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Analogical Reasoning Process Based On The Development Of High Order Thinking Skill Prospective Teacher Students

Supratman[1)], Subanji[2)], Muh. Zulfikar Mansyur[3)]

[1) & 3)] Universitas Siliwangi, Tasikmalaya, Jawa Barat, Indonesia e-mail: supratman@unsil.ac.id
[2)] Universitas Negeri Malang, Jawa Timur, Indonesia.

Abstract
This study aims to see the Analogy Reasoning Process Based on the Hots Development of Prospective Students When students solve the problems given by the researcher. While learning is taking place, prospective teacher students are given basic concepts to find the distance between 2 points, the distance between a point and a line and the bisector of the angle between two lines. So it is hoped that prospective teacher students can use it to solve problems on the basis of analogies and analogy targets. Based on the analogy of events on the basis of analogy and target analogy, it is expected that students' thinking processes include High Order Thinking Skills. So that after college students are able to apply High Order Thinking Skills when teaching at school. When students solve problems, students who are classified as High Order Thinking Skills (C4, C5, and C6 according to Bloom's B S and According to Krulik et al. Critikel thinking, and creative thinking) the results of student data analysis all optimize the use of concepts that have been mastered previously, able to avoid inaccuracies. complete thinking. substructure in the process of assimilation and accommodation, as well as avoiding mismatches in the use of thinking substructures in the process of assimilation or accommodation. What happened was (1) the problem accommodation process, (2) the strategy accommodation process, (3) the problem assimilation process, (4) the strategy assimilation process, (5) the relationship assimilation process, and (6) the relationship accommodation process. The processes in the steps of analogical reasoning when Problem-Solving in constructing the conic section equation are characterized by the following behavior/activities. In addition, this study found 2 interesting things, namely; (1) categorization or type of analogical reasoning when solving problems based on the hierarchy of thinking Krulik (2003) and (2) Not all students are able to determine the use of generally accepted concepts in constructing the equation of a conic section.

Keywords: assimilation, accommodation, Basic Analogy, Target Analogy, Construction of new knowledge, High Order Thinking Skill.

1. Introduction

Mathematics is a very important material because mathematics is closely related to other sciences. Aminu (1990) argues that mathematics is not only the language of science, but an essential nutrient for thinking, logical reasoning and progress. Mathematics frees the mind and also provides an assessment of intellectual abilities to individuals by pointing out the direction of improvement. In fact, with analogy reasoning ordinary students can be turned into gifted students (Supratman, et al 2017). Despite the fact that there are still many students who experience misconceptions in understanding the concept (Supratman, 2018). The fact that many conjectures in problem solving can be built with reasoning, especially with analogy reasoning (Supratman, S., 2019). Even problem solving through analogy reasoning can produce divergent thinking (Supratman, Herawati L, Akbar R E, 2019).

Therefore, the essence of Mathematics lies in its beauty and intellectual challenge. Both scientific breakthroughs and technological developments are facilitated by the proper language of Mathematics. This implies that there is a strong relationship between progress in mathematics and technological progress. Thus, every human being needs a certain amount of competence in basic mathematical topics for the purposes of handling money, running daily business, interpreting mathematical graphs and charts and thinking logically. (Bandura, 1997) In order for the abilities gained in learning mathematics to help the process of discovery and development of other fields, of course, you must first achieve the objectives of learning mathematics itself (Pala, 2016:1-2).

In learning mathematics, students are expected to be able to understand the concepts, and procedures for solving mathematical problems. However, currently there are still many students who have not been able to understand the concepts and procedures of solving mathematical problems well. Because according to Subanji & Supratman (2015) there are still students who are wrong in solving problems because the procedures taught are different from the questions. faced. This is because most mathematical concepts are abstract concepts that are difficult for students to understand, so a mathematical ability is needed that can help students understand mathematical concepts. One of the mathematical thinking skills is mathematical reasoning ability which is based on increasing students' high order thinking skills. It is realized that an increase in High order tinking skills (HOTs) needs to be carried out. As'ari AR, et al. (2019:6) states that there must be certain advantages in causing the government to often direct all its resources to improve student HOTS. It is said that HOTS enable children to have analytical competence, think critically, solve problems, increase creativity, and produce innovations.

This mathematical reasoning ability is one of the mathematical abilities that are expected to be mastered by students after learning takes place. Regulation of the Minister of National Education Number 22 of 2006 concerning Content Standards also states that the objectives of learning mathematics, one of which is to use reasoning on patterns and characteristics, to manipulate mathematics in making generalizations, compiling evidence, or explaining mathematical ideas and statements.

Sumarmo (2015:198) also mentions that this mathematical reasoning ability can develop logical, analytical, and critical thinking processes. This can be seen in the indicators that have been mentioned, namely directing students to be able to draw analogy conclusions, generalizations, and construct conjectures where the process is related to logical, analytical, and critical thinking processes.

Furthermore, Sumarmo (2015: 456) argues that based on an analysis of the work of several experts, mathematical reasoning can be classified into two types, namely inductive reasoning and deductive reasoning.

Furthermore, Sumarmo (2015: 460) explains that deductive reasoning is drawing conclusions based on agreed rules while inductive reasoning is drawing conclusions based on observations of limited data. This inductive reasoning consists of several parts, including transductive, analogy, and generalization, so that the analogy intended in this discussion is analogy reasoning.

The author examines the ability of analogical reasoning in learning because the ability of analogical reasoning is able to help students understand mathematical concepts and then be able to solve given mathematical problems.

For this reason, it is very important to increase the development of HOTS for prospective teachers, so that if they become teachers they have the skills to improve the HOTS of their students. Mathematics frees the mind and also provides an assessment of intellectual abilities to individuals by pointing out the direction of improvement. And the reality is that ordinary students can be turned into gifted students (Supratman, 2017). Despite the fact that there are still many students who experience misconceptions in understanding the concept (Supratman, 2018). The fact that many teachers have difficulty in understanding the curriculum content that must be taught (Supratman, S Ryane, R Rustina, 2016).

Therefore, the ability and mastery of problem-solving concepts and procedures need to be mastered by the teacher. So that prospective teachers must master the concepts and procedures in problem solving. Reasoning This analogy implies that there is a strong relationship between advances in mathematics and advances in technology. Thus, every human being needs a number of competencies in basic mathematical topics for the purposes of handling money, running daily business, interpreting mathematical graphs and charts and thinking logically (Bandura, 1997). Apart from all this, revealing the thinking process of students in receiving knowledge is very important so that teachers do not get caught up in delivering the material in accordance with the thinking processes of students, right? As for using the analogy process, Piaget adopts the theory of Subanji and Supratman (2015).

2. Theoretical Framework

2.1. Understanding Reasoning

We know that the thinking process is continuous and according to the thinking hierarchy. According to Krulik, Rudnick and Milou (2003: 89) thinking is divided into four categories, including (1) recall (remembering), (2) basic thinking (3) critical thinking, and (4) creative thinking and reasoning are part of the thinking process. While reasoning according to Piaget (Bybee. 1982: 133) "reasoning manifested are systematic and involve logically complex processes". In addition, according to Braine and O'Brien (Brown, C. 2007: 122) reasoning is logical and abstract thinking in the freedom to use the content of the rules used.

