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Profile of Students' Conceptual Understanding of the Pythagorean Theorem Viewed from Learning Styles

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ABSTRACT

Conceptual understanding of mathematics enables individuals to explore and comprehend mathematical concepts. However, many students face obstacles in mastering these concepts due to various internal and external factors. This study aims to describe the profile of students' conceptual understanding of the Pythagorean Theorem in Grade VIII of SMP Negeri 1 Sigi viewed from learning styles. This research employed a descriptive qualitative approach. Data were collected through a learning style questionnaire, written tests, and interviews, and analyzed using the Miles and Huberman model with time triangulation to ensure data credibility. The results show that all three subjects PA (visual), IM (auditory), and COM (kinesthetic) met all three conceptual understanding indicators: restating a concept, presenting a concept in mathematical representation, and using and selecting certain operational procedures. However, differences were found in their thinking process characteristics: the visual subject demonstrated strong visual-spatial reasoning; the auditory subject showed structured verbal reasoning; and the kinesthetic subject applied systematic step-by-step procedures guided by contextual cues. It is concluded that learning style influences not only learning outcomes but also the characteristics of students' conceptual understanding profiles.

1. Introduction

Education is one of the fundamental aspects of human life that functions to develop skills and realize the character and civilization of a nation. Aniek et al., (2019) stated that a person can acquire knowledge and skills that are very helpful in life through education, as it is one of the most important needs for every individual. One of the subjects that plays an important role in education is mathematics. Mathematics is taught from the primary level of education through higher education, making it a subject of considerable importance for the academic success of students. Yanala et al., (2021) stated that mathematics is a science with objective

truth, making it essential for students to thoroughly understand its basic concepts to solve various problems in their learning.

Mathematics plays an important role in efforts to improve the quality of human resources. Given the importance of mathematics as a foundational science, mathematics learning at various levels of formal education requires serious attention. One of the goals of mathematics learning is for students to have a good conceptual understanding as a basis for developing problem-solving skills (Siswondo & Agustina, 2021). Anwar et al., (2026) emphasized that students' conceptual understanding remains relatively low, particularly in topics requiring abstract and representational thinking, and that adaptive learning approaches accommodating students' individual learning characteristics are needed to improve outcomes.

Mathematical conceptual understanding is a skill that enables individuals to explore and comprehend various concepts in mathematics. Many students frequently encounter obstacles in mastering these concepts due to various factors, both internal and external (Rahmawati & Roesdiana, 2022). Alqadri & Munawwarah, (2025) emphasized that students often hold incomplete or incorrect mental models of concepts, and that these conceptual gaps significantly hinder their ability to develop accurate and durable understanding. This highlights the importance of understanding not only whether students arrive at correct answers, but how they think about and represent mathematical concepts in the process of solving problems. Therefore, the development of effective education and teaching is essential to support students' progress in the subject of mathematics, particularly in identifying the factors that shape the way students understand and demonstrate conceptual knowledge.

One of the mathematics topics that requires strong conceptual understanding is the Pythagorean Theorem. The Pythagorean Theorem is one of the topics taught at the junior high school level and is closely related to everyday life (Nurkhaeriyah et al., 2018). According to Rohmah, (2020), There are several errors made by students in solving Pythagorean Theorem problems, including: (1) errors in understanding the concept of the Pythagorean Theorem; (2) errors in understanding the language of the problem; and (3) errors in principles. Mayasari & Habeahan, (2021) also stated that students' mathematical conceptual understanding ability remains low, and this is reinforced by Hendrakus et al., (2022) who found that students' conceptual understanding is still relatively low, particularly regarding the Pythagorean Theorem. Based on interviews with mathematics teachers at SMP Negeri 1 Sigi, it was found that students' conceptual understanding of the Pythagorean Theorem is still lacking. Some students have difficulty drawing right-angled triangles, identifying the hypotenuse, and performing square root calculations.

