



The Students' Truth-Seeking Behaviour in Solving the Problems With No Specified Universal Set Based on IDEAL Problem Solving

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Abstract

The truth-seeking behaviour of students is the main predictor of someone having critical thinking behaviour. Therefore, it is necessary to conduct research related to students' seeking behaviour in responding to mathematical problems. The purpose of this study was to describe the truth-seeking behaviour of students in working on problems with an unknown universe based on the IDEAL problem-solving model. This research was a qualitative descriptive study, with the stages were (1) determining the research subject, (2) making instruments, (3) giving questions to the subject and recording truth-seeking behaviour, (4) analyzing data, (5) triangulating between observations and interviews, interviews, and (5) conclusions. The results of this study are students tend not to behave truth-seeking in working on problems with an unknown universe based on the IDEAL model. However, students did the steps contained in the IDEAL model, although they did not use all the existing stages. In addition, students tend not to give conclusions that are in accordance with the purpose of the question after working on the problem.

Abstrak

Perilaku truth-seeking siswa merupakan prediktor utama seseorang memiliki perilaku berpikir kritis. Oleh karena itu, perlu dilakukan penelitian yang berkaitan dengan perilaku truth-seeking siswa dalam merespon permasalahan matematika. Tujuan penelitian ini adalah mendeskripsikan perilaku truth-seeking yang dimiliki oleh siswa dalam mengerjakan soal dengan semesta yang tidak diketahui berdasarkan model pemecahan masalah IDEAL. Penelitian ini merupakan penelitian deskriptif kualitatif, dengan tahapan (1) penentuan subjek penelitian, (2) pembuatan instrumen, (3) pemberian soal kepada subjek dan perekaman perilaku truth-seeking, (4) penganalisisan data, (5) triangulasi antara hasil pengamatan dan wawancara, dan (5) penyimpulan. Hasil dari penelitian ini adalah siswa cenderung tidak berperilaku truth-seeking dalam mengerjakan soal dengan semesta yang tidak diketahui berdasarkan model IDEAL. Tetapi, siswa melakukan tahap-tahap yang terdapat di dalam model IDEAL, meskipun tidak menggunakan semua tahapan yang ada. Selain itu, siswa cenderung tidak memberikan kesimpulan yang sesuai dengan tujuan soal setelah mengerjakan soal tersebut.

Keywords: Critical Thinking; Truth-Seeking; PWNSUS; IDEAL Model.

INTRODUCTION

Critical thinking is one of the special skills that currently need to be evolved from students. The education hope in the 21st century is the education that contains of creative thinking, critical thinking, communicative and collaborative. This is in accordance with the opinion in the US-Based Partnership for 21st Century Skills (P21) declared that the competencies needed are communication, collaboration, critical thinking, and creativity or commonly called the 4C's. The Indonesian government also assigns the learning objectives in schools and universities, that is developing and educating students to have critical thinking (Kementerian Pendidikan dan Kebudayaan Republik Indonesia, 2016).

Critical thinking is reflective and rational thought process associated with the things that must be done or believed (Ennis, 1996). Someone who has critical thinking can usually differentiate between facts and opinions. The analyze and identify problems ability in detail is an capability that is usually possessed by a critical thinker (Poe, 2016). The things that must be considered from critical thinking are abilities and behavior (Lai, 2011).

Behavior is a habit of a person's mind when obtain a problem (Lai, 2011). Critical thinking behavior is related in facing with a problem and being able to be careful in making a decision to resolve the problem. If students possess the critical thinking behavior and are given a problem, then the students do not solve the problem immediately, but verifies the truth that is known in the problem and classifies the things (Kurniati & Zayyadi, 2018).

Truth-seeking is one of the seven components in critical thinking behavior (Facione et al., 1995). Truth-seeking is

the main predictor of someone who tends to have critical thinking behavior. Junior high school students, especially in Jember at this time have not shown truth-seeking behavior, because the students are not wanted to solve the problems that can accustom truth-seeking behavior (Kurniati & Zayyadi, 2018).

Another cause of the undeveloped truth-seeking behavior in junior high school is most of the prospective teachers and mathematics teachers are not wanted to have critical thinking behavior. This contention is in line with research conducted by Kurniati, Purwanto, As'ari, & Dwiyanana (2019) which declares that the truth-seeking behavior of prospective teachers and mathematics teachers has not emerged in solving non-routine questions. Because they are not wanted to solve non-routine questions and select to memorize the formula that has been learned.

A description of students' truth-seeking behavior is required, so the teachers can attain learning objectives about critical thinking in school in accordance with the regulation set by the Education and Culture Ministry of Indonesia. Teachers must have critical thinking facilities to teach critical thinking behavior, especially truth-seeking (Emir, 2009). Enhancement of students' critical thinking behavior can be done by applying infusion, immersion, combined infusion and immersion learning, as well as problem solving (Kurniati, Purwanto, As'ari, & Dwiyanana, 2019). Teachers can apply learning models that have been adjust with the initial abilities possessed by most of students to increase critical thinking behavior (Jumaisyaroh et al., 2014). A student who has truth-seeking behavior in problem solving is characterized by (1) leads in comprehension of situation presented in the problem, (2) emphasis on evidence and reason, (3) en-

quire the beliefs to more expert people such as teachers and (4) observe the important details in the problem (Facione, 2015). Therefore, it is necessary to do the research that accustoms junior high school students to have truth-seeking behavior thru giving a problem.