2.2. Understanding Analogy and Analogy Reasoning

Analogy according to Polya (1954: 14) from the word "analogy" the origin of the word "analogy" comes from the Greek which means "proportion". Furthermore, Polya (1954: 13) explains, analogy is a kind of similarity. This, one might say similarity on a more definite and more conceptual level, but could be expressed a little more accurately. According to Gentner, Holyoak, and Kokinov (2001), the general sense of analogy is the basic human ability to reason with a relational pattern. Humans are able to detect patterns to identify repeating patterns in the face of variations in elements, to abstract from patterns, and to communicate abstractions. The definition is literally analogous to similarity (Gentner and Markman, 1995; Goldstone, 1995; Markman and Gentner, 2000; Medin, Goldstone, and Gentner, 1993). Furthermore, Gentner and Markman, (1995) explain similarity involves overall fit at all levels. According to this view, the fit in relational structure rather than object attribute fit, even in the overall similarity assessment.

Analogy occurs when there are two interrelated events in its formation, namely the first event is used as the basis of analogy (DA) for the next event (Target Analogy) (TA) on the basis of similarities in using propositions (propositions/formulas), predicates, and objects (Holyoak). KJ and Thagard P, 1989). Furthermore, Holyoak K J and Thagard P said, analogy mapping can be seen as a process of finding the correspondence between the elements of the existing structure in DA and TA. In proportional representation, the elements will include propositions, predicates, and objects. Bullgren, Deshler, Schumalter, and Lenz, 2000; Mc.Daniel and Dannelly, 1996 (Slavin, 2006: 199) "Analogyes can help students learn new information by relating it to concepts they already know", whereas according to Reed (Tusyani, 2011: 302), analogy requires that solving problems using solutions of the same problem to solve the current problem. Halpern (Matlin, 1994: 350) states that analogy is using previous problem solutions to solve new problems. Fischbein, E. (2002: 127) explains, analogy is a very rich source of models. Two bodies, two systems are said to be analogous if, on the basis of certain partial similarities. One feels entitled to assume that the respective entities are equal in other respects as well. Gentner (1999: 17) explains, analogy is central in the study of learning and discovery, and analogy allows the transfer of all concepts, situations or different domains, and is used to explain new topics.

Several scholars have defined analogy reasoning (Gentner, D, 1983a; Matsumoto, D, Yoo, S.H., and Fontaine, J., 2008; Geathner and Rattermann, 1991; Holyoak, K.J. and Thagard P, 1989; Trench, Oberholzer and Minervino. R., 2002). Gentner, D, (1983a) suggests analogy reasoning is a type of reasoning that applies between certain cases, one case that is known about is used to conclude new information about another new case. Matsumoto, D, Yoo, S.H., and Fontaine, J., (2008) argue, analogy reasoning is a reasoning in which decisions about one thing or event are concluded based on the similarity of objects, including other things or events that are known. Holyoak, K.J. and Thagard P (1989) argue that the essence of analogy reasoning lies in the mapping process: establishing an orderly correspondence between the elements of the basic analogy source and the elements of the analogy target. Trench, Oberholzer, and Minervino (2002) state, analogy reasoning presupposes the transfer of knowledge from a known situation (source of analogy / analogy basis) to a new situation on the target of analogy with the aim of increasing understanding of the latter. Based on the explanation above, it can be concluded that analogy reasoning is a process of cognition related to the development of representational abilities, understanding, and operating on the basis of the similarity of structures in suitable objects, whose surface features are not always the same.

Holyoak and Hummel (2001) explain, analogy reasoning has long been believed to play a central role in learning mathematics and problem solving. In addition, analogy provides an important example of what appears to be a very general cognitive mechanism, which takes input from each specific domain on the basis of an analogy that can be represented in an explicit proportional form, and operates on the basis and target of the analogy to produce specific conclusions on the basis of analogy. analogy targets. Analogies are often used in problem solving and inductive reasoning because they can capture significant parallels in different situations. Analogy reasoning is considered an important part of students' ability to adapt to new contexts.

English (2004:.4–10) states, analogy consists of classical analogy, problem analogy and pedagogical analogy. The explanations for classical analogies, problem analogies, and pedagogical analogies are as follows:

2.3. Kinds of Analogies

2.3.1 Classic analogy

A classic or conventional analogy is an analogy that takes the form A∶B∷C∶D (for example: 3∶9∷2∶⋯, becomes: 3∶9∷2∶6), provided that C and D things must be related in the same way. the same as the relationship between A and B. In this case, 3 becomes 9, it is multiplied by 3, so to fill in the empty column (⋯), 2 multiplied by 3 becomes 6. That's one example of a simple analogy. The ability to link an A∶B pair to a C∶D pair involves a higher relationship.

2.3.2 Analogy problem

Analogy problems to overcome the ability to reason through analogy in problem solving. In this study, students must recognize the similarity in the relational structure between a known problem (called a basis/source/basic analogy) and a new problem (a target analogy) i.e. a "structural alignment" or "mapping" between two problems must be discovered. In this case, students in solving new problems must be based on solving problems that have been solved before.

2.3.3 Pedagogical analogy

Such reasoning has received less attention even though instructional analogies have long been used in mathematics and science education. Analogy pedagogy is designed to provide a concrete representation of abstract ideas. That is, this analogy is a real source for students to be able to build mental representations of abstract ideas or processes presented.

2.4. Understanding Higher Order Thinking Skills (HOTS)

2.4.1 Definition of HOTS

According to Bloom B S (1956) Midahwati (2020) Higher Order Thinking Skill (HOTS) is a thinking ability that does not just recall (recall), restate (restate), or refer without processing (recite). HOTS questions in the context of an assessment measure the ability to transfer one concept to another, process and apply information, find connections from different kinds of information, use information to solve problems, examine ideas and information critically.

However, HOTS-based questions do not mean more difficult questions than recall questions. Viewed from the dimension of science, generally HOTS questions measure the metacognitive dimension, not just measuring the factual, conceptual, and procedural dimensions. The metacognitive dimension describes the ability to relate several different concepts, interpret, solve problems (Problem Solving), choose problem solving strategies, find (discovery) new methods, argue (reasoning), and make the right decisions.

In the Minister of Education and Culture Number 21 of 2016 concerning the content standards of primary and secondary education, it is explicitly stated that learning outcomes in the realm of knowledge follow Bloom's taxonomy which has been revised by Bloom, B.S. (1956,18), Lorin Anderson and David Krathwohl (2001) consisting of the following abilities: knowing (knowling-C1), understanding (Understanding -C2), applying (applying-C3), analyzing (analyzing-C4), evaluating (evaluating-C5), and creating (Creating-C6). The thought process can be seen in the following figure.

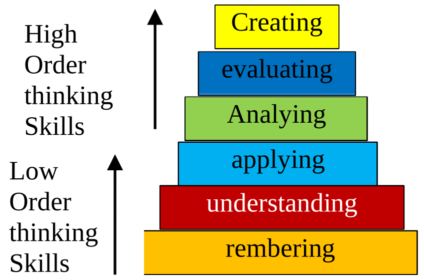


Figure 8 Cognitive Thinking Process in Bloom's Taxonomy

Then the dimensions of cognitive processes by Puspendik are grouped into 3 levels. Level 1(LOTS): C1 knows and C2 understands, Level 2 (undestanding): C3 (apply), and Level 3(HOTS): C4 (analyzes), C5 (evaluates), and C6 (creates).

2.4.2 Writing HOTS Questions

To write the HOTS items, the question writer is required to be able to determine the behavior to be measured and formulate the material that will be used as the basis for the question (stimulus) in a certain context in accordance with the expected behavior. In addition, the description of the material to be asked (which requires high reasoning) is not always available in the textbook. Therefore, in writing HOTS questions, mastery of teaching materials is needed, skills in writing questions (construction questions), and teacher creativity in choosing stimulus questions according to the situation and conditions of the area around the educational unit. The following is the flow of the preparation of the HOTS questions.