One factor that influences conceptual understanding is learning style (Nurlia et al., 2021). Learning style refers to the unique differences in learning or the way students understand instruction, which, when applied in accordance with students' characteristics, will encourage them to learn more quickly and meaningfully

(Ambarita, 2022). According to DePorter & Hernacki (in Ningrat et al., 2018), Learning styles consist of three types: visual (learning by seeing), auditory (learning by listening), and kinesthetic (learning by moving). Nuuryadin et al., (2026) found that visual learning styles had a positive and significant effect on students' mathematical understanding. Similarly, Sakina et al., (2026) demonstrated that learning style differences influence the characteristics of students' mathematical conceptual understanding, including how students process and represent mathematical concepts. These findings suggest that examining conceptual understanding through the lens of learning styles can reveal important nuances in students' thinking that would otherwise remain hidden. Based on this background, this study aims to describe the profile of conceptual understanding of Grade VIII students at SMP Negeri 1 Sigi on the Pythagorean Theorem material based on visual, auditory, and kinesthetic learning styles.

2. Methodology

This research is descriptive with a qualitative approach. Qualitative descriptive research aims to describe or explain certain phenomena or events in the form of words or narratives, without using numbers or statistics. This approach focuses more on a deep understanding of the research subjects rather than quantitative measurement. This research was conducted at SMP Negeri 1 Sigi, located at Jalan Karajalemba No. 21, Mpanau, Sigi Biromaru District, Sigi Regency, Central Sulawesi Province, during the even semester of the 2025/2026 academic year.

The research subjects were selected from students of class VIII B at SMP Negeri 1 Sigi, totaling 28 students. Subject selection was carried out by grouping students based on their learning style results, namely visual, auditory, and kinesthetic learning styles. The grouping was obtained by administering a learning style questionnaire. From each learning style, the student with the highest score was identified, and the researcher then selected only 3 students one with a visual learning style, one with an auditory learning style, and one with a kinesthetic learning style. To facilitate data collection, the researcher selected high ability students as the sample from each learning style. In determining high ability students, the researcher consulted and requested recommendations from the mathematics subject teacher.

The data collection techniques employed were a learning style questionnaire, written tests, and interviews. The learning style questionnaire used in this study was the Victoria Chrislett and Alan Chapman learning style questionnaire as developed by Nizaruddin et al., (2020). The written test on conceptual understanding of the Pythagorean Theorem was validated by a mathematics education lecturer, Dr. Gundung Sugita, M.Si., to ensure content validity and alignment with the three conceptual understanding indicators used. The interview guide was also validated to ensure that the questions posed could effectively explore students' conceptual understanding in accordance with the research objectives. The data credibility checking technique in this qualitative research was carried out through time triangulation, in which each subject was given two written tests, S1 and S2, at

different times. The consistency of answers between S1 and S2 was compared to verify the reliability of each subject's conceptual understanding profile.

The data analysis technique in this study refers to qualitative data analysis according to Miles and Huberman, namely: Data Condensation, Data Display, and Conclusions Drawing (Thalib, 2022). Data condensation refers to the process of selecting, focusing, simplifying, abstracting, and transforming data that approximates the entirety of written field notes, interview transcripts, documents, and empirical materials. Data display is the process of organizing, unifying, and summarizing relevant information from the existing data. Through data display, complex information can be broken down into a more structured and easily understood form. The conclusion drawing activity in this study was carried out by describing the results of the data display in relation to the conceptual understanding indicators that had been achieved by the students, which were then analyzed, so that conclusions could be drawn from the data presentation.

3. Results and Discussion

Prior to the main data collection, the researcher coordinated with the mathematics teacher of class VIII B to schedule the research activities. The teacher introduced the researcher to the students and explained the purpose of the study. The researcher then distributed the VAK learning style questionnaire to all 28 students of class VIII B and gave them adequate time to complete it independently. After collecting and analyzing the questionnaire results, the teacher assisted the researcher in identifying one representative student from each learning style category based on both the questionnaire outcomes and the teacher's knowledge of each student's academic and communicative characteristics. The three selected subjects were: subject PA representing the visual learning style, subject IM representing the auditory learning style, and subject COM representing the kinesthetic learning style.

The selected subjects then participated in two rounds of written tests on Pythagorean Theorem conceptual understanding, conducted at different times to allow for time triangulation. Following each test, the researcher conducted individual semi-structured interviews with each subject to explore their reasoning and verify their written answers. All interview sessions were recorded and transcribed for analysis. The data from the written tests and interviews were then analyzed using the Miles and Huberman model to construct the conceptual understanding profile of each subject across three indicators: (1) restating a concept, (2) presenting a concept in mathematical representation (drawing), and (3) using, utilizing, and selecting certain operational procedures. A summary of indicator achievement across all three subjects is presented in Table 1 below.

