure 16 shows that SP28 and SP29 were unable to return to the original problem after obtaining the results using the correct procedure according to what was instructed in the problem. This shows that SP28 did not fulfill the aspect of returning to the initial data after getting the results. Reinforced by the results of the interview as follows.

Researcher : What is known in this problem?
SP28 dan SP29 : Sorry, I can't work on this problem, because I don't know how to solve it.

3.1.3.4 Discussion

Based on snippets of test results and interviews with SP6 and SP7 subjects, a summary of the analysis is presented in Table 2.

TABLE 2 Analysis of Low Subject Mathematical Reversible Thinking Ability

Subject	Aspect	Test Result	Result Interview	Conclusion	Category
SP28	*Negation or Invers*	Not Meet	Not Meet	Not Meet	Not Able
SP29		Not Meet	Not Meet	Not Meet	
SP28	*Reciprocity*	Not Meet	Not Meet	Not Meet	Not Able
SP29		Not Meet	Not Meet	Not Meet	
SP28	Return To Initial Data After Getting Result	Not Meet	Not Meet	Not Meet	Not Able
SP29		Not Meet	Not Meet	Not Meet	

The results showed that the ability of reversible thinking mathematics of class VIII.3 students at SMPN 8 Bukittinggi was categorized as moderate. Achievement in the negation or inverse aspect with moderate category, achievement in the reciprocity aspect with moderate category and achievement in the aspect of returning to the initial data after getting results with moderate category. Based on the interview that were conducted the result showed that, the high group students had able to complete the reversible thinking mathematical ability test questions well. However, there are still small mistakes made by students in working on the problems given. Medium group students have also been able to solve the problem of reversible thinking mathematical ability, it's just that there are some aspects that have not been achieved. While low group students most of the mathematical reversible thinking ability test questions given have not been able to be answered and there are even just answers, besides that the answers they describe are not in accordance with the achievement of the expected aspects. The low ability of reversible thinking mathematical students in class VIII.3 SMPN 8 Bukittinggi is influenced by several factors, including students not mastering lessons on flat-sided space geometry material so that students are unable to solve the reversible thinking mathematical problems given correctly, besides that this is influenced by the thinking process or reasoning of students in two-way reasoning, namely thinking the opposite well which is influenced by the attitude of not daring to answer and present answers to the problems being worked on, as well as the lack of paying attention to educators when explaining the material and not repeating the lessons at home.

4. Conclusion

The results of this study indicate that the mathematical reversible thinking ability of class VIII.3 students at SMPN 8 Bukittinggi is categorized as medium ability. Based on the results of the interview, it can be concluded that high group students have been able to master all aspects (fulfill the aspects of negation or inverse, reciprocity, and return to the initial data after getting results) of mathematical reversible thinking ability so that students are able to solve the test questions of mathematical reversible thinking ability well. However, there are still small mistakes made by students in solving the problems given. In the medium group students have a fairly good mathematical reversible thinking ability in mastering each aspect, but there are still some aspects that have not been achieved. Whereas in the low group students, most students have not been able to master aspects of mathematical reversible thinking ability so that students are unable to solve the test questions given.

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