2.4.3 Composing HOTS Questions

1) Analyzing KD that can be made about HOTS questions. Because not all KD models can be made HOTS questions. For

this reason, teachers individually or in the MGMP forum can carry out KD analysis which can be made HOTS questions

2) Arrange a grid of questions. Aims to assist teachers in writing HOTS items. In general, the grid is needed to guide teachers in: (a) choosing KD that can be made HOTS questions, (b) choosing basic material related to KD to be tested, (c) formulating question indicators, and (d)) determine the cognitive level.
3) Choose an interesting and contextual stimulus. The stimulus used should be interesting, meaning that it encourages students to read the stimulus. Interesting stimuli are generally new, have never been read by students. While contextual stimulus means a stimulus that is in accordance with the reality in everyday life, is interesting, encourages students to read.
4) Write question items according to the question grid. The questions are written in accordance with the rules for writing HOTS items by paying attention to 3 aspects, namely substance/material, construction, and language.
5) Create scoring guidelines or answer keys. The scoring guidelines are made for the form of description questions, while the answer keys are made for the form of multiple choice questions and short entries.

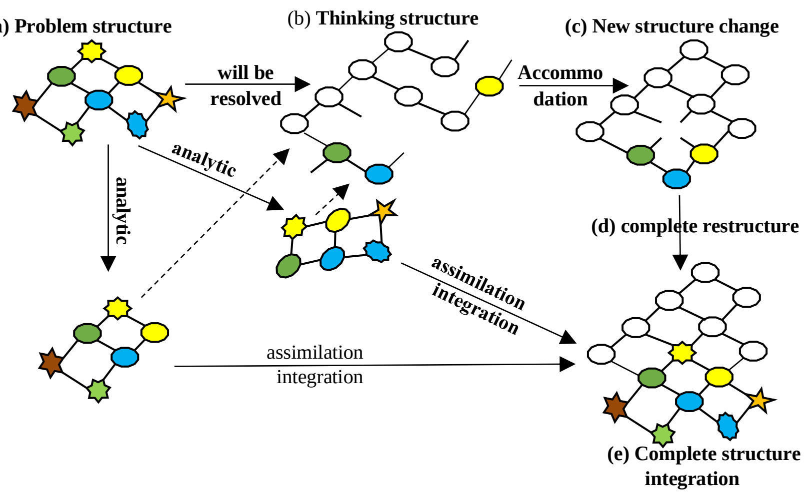
Based on the explanation above, it can be concluded that: HOTS according to the concept of Anderson and Krathwol, (2017) is a high-level thinking skill that requires a more complex thought process including, analyzing, evaluating, and creating supported by the ability to understand (understanding), so that: (1) able to think critically (critical thinking); (2) able to give reasons logically, systematically, and analytically (practical reasoning); (3) able to solve problems quickly and accurately (problem solving); (4) able to make decisions quickly and accurately (decision making); and (5) being able to create a new product based on what has been learned (creating).

3. **Adaptation from Piaget**

Environmental adaptation begins with disequilibrium that gives rise to the process of assimilation and accommodation. With this process, the cognitive structure develops through the process of changing, merging, or forming new schemes until equilibrium condition occured. The adaptation process begins with the desire to absorb the structure of the problem (intelligent behavior) that is an input to the cognitive structure in the initial level equilibrium conditions. That resulted in disequilibrium (imbalance) between the structure of the problem with the cognitive structure. Therefore, there is an adaptation of the cognitive structure through assimilation and accommodation. After assimilation and accommodation there will be a cognitive structure at the new level of equilibrium.

A person's cognitive development basically has three elements, namely structure, function, and content (Piaget, 1985; Bybee, 1982). Structure is the organization of schemata in the cognitive structure. The function shows the nature of intellectual activity, including assimilation and accommodation that continues throughout cognitive development takes place. While the content is knowledge mastered / known by someone. The development of cognitive structures in a person can run if a person is always willing to accept stimulus from his environment (adapt) so that there is assimilation and accommodation.

Assimilation of motor or cognitive action is based on hidden cognitive structures. Figure is the construction of new knowledge when the problem is complex. Then the problem structure is integrated into the student's cognitive structure. Whereas if the structure of the problem is integrated by first changing the cognitive structure it is said to be accommodation. The event of assimilation and accommodation can be in the elements of problems, relationships, and strategies. As in Figure 1. Nex



Description :
- - -▸ State the mismatch between the structure of the problem and the cognitive structure
——▸ Express changes in cognitive structure from initial level balance to new level balance

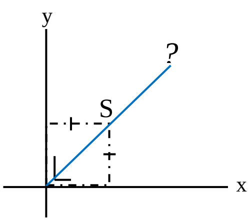
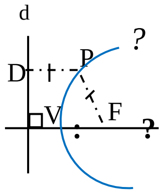
Figure 1. The process of assimilation and accommodation (Modification from Supratman, Ratnaningsih N and Ryane S, 2017)

3. Research Method

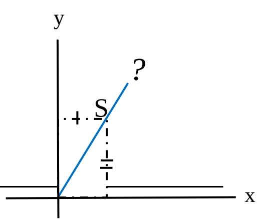
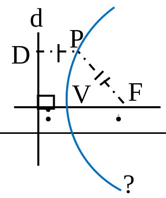
This research is qualitative research. As for looking for research subjects using exploratory methods, namely by exploring as many as 82 prospective teacher students using analogical reasoning and HOTS thinking in solving problems in Analytical Geometry in the semester of the 2022 academic year. As for revealing data that thinks verbally, Think out Loads is done, namely student teacher candidates. think hard and be expressed orally and in writing with the help of visual video recordings and interviews in an unstructured way so that it does not interfere with the activities of prospective teacher students and can be seen again by researchers.

The research instruments are as follows

1)

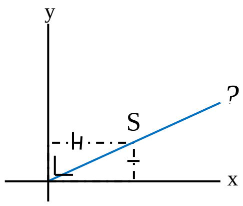
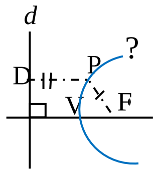
A : B	:: C : D
 : y = x	:: 
The set of points that have the same distance from the x-axis, and the y-axis, is y = x	The set of points that are equidistant from line d and point F is...

2)

A : B	:: C : D
 : y = 2x	:: 

The set of points whose distance from the x-axis and to the y-axis is equal to 2:1, is y = 2x	The set of points whose distance from F and to line d is 2:1 is...

3)

A : B :: C : D	
 : $y = \frac{1}{2}x$ :: 	
The set of points that has a ratio of the distance to the x-axis, and to the y-axis equal to 1: 2, is $y = \frac{1}{2}x$	The set of points that has a ratio of the distance to F, and to the line d equal to 1:2, is ...

Figur 2 Diadopsi dari AhmanMaedi, S (2013)

Results

The various student performances are shown in Table 1. A total of 24.39% of students were able to do correct solving for parabolic equations through analogical reasoning, and did it with HOTS. Meanwhile, as many as 26.83.03% and 29.73% of students were able to solve ellipse and hyperbola equations well through analogical reasoning, and did it with HOTS.