The overall pattern of conceptual understanding fulfilled by the three subjects across the three indicators is summarized in Table 1, which serves as a reference point before each indicator is discussed in more detail in the following subsections.

Table 1. Summary of Conceptual Understanding Indicator Achievement per Subject

Indicator	PA (Visual)	IM (Auditory)	COM (Kinesthetic)
Restating a Concept	Met ✓	Met ✓	Met ✓
Presenting Concept in Mathematical Representation (Drawing)	Met ✓	Met ✓	Met ✓
Using, Utilizing and Selecting Procedures/Operations	Met ✓	Met ✓	Met ✓

a. Data Presentation of Subject PA with Visual Learning

1. Restating a Concept

The results of PA's written test in restating a concept that has been learned are presented in Figure 1.

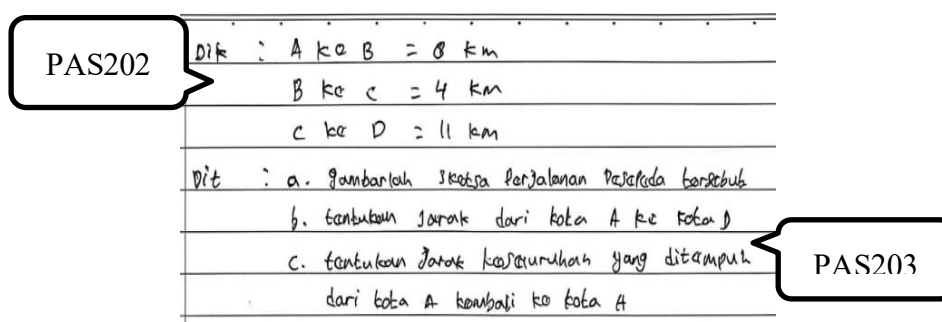


Figure 1. Subject PA's Answer in Restating a Concept

Based on Figure 1, PA's answer shows that PA wrote down the known information in the word problem, namely that a cyclist moved from city A eastward 8 km to city B, then northward 4 km to city C. After resting, the cyclist continued westward 11 km to city D. Subject PA was also able to re-explain what was asked: part a, to draw a sketch of the cyclist's journey; part b, to determine the distance between city A and city D; and part c, to determine the total distance traveled from city A back to city A. The researcher then conducted an interview with PA to obtain further information. The following are the interview results with PA:

- PIS201 : Do you understand the problem?
 PAS201 : Yes, I understand.
 PIS202 : From the word problem, please retell what you know.
 PAS202 : What I know is that a cyclist travels from city A eastward 8 km to city B, then northward 4 km to city C. After resting, the cyclist continues westward 11 km to city D
 PIS203 : Is there anything else you know?
 PAS203 : Yes, what is also asked is: draw a sketch of the cyclist's journey, determine the distance between city A and city D, and determine the total distance traveled from city A back to city A.

2. Presenting Concepts in the Form of Mathematical Representation (Drawing)

The results of PA's written test in presenting a concept in the form of mathematical representation (drawing) that has been learned are presented in Figure 2.

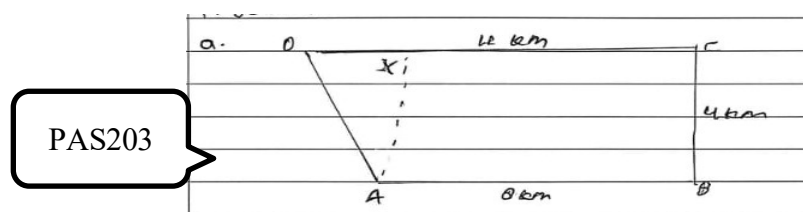


Figure 2. Subject PA's Answer in Presenting Concepts in the Form of Mathematical Representation (Drawing)

Based on Figure 2, PA's answer shows that PA drew the journey from point A eastward to point B for 8 km, then from point B northward to point C for 4 km, then from point C westward to point D for 11 km, and since the question asked for the distance from point A to point D, a line was drawn from point A to point D. The researcher then conducted an interview with PA to obtain further information. The following are the interview results with PA:

PIS201 : Is the drawing like this?

PAS201 : Yes.

PIS202 : How were you able to draw this?

PAS202 : I drew it following the cardinal directions and reading the description in the problem.

PIS203 : Could you explain in detail?

PAS203 : First, I placed a point as city A, then drew eastward to point B for 8 km, then from point B northward to point C for 4 km, then from point C westward to point D for 11 km, and since the question asked for the distance from point A to point D, I drew a line from point A to city D.

PIS204 : Are you confident in the drawing you made?

PAS204 : Yes.

3. Using, Utilizing, and Selecting Certain Procedures or Operations

The results of PA's written test in using, utilizing, and selecting certain procedures or operations that have been learned are presented in Figure 3.

PAS201

PAS204

PAS205

B. Dik. Jaraknya Sistem-Sistem, $AB = 8$ km dan $CB = 4$ km

$DC = 11$ km

Jarak A ke D

$$AD^2 = AB^2 + BC^2 + CD^2$$

$$= 8^2 + 4^2 + 11^2$$

$$= 64 + 16 + 121$$

$$AD^2 = 201$$

$$AD = \sqrt{201}$$

$$= 14.17$$

C. Jarak A Kembali ke A = $AB + BC + CD + DA$

$$= 8 + 4 + 11 + 14.17$$

$$= 37.17$$

Figure 3. Subject PA's Answer in Using, Utilizing, and Selecting Certain Procedures or Operations

Based on Figure 3, PA's answer in using, utilizing, and selecting certain procedures or operations shows that PA was able to solve part b. The first step PA took was to find the value of Dx , where $Dx = CD + AB = 11 - 8 = 3$ km. PA then found the value of AD using the Pythagorean Theorem formula, namely $AD^2 = Ax^2 + Dx^2$, then substituting the values of Ax and Dx , obtaining $AD^2 = 4^2 + 3^2$, $AD^2 = 16 + 9$, $AD^2 = 25$, $AD = \sqrt{25} = 5$. Based on this calculation, the distance from A to D is 5 km. The researcher then conducted an interview with PA to obtain further information. The following are the interview results with PA:

- PIS201 : How did you solve part b of the problem?
 PAS201 : First, I found Dx by subtracting distance AB from distance CD , that is, $11 - 8 = 3$, so the value of Dx is 3.
 PIS202 : Then what?
 PAS202 : I found the value of AD using the Pythagorean Theorem formula.
 PIS203 : Please state the Pythagorean Theorem formula.
 PAS203 : $a^2 + b^2 = c^2$
 PIS204 : Then what?
 PAS204 : I found the value of AD using the formula $AD^2 = Ax^2 + Dx^2$, then I substituted the values of Ax and Dx : $AD^2 = 4^2 + 3^2$, $AD^2 = 16 + 9$, $AD^2 = 25$, $AD = \sqrt{25} = 5$, so the result of AD is 5.
 PIS205 : Then for part c?
 PAS205 : For part c, I added up all the sides, namely $AB + BC + CD + AD = 8 + 4 + 11 + 5 = 28$, so the answer is 28.
 PIS206 : Are you sure about the answer?
 PAS206 : Yes.

b. Data Presentation of Subject IM with Auditory Learning Style

1. Restating a Concept

The results of IM's written test in restating a concept that has been learned are presented in Figure 4.

IMS202	Diketahui : Kota A ke B = 8 km
	Kota B ke C = 4 km
	Kota C ke D = 11 km
IMS203	Ditanyakan : a. Gambarkan sketsa perjalanan pesepeda tersebut
	b. Tentukan jarak dari kota A ke kota D
	c. Tentukan jarak keseluruhan yang ditempuh dari kota A kembali kota A

Figure 4. Subject IM's Answer in Restating a Concept

Based on Figure 4, IM's answer shows that IM wrote down the known information in the word problem, namely city A to city B = 8 km, city B to city C = 4 km, and city C to city D = 11 km. Subject IM was also able to explain what was asked: part a, to draw a sketch of the cyclist's journey; part b, to determine the distance from city A to city D; and part c, to determine the total distance traveled from city A back

to city A. The researcher then conducted an interview with IM to obtain further information. The following are the interview results with IM:

- PIS201 : Do you understand the problem?
 IMS201 : Yes.
 PIS202 : From the word problem, please retell what you know.
 IMS202 : It is known that a cyclist moved from city A eastward 8 km to city B, then northward 4 km to city C. After resting, the cyclist continued westward 11 km to city D.
 PIS203 : Is there anything else you know?
 IMS203 : Yes, what is asked is: part a, draw a sketch of the cyclist's journey; part b, determine the distance between city A and city D; part c, determine the total distance traveled from city A back to city A.