Tabel 1 Hasil pemecahan masalah dari tugas penalaran analogy

Task No	Task		Result ($n = 82$)					
			No Answer	Non Analogy		Analogy		
				Incorrect	Correct	Incorrect	Non HOTS	HOTS
				A1	A2	A3	A4	A5
1	Parbola	Problem solving	2 (2,44%)	9 (8,2%)	5 (6,10%)	16 (19,51%)	20 (24.39%)	20 (24,39%)
2	Ellips		1 (1,22%)	10 (12,20%)	5 (6,10%)	24 (29,27%)	20 (24,39%)	22 (26,83%)
3	Hyperbola		3 (3,66%)	14 (12,20%)	5 (6,10%)	16 (19,51%)	20 (24,39%)	24 (29,27%)
A1: Result problem solvi wrong, and cannot do analogical reasoning A2: Result problem solvig result, but not via analogical reasoning A3: Result problem solving wrong, but is able to use analogical reasoning A4: Result ploblem solving rigt, via analogical reasoning but not HOTS A5: Result problem solving correctly, using analogical reasoning, and able to answer HOTS								

Interviewer (Q) : Have you made a guess, concept to solve problem A: B?

Subject 1 (S1): Already, this (while showing the result)

$$\frac{(y-y_1)}{(y_2-y_1)}=\frac{(x-x_1)}{(x_2-x_1)}$$
$$\frac{(y-0)}{(1-0)}=\frac{(x-0)}{(1-0)}$$
$$y=x$$

Q : How do I get it?

S1 : Since the distance from S to the x-axis is the same as S to the y-axis, then S (1.1), and the starting point (0,0).

Q : Can this concept be used for C:D problems?

S1: That, I find it difficult, finally I can't solve the problem C: D

Meanwhile, the researcher found that the students' problem solving was correct but not through analogical reasoning, namely 6.10% for each parabolic task, hyperbola task, and ellipse task. After the interview, it turned out that the students had read books, and opened the internet. So those in solving C:D problems don't see the concept of solving problems in A:B. Most students are able to do problem solving correctly through analogical reasoning, but only a few of them are able to use analogical reasoning to solve problems. Researchers analyzed the results of exploring students' answers to the truth, then conducted interviews with them, including:

Q : Have you ever come across a problem like this?

S6: Never (be directing the implementation of problem-solving as expected)

Q : You Alleged, what is the concept of the right to build the A: B?

S6: 1) On the basis of Analogy:

The first way Let's say S(x,y) is approximate, S on the x-axis is S1(x,0) and the estimated S on the y-axis is (0,y) so that the ratio between S to S1 with S to S2 is with the center (0,0) got

Comparison of $|SS_1|:|SS_2|=1:1$

($\sqrt{(x-x_1)^2-(y-y_1)^2}:\sqrt{(x-x_2)^2-(y-y_2)^2}=1:1$

$(\sqrt{(x-x\}^2-(y-0)^2}:\sqrt{(x-0)^2-(y-y)^2}=1:1$

$(\sqrt{(0)^2-y^2}:\sqrt{x^2-0^2}=1:1$

$\sqrt{y^2}:\sqrt{x^2}=1:1$

$\sqrt{y^2}=\sqrt{x^2}$

$y=x$

Q : Is the concept to solve problems in A: B can be used to solve the problem of C: D?

S6: Could, but there is a variation concept. if A: B using distance point to the line only, whereas to solve the problem C: D is the distance of the point to the line variation with distance point to point. (While showing the calculation) PF = PD If P (x, y), and d coincides with the y-axis and F on the x-axis, then $d\equiv x=0$, consequently $V(1,0)$ and $F\ (2,0)$

$|PF|:|PD|$ = 1:1

$\sqrt{(a-x)^2+(0-y)^2}$: $\sqrt{(-a-x)^2+(y-y)^2}$ = 1:1 for task 1

$\sqrt{(a^2-2ax+x^2)+y^2}:\sqrt{(a^2+2ax+x^2)+0}=1:1$

$\sqrt{(a^2-2ax+x^2)+y^2}=\sqrt{a^2+2ax+x^2+0}$

$$a^2-2ax+x^2+y^2=a^2+2ax+x^2$$
$$y^2=4ax$$
$$y=2\sqrt{ax}$$

Q : Are there other possibilities for the problem?

S6: Yes, Second way in task 1: create and complete the necessary sketches both on DA on DA S(x,y), S1(x,0) as projection on the x-axis, S2(0,y) as approximation S on the y-axis, the x-axis (sx) and the y-axis (sy) already exist.

$\sqrt{(x-x)^2+(0-y)^2}:\frac{x}{\sqrt{1^2+0^2}}=1:1$

$\sqrt{0-y^2}:\frac{x}{1}=1:1$

$y=x$

Likewise in TA: point P(x,y) on the curved line and F(a,0) on the x-axis and D on the d-line, so that it will be obtained in task 1: if F(a,0), V(0,0) then the $line-d\equiv x=-a$ consequently D$(-a,y)$,

$|PF|:|point\ P\ and\ d-line\ |$ = 1:1

$\sqrt{(a-x)^2-(0-y)^2} : \dfrac{x+a}{\sqrt{1^2-0^2}} = 1:1$

$\sqrt{(a^2-2ax+x^2+y^2}:\frac{x+a}{1}$ =1:1

$(a^2-2ax+x^2+y^2) = (x+a)^2$

$a^2-2ax+x^2+y^2 = x^2+2ax+a^2$

$-4ax+y^2 = 0$

$y^2 = 4ax$

$y = 2\sqrt{ax}$

The result of solving the problem is the same between the first and second method

Next, S6 explains the second task

On the basis of analogy: Let S(x,y) projection S on the x-axis $S_1(x,0)$ and the projection S on the y-axis is $S_2(0,y)$ so that the ratio of the distance from S to S1 to S to S_2 is center (0,0) got

$|SS_1| = |SS_2|$

$\sqrt{(x-x_1)^2+(2y-y_1)^2}:\sqrt{(x-x_2)^2+(y-y_2)^2} = 2:1$

$\sqrt{(x-x_1)^2+(2y-y_1)^2}:\sqrt{(x-0)^2+(y-y_2)^2} = 2:1$

$(\sqrt{(0)^2+y^2}:\sqrt{4x^2-0^2} = 2:1$

$\sqrt{y^2}:\sqrt{x^2} = 2:1$

$\sqrt{y^2} = 2\sqrt{x^2}$

$y = 2x$

In the analogy target: Let $P(x,y)$ project P on the x-axis $F(2a,0)$ and the approximate S on the y-axis is $D(-a,y)$ so that the ratio between P to F with P to D with V (0,0) got

$|PF|:|PD| = 2:1$ got $y^2 = 12ax+3x^2$

Second way

On the basis of analogy: Suppose that $S(x,y)$ projection S on the x-axis $S_1(x,0)$ and the projection S on the y-axis is $S_2(0,y)$ so that the ratio of the distance S to S_1 with S to the $x-line\ d\ = x = -a$ with center (0,0) we get

$|SS_1|:|\,point\ S\ to\ x-line| = 2:1$ got $y = 2x$

Target Analogy

In the analogy target: Let P(x,y) projection P on the x-axis F(2a,0) and the projection S on the y-axis is D(-a,y) so that the ratio of the distance P to F with P to the d-line with V(0,0) we get

$|PF|:|point\ P\ to\ d-line| = 2:1$ got

$y^2-12ax-3x^2 = 0$ or

$y^2 = 12ax+3x^2$ using the first method with the second method the result is the same

3rd task

First Way

On the basis of analogy: Suppose S(x, y) projection of S on the x-axis is $S_1(x,0)$ and the projection of S on the y-axis is D(x,0) so that the ratio of the distance S to F with S to D with the center (0,0) got

$|SS_1|:|SS_2| = 1:2$ got

$y = \dfrac{1}{2}x$

Target analogy

if for example $V(0,0)$ and $F(a,0)$, then $D(-2a,0)$, consequently the d-line x+2a. so