2. Presenting Concepts in the Form of Mathematical Representation (Drawing)

The results of IM's written test in presenting a concept in the form of mathematical representation (drawing) that has been learned are presented in Figure 5.

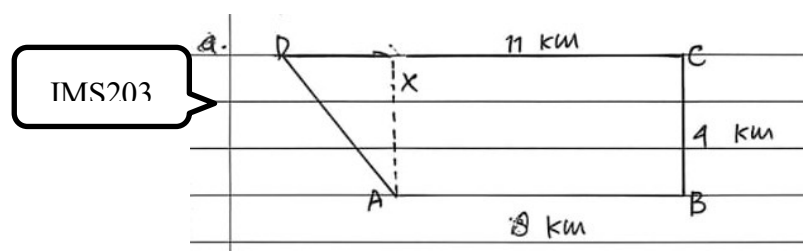


Figure 5. Subject IM's Answer in Presenting Concepts in the Form of Mathematical Representation (Drawing)

Based on Figure 5, IM's answer shows that IM drew the journey from point A eastward to point B for 8 km, then from point B northward to point C for 4 km, then from point C westward to point D for 11 km, and since the question asked for the distance from point A to point D, a line was drawn from point A to city D. The researcher then conducted an interview with IM to obtain further information. The following are the interview results with IM:

- PIS201 : Is the drawing like this?
 IMS201 : Yes.
 PIS202 : How were you able to draw this?
 IMS202 : I simply followed the route sequence from A to B, to C, to D, using the cardinal directions.
 PIS203 : Could you explain in detail?
 IMS203 : First, I drew a line from point A eastward to point B for 8 km, then northward to point C for 4 km, then westward to point D for 11 km. After that, I drew a line from city A to city D and added point x, making the drawing look like this.
 PIS204 : Are you confident in the drawing you made?

IMS204 : Yes.

3. Using, Utilizing, and Selecting Certain Procedures or Operations

The results of IM's written test in using, utilizing, and selecting certain procedures or operations that has been learned are presented in Figure 6.

b. panjang $AB = Cx$, $BC = Ax$
 $Dx = CD - AB$
 $Dx = 11 - 8$
 $Dx = 3$
 Mencari jarak A ke D
 $AD^2 = Dx^2 + Ax^2$
 $AD^2 = 3^2 + 4^2$
 $AD^2 = 9 + 16$
 $AD^2 = 25$
 $AD = \sqrt{25}$
 $AD = 5$
 jadi jarak kota A ke D adalah 5
 c. jarak A ke A = jarak AB + jarak BC + jarak CD + jarak DA
 $= 8 + 4 + 11 + 5$
 $= 28$

Callouts:
 IMS201 points to $Dx = CD - AB$
 IMS204 points to $AD^2 = 3^2 + 4^2$
 IMS205 points to $AD = 5$

Figure 6. Subject IM's Answer in Using, Utilizing, and Selecting Certain Procedures or Operations

Based on Figure 6, IM's answer in using, utilizing, and selecting certain procedures or operations shows that IM was able to solve part b. The first step IM took was to find the value of Dx , where $Dx = CD + AB = 11 - 8 = 3$ km. IM then found the value of AD using the Pythagorean Theorem formula, namely $AD^2 = Ax^2 + Dx^2$, then substituting the values of Ax and Dx, obtaining $AD^2 = 4^2 + 3^2$, $AD^2 = 16 + 9$, $AD^2 = 25$, $AD = \sqrt{25} = 5$. The researcher then conducted an interview with IM to obtain further information. The following are the interview results with IM:

- PIS201 : How did you solve part b of the problem?
 IMS201 : First, I found DX by subtracting distance AB from distance CD, that is $11 - 8 = 3$.
 PIS202 : Then what?
 IMS202 : I found the value of AD using the Pythagorean Theorem formula.
 PIS203 : Please state the Pythagorean Theorem formula.
 IMS203 : $c^2 = a^2 + b^2$
 PIS204 : Then what?
 IMS204 : I found the value of AD using the formula $AD^2 = Ax^2 + Dx^2$, then I substituted the values of Ax and Dx: $AD^2 = 4^2 + 3^2$, $AD^2 = 16 + 9$, $AD^2 = 25$, $AD = \sqrt{25} = 5$, so the result of AD is 5.
 PIS205 : Then for part c?
 IMS205 : For part c, I calculated all the sides: $AB + BC + CD + AD = 8 + 4 + 11 + 5 = 28$, so the answer is 28 km.
 PIS206 : Are you confident in your answer?
 IMS206 : Yes.

c. Data Presentation of Subject COM with Kinesthetic Learning Style

1. Restating a Concept

The results of COM's written test in restating a concept that has been learned are presented in Figure 7.

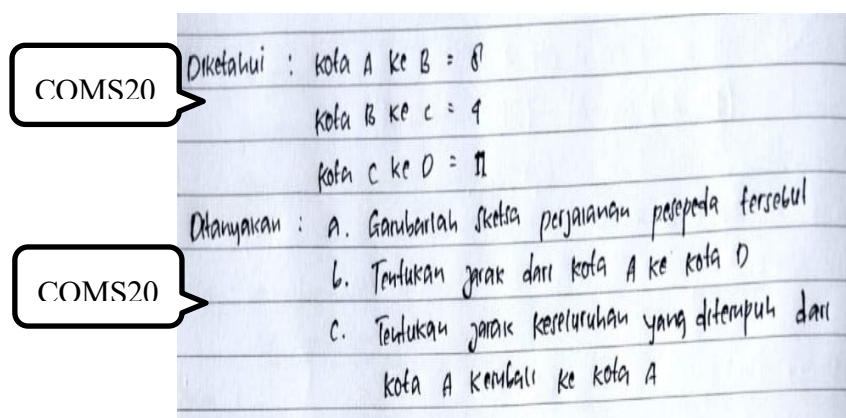


Figure 7. Subject COM's Answer in Restating a Concept

Based on Figure 7, COM's answer shows that COM explained the known information in the word problem, namely city A to city B = 8 km, city B to city C = 4 km, and city C to city D = 11 km. Subject COM was also able to explain what was asked: part a, to draw a sketch of the cyclist's journey; part b, to determine the distance from city A to city D; and part c, to determine the total distance traveled from city A back to city A. The researcher then conducted an interview with COM to obtain further information. The following are the interview results with COM:

- PIS201 : Do you understand the problem?
 COMS201 : Yes, I understand.
 PIS202 : From the word problem, please retell what you know.
 COMS202 : It is known that a cyclist moved from city A eastward 8 km to city B, then northward 4 km to city C. After resting, the cyclist continued westward 11 km to city D.
 PIS203 : Is there anything else you know?
 COMS203 : Yes, what is asked is: part a, draw a sketch of the cyclist's journey; part b, determine the distance between city A and city D; part c, determine the total distance traveled from city A back to city A.

2. Presenting Concepts in the Form of Mathematical Representation (Drawing)

The results of COM's written test in presenting a concept in the form of a mathematical representation (drawing) that has been learned are presented in Figure 8.

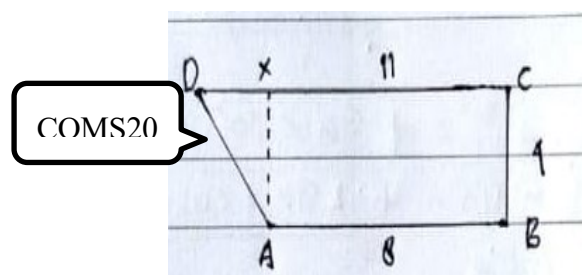


Figure 8. Subject COM's Answer in Presenting Concepts in the Form of Mathematical Representation (Drawing)

Based on Figure 8, COM's answer shows that COM was able to draw what was described in the word problem given by the researcher, where COM depicted point a as city A eastward toward city B or point b for 8 km, then point b northward toward city C or point c for 4 km, then point C westward toward city D or point d for 11 km, and then drew a line from city A to city D. The researcher then conducted an interview with COM to obtain further information. The following are the interview results with COM:

- PIS201 : Is the drawing like this?
 COMS201 : Yes.
 PIS202 : How were you able to draw this?
 COMS202 : I followed the directions given for the problem.
 PIS203 : Could you explain in detail?
 COMS203 : First, I drew a line from A to B for 8 km, then continued from B to C for 4 km, then from C to D for 11 km. After that, I drew a line from city A to city D and added point x.
 PIS204 : Are you confident in the drawing you made?
 COMS204 : Yes.

3. Using, Utilizing, and Selecting Certain Procedures or Operations

The results of COM's written test in using, utilizing, and selecting certain procedures or operations that have been learned are presented in Figure 9.

COMS20

b. $AB = 8 \text{ km}$ dan $BC = 4 \text{ km}$ $AD^2 = DX^2 + AX^2$
 $DX = CD - AB$ $AD^2 = 3^2 + 4^2$
 $DX = 11 \text{ km} - 8 \text{ km}$ $AD^2 = 9 + 16$
 $DX = 3 \text{ km}$ $AD^2 = 25$
 $AD = \sqrt{25}$ $AD = 5$

COMS204

c. Jarak A ke A = $AB + BC + CD + DA$
 $= 8 + 4 + 11 + 5$
 $= 28$

COMS20

Figure 9. Subject COM's Answer in Using, Utilizing, and Selecting Certain Procedures or Operations

Based on Figure 9, COM's answer in using, utilizing, and selecting certain procedures or operations shows that COM was able to solve part b. The first step COM took was to find the value of Dx, where $Dx = CD + AB = 11 - 8 = 3$ km. COM then found the value of AD using the Pythagorean Theorem formula, namely $AD^2 = Ax^2 + Dx^2$, then substituting the values of Ax and Dx, obtaining $AD^2 = 4^2 + 3^2$, $AD^2 = 16 + 9$, $AD^2 = 25$, $AD = \sqrt{25} = 5$. The researcher then conducted an interview with COM to obtain further information. The following are the interview results with COM:

- PIS201 : How did you solve part b of the problem?
 COMS201 : First, I found the value of DX by subtracting AB from CD, that is $11 - 8 = 3$.
 PIS202 : Then what?
 COMS202 : Then I found the value of AD using the Pythagorean Theorem formula.
 PIS203 : Please state the Pythagorean Theorem formula
 COMS203 : $c^2 = a^2 + b^2$
 PIS204 : Then what?
 COMS204 : I found the value of AD using the formula $AD^2 = Ax^2 + Dx^2$, then I substituted the values of Ax and Dx: $AD^2 = 4^2 + 3^2$, $AD^2 = 16 + 9$, $AD^2 = 25$, $AD = \sqrt{25} = 5$, so the result of AD is 5.
 PIS205 : Then for part c?
 COMS205 : For part c, I added $AB + BC + CD + AD = 8 + 4 + 11 + 5 = 28$, so the answer is 28.
 PIS206 : Are you confident in your answer?
 COMS206 : Yes, I am confident.

Discussion

Profile of Conceptual Understanding of Students with a Visual Learning Style

Based on the data analysis of subject PA, PA was able to reexplain the known information and what was asked in a detailed and accurate manner across both tests. This finding is consistent with (Wawan et al., 2017), who stated that subjects with visual learning styles meet the indicators of conceptual understanding, including the ability to identify and reexpress information contained in a mathematical problem. Nuuryadin et al., (2026) further confirmed that visual learning styles positively influence students' mathematical understanding, as students with this style tend to process information more effectively through visual and graphical representations. Regarding the second indicator, PA demonstrated the ability to construct geometrically accurate sketches by systematically applying cardinal directions, which reflects strong visual-spatial reasoning. This is supported by Ilhamsyah & Bahar, (2024) who stated that students with visual learning styles are able to communicate situations in the form of drawings and connect them to mathematical models. Regarding the third indicator, PA correctly applied the Pythagorean Theorem formula and arrived at accurate answers for both parts b and c. These findings are consistent with Sakina et al., (2026), who found that visual

learners demonstrate systematic approaches to procedural problem-solving, often relying on visual arrangements and representations to structure their calculations. Taken together, the profile of subject PA reveals that visual learners characteristically demonstrate conceptual understanding through strong graphical representation, clear identification of problem components, and systematic procedural application. These characteristics are distinct from those observed in auditory and kinesthetic learners, even though the outcome of meeting all three indicators is the same.