$|PF| : |PD|\ distance = 1:2$

Got $4y^2-10ax+3x^2 = 0$

Second way

On the basis of analogy: Suppose S(x,y) projection S on the x-axis $S_1(x,0)$ and the projection S on the y-axis is $S_2(0,y)$, then the x-line $x = 0$ so that the ratio of the distance S to S_1 with S to S_2 with center (0,0) get

$|SS_1|:|point\ S\ to\ x-line| = 1:2$ got

$y = \frac{1}{2}x$

Target Analogy

Let $P(x,y)$ project P on the x-axis $F(a,0)$ and the approximate S on the y-axis is $D(-2a,y)$ so that the ratio between P to F with P to the d-line with V(0,0)

$|PF|:|point\ P\ to\ d-line| = \frac{1}{2}$ got

$4y^2-10ax+3x^2 = 0$

The result of solving the problem is the same between the first and second method

This research examines and describes analogical reasoning when students solve problems in constructing the conic section equation through analogy problem solving in the HOTS category. The study was conducted based on the adaptation of Piaget's theory (process of assimilation and accommodation). The findings of the test results of the instrument are based on the assignment sheet (Supratman, 2013a and 2014a) and when students solve analogy problems. There are students who use various concepts according to the concepts mastered (cognitive structure) and adapt to the concept of the problem (problem structure) they are facing. In solving analogy problems, students solve problems through analogical reasoning, and 3 groups of students are obtained, namely (1) students are not able to construct the conic equation correctly due to a step error when solving the problem, (2) students are able to construct the conic equation in one way, and (3) students are able to construct the conic equation in two ways including HOTS.

Analogous reasoning when solving problems in constructing the conic equation based on Piaget's adaptation (process of assimilation and accommodation) in general, students take steps sequentially, namely: (1) problem accommodation process, (2) strategy accommodation process, (3) problem assimilation process , (4) strategy assimilation process, (5) relationship assimilation process, and (6) relationship accommodation process. The steps of the assimilation and accommodation process along with the scope of their activities are listed in Table 1 and Table 2 below.

Discussion

Table 1 Steps for Analytical Reasoning When Solving Problems based on Piaget's Adaptation in Method 1 (Problem Substructure 1)

Order of Steps	**Activity**	**DA**	**TA**
1. problem accommodation process	Correspondence 1 (Problem constructing equations of straight/curved lines constructed by distance comparisons)	a	n
2. strategic accommodation process	Correspondence 2 (complete the graphic sketch as required)	u	v
	Correspondence 3 (The x-axis in DA already exists, while in TA interprets the horizontal line as the x-axis)	s_x	s_x
	Correspondence 4 (Y-axis on DA already exists, and d-line on TA already exists)	s_y	g_d
	Correspondence 5 (Equally take any point to represent the point in the equation of a straight line / curve in DA and in TA)	b	o
	Correspondence 6 (Create S2 as the S image on the y-axis for DA, and make D as the P image on the d-line for TA)	c	p
	Correspondence 7 (Creating S1 as an image of S on the x-axis for DA, using the existing F on the curved line	d	q
	Correspondence 8 (Giving position S2 on DA, and on TA: D)	c’	p’

	Correspondence 9 (Giving position S1 on DA, and on TA: F)	d’	q’
3. problem assimilation process	Correspondence 10 (Using distance between two points: |SS2| on DA and |PF| on TA)	e	r
	Correspondence 11 (Usage between two points: |SS1| on DA and |PD| on TA)	f	s
4. strategy assimilation process	Correspondence 12 (Comparison of the distance between two points to the distance of two points)	h	h
	Correspondence 13 (1:1/ 2:1/ 1:2 ratio was performed on DA and TA)	1	1
5. proses asimilasi hubungan	Correspondence 14 (Use of quadratic operations on DA and TA, even though there is an error in TA)	x	x
	Correspondence 15 (Use of root operations on DA and TA)	w	w
	Correspondence 16 (DA and TA both use addition and subtraction operations)	j	J
	Correspondence 17 (DA and TA both use multiplication and division operations)	k	k
	Correspondence 18 (Results of assignment 1 on DA and TA)	m_1	z_1
6. relationship accommodation process	Correspondence 19 (Name the resulting straight/curved line equation)	m	z

Table 2 Steps of Analytical Reasoning When Solving Problems based on Piaget's Adaptation in Method 2 (Problem Substructure 2)

Urutan Langkah	**Activity**	**DA**	**TA**
1. proses akomodasi masalah	Correspondence 1 (Problem constructing equations of straight/curved lines constructed by distance comparisons)	a	n
2. strategic accommodation process	Correspondence 2 (complete the graphic sketch as required)	u	v
	Correspondence 3 (X-axis on DA already exists, whereas on TA S7 interprets horizontal line as x-axis)	s_x	s_x

	Correspondence 4 (Y-axis on DA already exists, and d-line on TA already exists)	s_y	g_d
	Correspondence 5 (Equally take any point to represent the point in the equation of a straight line / curve in DA and in TA)	b	o
	Correspondence 6 (Creates S1 as an image of S on the x-axis for DA, using the existing F on)	d	q
	Correspondence 7 (Giving position S1 on DA, and on TA: F)	d’	q’
3. problem assimilation process	Correspondence 8 (Using distance between two points: |SS1| on DA and |PF| on TA)	f	s
	Correspondence 9 (|S to the y-axis| on DA and |P to the d-line| on TA)	g	t
4. strategy assimilation process	Correspondence 10 (The ratio of the distance between two points to a point to a line)	i	i
	Correspondence 11 (1:1 ratio performed on DA and TA)	1	1
5. relationship assimilation process	Correspondence 12 (Use of quadratic operations on DA and TA, even though there is an error in TA)	x	x
	Correspondence 13 (Use of root operations on DA and TA)	w	w
	Correspondence 14 (DA and TA both use addition and subtraction operations)	j	J
	Correspondence 15 (DA and TA both use multiplication and division operations)	k	k
	Correspondence 16 (Results of task 1 on DA and TA)	m_1	z_1
6. relationship accommodation process	Correspondence 17 (Name the resulting straight/curved line equation)	m	z

Analogous reasoning when students solve problems in constructing conic equations based on Piaget's adaptation can occur in three types, namely (1) the problem substructure is imperfectly integrated into the student's cognitive structure during the assimilation process after the accommodation process. (2) the problem structure is not perfectly integrated into the student's cognitive structure during accommodation (there is a problem substructure that is not integrated into the student's cognitive structure during the accommodation process), and (3) the problem structure is perfectly integrated into the student's cognitive structure during the accommodation process. assimilation and accommodation.

The first type, the problem substructure is imperfectly integrated into the student's cognitive structure during the assimilation process after the accommodation process is the simplest thought process. The problem substructure is not perfectly integrated into the cognitive structure, meaning that students in solving problems through analogical reasoning do not fully construct the conic equation. When solving problems, students take the wrong (wrong) problem-solving steps. This happens because students do not correspond to all elements in DA with all elements in TA based on the substructure of the problem. However, the students' steps in corresponding elements of DA with elements in correct TA fulfill the characteristics of some critical thinking from Krulik et al. (2003), so that these students are categorized as semi-critical analogy reasoning.

This type of student has actually done problem solving by looking at the similarity of the problem, the similarity of the supporting elements, and the use of concepts in problem solving. However, S1 and S2 when solving problems there were steps that were carried out less systematically, resulting in wrong problem solving. S1 and S2 did not realize that there were steps that they were actually able to complete, but because there were steps that were skipped, there was a process error which in the end the result of solving the problem was wrong. The wrong steps were actually able to be completed by them (S1 and S2), as evidenced by their ability to complete almost the same steps and even more complex and difficult steps in the next step. In addition, they have no desire to reflect on the problem-solving steps.

S1 in constructing the conic section equation uses method 1. The wrong step taken by S1 in TA is when S1 solves the problem when $\sqrt{4a^2-4ax+x^2+y^2}=2\sqrt{a^2+2ax+x^2}$ squared for each segment. However, 2 is not squared so that we get $4a^2-4ax+x^2+y^2=2(a^2+2ax+x^2)$, it should be like this $(4a^2-4ax+x^2+y^2=4(a^2+2ax+x^2)$ in task 2. In addition, in task 3: S1 intends to square $\sqrt{a^2-2ax+x^2+y^2}=\frac{1}{2}\sqrt{4a^2+4ax+x^2}$ for each segment, but $\frac{1}{2}$ is not squared so that we get $a^2-2ax+x^2+y^2=\frac{1}{2}(4a^2+4ax+x^2)$ should $a^2-2ax+x^2+y^2=\frac{1}{4}(4a^2+4ax+x^2)$.

According to Holyoak and Thagard, P (1989) the student made a mistake in transferring from DA to TA. In this case, DA is $\sqrt{y^2}=2\sqrt{x^2}$ not squared first, but directly to the root which results in $y=2x$. There is a disconnect between DA and TA, that is, there are unequal steps between steps in DA and steps in TA. In DA, S1 should square each side of $\sqrt{y^2}=2\sqrt{x^2}$so we get $y^2 = 4x$. This is if S1 has roots $\sqrt{4a^2-4ax+x^2+y^2}=2\sqrt{a^2+2ax+x^2}$ on task 2 or $\sqrt{a^2-2ax+x^2+y^2}=\frac{1}{2}\sqrt{4a^2+4ax+x^2}$ in task 3 there will be difficulties, although not absolutely every step must be the same.

S2 in constructing the equation of the conic section using method 2. The wrong step is not changing $x = -a$ becomes $x + a = 0$ and $x=-2a$ becomes $x+2a=0$. As a result, the distance of the point to the d-line for task 1 and task 2 uses $\frac{x-a}{\sqrt{1^2+0^2}}$ should $\frac{x+a}{\sqrt{1^2+0^2}}$ and on task 3 using $\frac{x-2a}{\sqrt{1^2+0^2}}$ should be $\frac{x+2a}{\sqrt{1^2+0^2}}$. While in the next step S2 is able to change $4a^2 - 4ax + x^2 + y^2 = 4x^2 - 4ax + a^2$ becomes $3x^2 - y^2 + 3a^2 = 0$ which is considered more difficult.

According to Holyoak and Thagard, P (1989), the student (2 made an error in transferring from DA to TA. In DA: the y-axis equation is written in the form “x = 0” while in TA: the d-line equation is written in the form "$x = -a$ and $x = -2a$" so that there is a discrepancy.

In other words, the thinking substructure used by the subject of the semi-critical analogy reasoning group to interpret the problem substructure uses a thinking substructure that is not in accordance with the problem substructure (Subanji 2007). Meanwhile, based on Gentner (1983) these students (S1 and S2) paid less attention to systematics and transparency. The systematic understanding is that the relational system must go through a strong structure, no steps are skipped, while what is meant by transparency is that the appropriate elements must be similar. According to Lee & Sriraman (2010) the student (S1 and S2) made a relational error.

S1 and S2 are said to do problem solving through analogical reasoning because they are able to analyze the similarity of the problem, the concepts that must be used, complete and use the elements needed in DA and TA. This they (S1 and S2) do when faced with a new problem for them and the problem is not a routine problem in the form of an analogy problem. Furthermore, they (S1 and S2) did problem solving through correspondence between elements in DA and elements in TA. What is meant by the elements is the problem, the concept used, supporting the use of the concept in problem solving both in DA and TA. S1 and S2 do problem solving in TA based on the incidence of AD, such a thinking pattern is problem solving through analogical reasoning (Canadas et al. 2007). Thus S1 and S2 do problem solving through analogical reasoning.

When solving problems, S1 and S2 perform problem solving through analogical reasoning characterized by the ability to analyze problems, determine the adequacy of data to solve problems, decide the need for additional information in a problem, and analyze situations. However, S1 and S2 were not able to validate from a conclusion (an error occurred). Based on the opinion of Krulik et al. (2003), S1 and S2 perform critical thinking steps. However, S1 and S2 were not able to validate a conclusion (a misstep occurred) so that the problem solving was wrong. Thus, S1 and S2 are categorized as solving problems through semi-critical analogy reasoning.

The cause of S1 and S2 was an error in this step, because they (S1 and S2) did not reflect on their work. They do not question whether the steps they take are systematic? Are the steps they took in TA in accordance with the steps they took in DA? Are the steps in troubleshooting wrong? Thus allowing the error to be corrected, and can make improvements so that it can produce the correct answer.

The second type, students of this group consist of S3 and S4. S3 and S4 integrate the problem structure into their thinking structure imperfectly in the accommodation process which continues in the assimilation process. This incident shows that in the process of accommodation and assimilation there is a problem substructure that is not integrated into the student's thinking structure. This student does not perfectly correspond the elements in DA with elements in TA based on the structure of the problem. S3 and S4 correspond to elements in DA with elements in TA based on only one problem substructure. The substructure of the problem in question is to construct the conic section equation in one way. Understanding one way S3 and S4 construct a conic equation by comparing the distance between two points to the distance between two points or constructing a conic equation by comparing the distance between two points with the distance from the point to the line. S3 and S4 do problem solving through correspondence in constructing the conic section equation to fulfill the critical thinking characteristics of Krulik et al. (2003). Based on this, S3 and S4 are categorized as critical analogy reasoning.

In constructing the conic equation S3 and S4 have been able to construct a thinking structure even though it is not perfect, by looking at the similarity of the problem, the similarity of the existing elements, making other elements needed in the use of concepts and based on similarities, and the use of concepts in DA and TA so that the conic section equation is constructed. But they do not realize that in solving the problem, apart from what they do, there are other ways to solve the problem.

Constructing the conic section equation uses method 1 and does not use method 2. Likewise, S4 constructs the conic section equation using method 2 without using method 1. So that each one only uses one method in constructing the conic section equation. Meanwhile, constructing the conic equation can be done in 2 ways, namely method 1 and method 2. Method 1 means that students in constructing the conic equation, compare the distance between two points with the distance of two points. Method 2 means that students in constructing the equation of a conic section, compare the distance between two points with the distance from the point to the line.

S3 constructing the conic section equation begins by looking at the problem in DA: finding the set of points constructed by the ratio of certain distances between these points (represented by S) to the x-axis and y-axis. The problem in TA: determine the set of points constructed by the comparison of the distance between the points P to F with P to the d-line. S3 solves the problem that the distance is only built between 2 points, so in comparison the distance must be related to 2 points. This knowledge, prompted S3 to compare the distances on the DA: $|SS_1| : |SS_2|$. S3 makes S_1 and S_2 an image of S on the x-axis and y-axis, respectively. As a complete comparison of the distance. Based on the comparison on DA, S3 solves the problem $|PF|:|PD|$. S3 considers the horizontal line as the x-axis, so the F points on the horizontal line correspond to the point S1. Likewise, D is the image/projection of P on the d-line corresponding to the point S_2.

S4 constructs the equation of a conic section of the ratio of a certain distance between the point S to the x-axis and S to the y-axis. The problem in TA : determine the set of points built by the comparison of the distance between the points P to F with P to the d-line. S4 solves the problem of distance comparison on TA based on distance comparison on DA: $|SS_1|$:|S y-axis|. S4 assumes that P in column C corresponds to S in column A, the horizontal line F in column C corresponds to S1 of the image S on the x-axis, and the d-line in column C corresponds to the y-axis in column A.