Profile of Conceptual Understanding of Students with an Auditory Learning Style

Based on the data analysis of subject IM, IM was able to restate the known information and what was asked in a structured and sequential manner, which is consistent with the verbal characteristic of auditory learners. This finding is in line with Wawan et al. (2017) who stated that subjects with auditory learning styles meet the indicators of conceptual understanding. A key characteristic observed in IM's thinking process was the tendency to explain steps verbally before committing to written answers. During the interviews, IM consistently articulated the reasoning process in an oral, step-by-step manner before finalizing responses. This is aligned with the characteristics of auditory learners described by DePorter and Hernacki, who learn effectively by hearing and verbalizing information. Regarding the second indicator, IM was able to correctly draw the sketch by following the route sequence from A to B to C to D using cardinal directions, and added point x to indicate the geometric relationship. Regarding the third indicator, IM correctly applied the Pythagorean Theorem and arrived at the correct answers for both parts b and c. These results indicate that auditory learners can fully meet all three conceptual understanding indicators, with the distinguishing feature being the verbal and oral nature of their thinking process rather than the accuracy of outcomes.

Profile of Conceptual Understanding of Students with a Kinesthetic Learning Style

Based on the data analysis of subject COM, COM was able to restate in detail what was known and what was asked in both Pythagorean Theorem problems. This finding differs from what was reported by Wawan et al., (2017) who stated that not all students with kinesthetic learning styles are able to meet all indicators, and from Tonda et al., (2020) who found that kinesthetic learners tend to make errors in restating concepts. In this study, COM demonstrated the ability to fully restate the concept in both test sessions, which is consistent with Abdillah et al., (2022), who found that kinesthetic learners were able to meet more indicators than expected. Regarding the second indicator, COM successfully drew the sketch by following the directional cues step by step. Although Khoirunnisa & Soro, (2021) found that kinesthetic learners were only able to meet two mathematical representation indicators, and Giriansyah et al., (2023) showed that kinesthetic students have limitations in representation, the present study found that COM successfully drew the sketch while correctly applying all cardinal directions. Regarding the third indicator, COM was able to correctly apply the Pythagorean Theorem procedure. A

key characteristic of COM's thinking process was its sequential and step-by-step nature, guided by the physical order of information presented in the word problem. This aligns with kinesthetic learning characteristics, where understanding is built through concrete, sequential actions. Pratiwi et al., (2026) similarly observed that individual cognitive characteristics significantly influence how students construct mathematical concepts. Overall, the profile of COM reveals that kinesthetic learners demonstrate conceptual understanding through a characteristic pattern of systematic, step by step procedural reasoning guided by contextual cues, which differs qualitatively from the graphical-spatial approach of visual learners and the verbal-explanatory approach of auditory learners.

4. Conclusion

This study concludes that students with visual, auditory, and kinesthetic learning styles all met the three indicators of conceptual understanding of the Pythagorean Theorem, namely restating a concept, presenting a concept in mathematical representation, and using and selecting certain operational procedures. However, differences were found in the characteristics of their thinking processes. The visual learner demonstrated conceptual understanding through strong visual-spatial reasoning and graphical representation. The auditory learner demonstrated understanding through structured verbal reasoning and oral explanation prior to written work. The kinesthetic learner demonstrated understanding through systematic, sequential step-by-step procedures guided by the contextual order of information in the problem. These distinct profiles confirm that learning style does not merely affect learning outcomes but also shapes the way students think about and demonstrate their understanding of mathematical concepts. These findings carry practical implications for mathematics teachers. By recognizing the diverse learning style profiles in the classroom, teachers can design differentiated instructional strategies that align with students' individual characteristics, such as using visual aids for visual learners, oral discussion activities for auditory learners, and step-by-step contextual tasks for kinesthetic learners, thereby more effectively supporting the development of conceptual understanding for all students

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