Comparison on TA: |PF|:|P to the d-line|, where F is the point on the horizontal line as the x-axis so that it corresponds to the point S_1. Likewise, D is the image/projection of P on the d-line corresponding to the point S2. The next step is to follow the required comparison, which is 1:1 for task 1, 2:1 for task 2, and 1:2 for task 3. S3 and S4 do the calculations they face without making mistakes, so the conic section equation is constructed.

This pattern of thinking is analogous reasoning and according to Gentner (1983) this type of student (S3 and S4) lacks adaptation to problems so that all problem structures are not integrated into the student's thinking structure. According to Holyoak and Thagard, P (1989) students do not do further learning so that they are satisfied with what they get. According to Krulik et al (2003) this type of student has a critical thinking level. The reason is said to be critical thinking because students are able to analyze problems, decide the need for additional information in a problem, determine the adequacy of data to solve problems, and analyze situations.

The third type, the perfection of the thinking structure in the process of assimilation and accommodation is the highest thought process. This means that students are able to integrate the structure of the problem into the structure of their thinking perfectly during the assimilation and accommodation process. This is proven, students are able to construct the conic section equation in two ways, namely method 1 and method 2. This means that students are able to correspond all elements in DA with all elements in TA based on the structure of the problem. The ability of students to correspond all elements in DA with all elements in TA so that the conical wedge equation is constructed to fulfill the characteristics of creative thinking from Krulik et al. (2003). Thus the student is categorized as creative analogy reasoning. Students belonging to the creative analogy reasoning group subject are S5 and S6. S5 and S6 solve complex problem structures into several substructures of problems by analyzing the problem and the possibility of several possible solutions.

When facing the problem of analogy, S5 and S6 have suspected that there is a link between problems in AD and problems in TA. S5 and S6 believe that solving problems in the column A:B relationship is not possible using the equation of a straight line through two points and the equation of a line through one point (0,0) and gradient 1, then he pays attention to the problem and what each sketch has. the graphs in columns A and C. S5 and S6 solve problems through analogical reasoning in constructing a conic section through method 1 and method 2. This is shown; from the beginning, seeing the similarity of the problem, namely looking for a set of points that have a certain comparison on the corresponding line and point, then completing the same corresponding element and using the same concept in solving TA problems, always based on DA. According to Krulik et al. (2003), S5 and S6 do problem solving through analogous reasoning at the level of creative thinking, and according to Bloom, B.S. (1956,) including HOTS thinking so that S5 and S6 are categorized as doing problem solving through creative analogy reasoning and HOTS.

According to Gentner (1983), this type of student has the ability to map analogies and adaptations, while according to Holyoak, K.J. & Thagard P, (1989) are able to see the source of a reasonable and useful analogy, mapping, transfer, subsequent learning. Based on English (2004), these students (S5 and S6) are able to see the alignment of the problem, the relationship between concepts in DA and TA, the ability to solve TA problems based on DA. Meanwhile, according to Lee & Sriraman (2010) these students have the ability to do similar perceptions or surfaces, transition similarities, and relational similarities.

The factor causing the perfection of the thinking structure during the accommodation process followed by the assimilation process, because students (S5 and S6) solve problems through analogical reasoning so that the conic section equation is correctly constructed in 2 ways, namely method 1 and method 2. These students (S5 and S6) is able to read the problem situation, complete the data needed in solving the problem and solve the problem perfectly so that the conic equation is constructed correctly. As for seeing more clearly Piget's adaptation, it can be seen in Figure 3 as follows

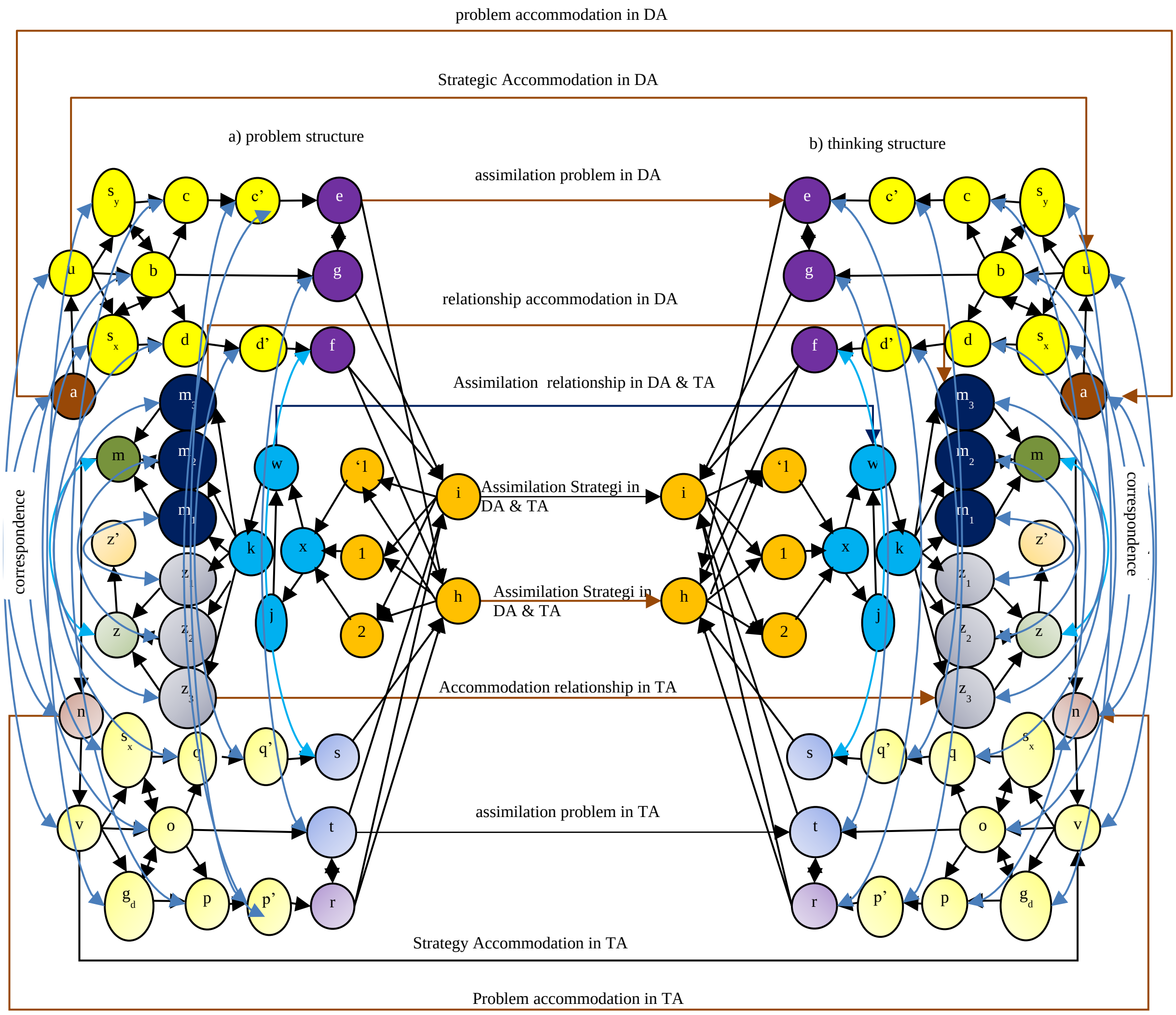


Figure 3 Piaget's Adaptation Process in Analytical Reasoning S5 and S6 in Task 1, Task 2, and Task 3

Conclusion

What happened was (1) the problem accommodation process, (2) the strategy accommodation process, (3) the relationship accommodation process the problem assimilation process, (4) the strategy assimilation process, (5) the relationship assimilation process, and (6) the problem assimilation process. The processes in the steps of analogical reasoning when Problem-Solving in constructing the conic section equation are characterized by the following behavior/activities. In addition, this study found 2 interesting things, namely; (1) categorization or type of analogical reasoning when solving problems based on the hierarchy of thinking Krulik (2003) and (2) Not all students are able to determine the use of generally accepted concepts in constructing the equation of a conic section.

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Reference

1. AhmanMaedi, S. 2013. Conjecturing via Analogical Reasoning to Explore Creative Thinking. Proceedings of the

2013 International Conf. on Math. Edu. (2013. 8. 9–10) 305-316 on Creativity & Giftedness (August 9–10, 2013) 305-316
2. Anderson, Lorin W. dan Krathwohl's, David R. (2017). Kerangka Landasan Untuk Pembelajaran, Pengajaran, dan Asesmen: Revisi Taksonomi Bloom. Yogyakaarta: Pustaka Pelajar.
3. Aminu, J. (1990). Address by the Honourable Minister of Education. Abacus 20(1), 22-29
4. As'ari, A R, Ali M, Basri H, Kurniati D, Maharani S,. 2019. Mengembangkan HOTS (High Order Thinking Skills) melalui Matematika. Penerbit Universitas Negeri Malang
5. Bandura, A. 1997. Self- Efficacy:The exercise of control. W H Freeman/Times BooksHenryHolt & Co
6. Bassok, M. 2001. Semantic alignments in mathematical word problems. In Gentner, D., Holyoak, K. J., & Kokinov, B. N. (Eds.) The analogical mind: Perspectives from cognitive science (pp. 401–433). Cambridge, MA: MIT Press.
7. Bloom, B.S. (Ed.). (1956-1964). Taxonomy of Educational Objectives. New York: David McKay Company Inc.
8. Brown. C. 2007. Cognitive Psychology, SAGE Publications India Pvt Ltd
9. BSNP (Badan Standar Nasional Pendidikan). 2006. Standar Isi untuk Satuan Pendidikan Dasar dan Menengah. Permendiknas RI no. 22 tahun 2006, Jakarta
10. Bybee R.W. 1982. Piaget for Educators, Charles E Merri Publising. co Colombus Ohio.
11. English LD. 2004. Mathematical and analogical Reasoning of Young Learners. New Jersey London Lawrence Erlbaum Associates Publisher Mahwah
12. English, L. D., & Halford, G. S. (1995). Mathematics education: Models and processes. Mahwah, NJ: Lawrence Erlbaum Associates.
13. Fischbein E. 2002. Intuition in science and Mathematics . New York: Kluwer Academic Publisher
14. Gentner D. 1999. Analogical Reasoning, Psychology of, Intermediate article Northwestern University, Evanston, Illinois, USA.106-112
15. Gentner D., 1983a. Structure-mapping : a theoretical framework for analogy . Cognitive Science 7(2) : 155-170 .
16. Gentner, D., & Markman, A. B. 1995. Similarity is like analogy: Structural alignment in comparison. In C. Cacciari (Ed.), Similarity in language, thought and perception (pp. 111-147). Brussels: BREPOLS.
17. Gentner, D., Holyoak, K. J.,&Kokinov, B. (Eds.). 2001. The analogical mind: Perspectives from cognitive science. Cambridge, MA: MIT Press.
18. Goldstone, R.L. (1994) Similarity, interactive activation, and mapping. Journal of Experimental Psychology: Learning Memory and Cognition. 20. 3-28
19. Holyoak, K.J dan Thagard, P. 1989. Analogical Mapping by Constraint Satis-faction, Cognitive Science 13, 295-355
20. Holyoak, K. J., & Hummel, J. E. 2001. Toward an understanding of analogy within a biological symbol system. In D. Gentner, K. J. Holyoak, & B. N. Kokinov (Eds.), The analogical mind: Perspective from cognitive science (pp. 161-196). Cambridge, MA: MIT Press.
21. Krulik, S., Rudnick, J. & Milou, E. 2003. Teaching Mathematics in Middle School. Boston, MA: Allin and Bacon.
22. Markman, A.B., and Gentner, D. 2000. Sructure-mapping in tthe comparison process. American Journal of Psychology, 113. 501-538.

23. Matlin, M W. 1994 Cognition, Holt, Rinehart and Winsthon, Inc Florida. third edition
24. Matsumoto, D, Yoo, S.H., dan Fontaine,J., 2008. Mapping Expressive Differences Aroundthe World: Trhe Relationship Between Emotional DisplayRulesand Indvidualism Versus Collectivism. Journal ofCross-Cultural Psychology vol.39 no. 1 55-74
25. Medin, D. L., Goldstone, R. L., & Gentner, D. 1993. Respects for similarity. Psychological Review, 100(2), 254-278.
26. Midahwati, 2020. Penilaian Berbasis Higher Order Thinking Skill (Hots). https://www.mtsn1kotatangsel.sch.id/read/24/penilaian-berbasis-higher-order-thinking-skill-hots
27. Pala, R.H. (2016). Efektivitas Pendekatan Kontekstual ditinjau dari Pemahaman Konsep Matematis Siswa. Skripsi pada FKIP UNILA. Dipublikasikan.
28. Permendikbud Nomor 21 Tahun 2016 tentang Standar Isi Pendidikan Dasar Dan Menengah
29. Polya, G. 1954. Mathematics and plausible reasoning; volume 1. Princeton: Princeton University Press.
30. Slavin R.E. 2006. Educational psychology : theory and practice. Boston: Allyn and Bacon
31. Subanji R, Supratman AM. 2015. The Pseudo-Covariational Reasoning Thought Processes in Constructing Graph Function of Reversible Event Dynamics Based on Assimilation and Accommodation Frameworks, J. Korean Soc. Math. Educ., Ser. D, Res. Math. Educ
32. Sumarmo, U. (2015). Berpikir dan Disposisi Matematik serta Pembelajarannya. Bandung: UPI.
33. Supratman. 2018. Developing Piaget's Theory in Mistakes Construction of Knowledge when Problem Solving through Analogical Reasoning. Journal of Physics Conference Series 1028(1):012146
34. Supratman. 2012b. Penalaran Analogi Klasik Matematik Guru Sekolah Dasar, Prosiding Konferensi Nasional Matematika XVI, Bandung, h.1081-1088.
35. Supratman, Ryane S, Rustina R,. 2016. Conjecturing via Analogical Reasoning in Developing Scientific Approach in Junior High School Students. Journal of Physics: Conference Series 693 (1), 1-9
36. Supratman, Ratnaningsih and Ryane S. 2017. Conjecturing via analogical reasoning constructs ordinary students into like gifted student. Journal of Physics: Conf. Series 943 (2017) 012025
37. Supratman. 2013a. Conjecturing Via Analogical Reasoning to Explore Creative Thinking, Proceeding The 14th International Conference on Education Research, Seoul Korea, p. 271-292Supratman. 2013b. Piaget's Theory in the Development of Creative Thinking, Journal Korean Society Mathematical Education, Serie D, Res. Math. Educ. Vol. 17, No. 4, December 2013, p.291–307
38. Trench M, Oberholzer N, & Minervino R. 2002. Dissolving The Analogical Paradox: Retrieval Under A Production Paradigm Is Highly Constrained By Superficial Similarity, Proceedings of the 2nd International Analogy
39. Tusyani, A, 2011. Kognisi Teori dan Aplikasi, Salemba Humanika Jakarta