Mathematical problems which can accustom students to have truth-seeking behavior must refer to the four traits and ideas contained in truth-seeking and students required to ask all the information in the problem (Kurniati, Purwanto, As'ari, Dwiyan, et al., 2019). This signifies that is not all math problems can accustom students to have truth-seeking behavior. A problem type that can be used to track students' truth-seeking behavior is *Problems with No Specified Universal Set Given (PWNSUS)* (As'ari, Abdur Rahman; Kurniati, Dian; Maharani, Swasti; Basri, 2019). *Problems with No Specified Universal Set Given (PWNSUS)* is a mathematical problem to stimulate thinking and responding of students to check the truth of the problem in any situation (Lewis & Ph, 2007).

If students behave in truth-seeking, then the demeanor propensity that emerge in solving PWNSUS problems are (1) inspecting the universe in the problem before resolve it, (2) writing out and specify the universe in problems, (3) writing down the substantiation and rationale to espouse the correct statement in the problem, (4) writing facts, concepts, tenets and mathematical calculation used in solving mathematic problem, (5) using all the information contained in the problem and specified universal in the problem solving process (6) writing down all answer or completion based on all the specified universal that have been determined (Kurniati et al., 2020). The behavioral predisposition is an indicator used in this research to determine students' truth-seeking in responding problems.

When students' critical thinking behavior increases, problem solving skills will also increase. IDEAL problem solving theory is a theory of solving the problem in more detail stages when compared to other solving theory, for example Polya problem solving, because the identification and purpose determination of the problem become one part in Polya problem solving, while the identification and purpose determination of the problem is divided into two parts in IDEAL problem solving (Susiana, 2010). The IDEAL problem-solving theory is a strategics used to improve critical thinking skills and resolve the given problem (Bransford & Stein, 1993). The strategies contained in the theory IDEAL are identifying problem, defining goal, exploring possible, anticipating outcomes and looking back. Specifically, IDEAL problem solving is a problem solving used for well-defined or structured problems (Prasetya, Kartono, Widodo, 2012)

Based on this explanation, it is necessary to conduct a research the focuses on the students' truth-seeking behavior in solving mathematical problems with no specified universal set given based on the IDEAL theory. The problem formulation in this research is how the students' truth-seeking behavior in solving mathematical problems with no specified universal set given based on the IDEAL theory?

METHODS

This research was the descriptive qualitative research because it describes qualitatively the students' truth-seeking behavior in responding the problems with no specified universal set given based on the IDEAL problem-solving theory. In this research, data were gained from observation, test, and interview which were described clearly from the propensity of

the students' truth-seeking behavior in responding problems. This is in accordance with the contention which states that qualitative research is an activity in accumulating data and providing an explanation of the condition that take place in the subject who are researched (Gulo, 2002).

The stages in this research are (1) determining research subject, (2) creating instruments, that is the problems, observation sheets and interview guidelines, (3) giving the problems to subjects and recording truth-seeking behavior, (4) analyzing data, (5) triangulation in the results of observation and interview, and (6) making the conclusion. The subject in this research were grade 8B students of Junior High School 4 Jember who had studied the Cartesian coordinate system. All students in 8B are requested to resolve the two problems given.

When solving problems, all student activities are recoded as an effort to support and bolster the statements when analyzing data. Moreover, research subjects were requested to do a think-aloud and record it. After that, taking in depth interviews were conducted with interview guidelines that had been tested the validity, the interview can confirm the results of test and observation. In addition, the test problem and observation sheets have also been validated by two experts in Mathematics Education.

At the data analysis stage, the results of recording students' behavior, recording think-aloud and students answer sheet were used as the elementary for determining students' truth-seeking behavior. The data analysis results are confirmation by the IDEAL problem-solving stages. The indicator of truth-seeking behavior in this research refers to the IDEAL problem-solving theory. The indicators of truth-seeking behavior in this research are presented in Table 1.

The next stage is to enforce the triangulation stages as a step to assure the validity of the data acquired. The triangulation opted is method triangulation, which is to confirm the primary data that has been acquired from the observation and test, compared and reviewed the validity of the data with interview. The data triangulation results are the results of data analysis, so the conclusion of the research results was based on the triangulation results.

Table 1. Truth-Seeking Behavior Indicator

IDEAL Problem Solving	Truth-Seeking Indicator
Identifying the problem	Determine all the information and check out the universal set in the problem
Defining goal	Look for the problems inquired in the test, write down and determine the universal set in the test
Exploring possible strategies	Write formulas and steps in solving problems
Implementing strategy	Using all the information in the formula and predefined steps
Looking back and evaluating results	Write down inference and all solution based on universal set that has been determined

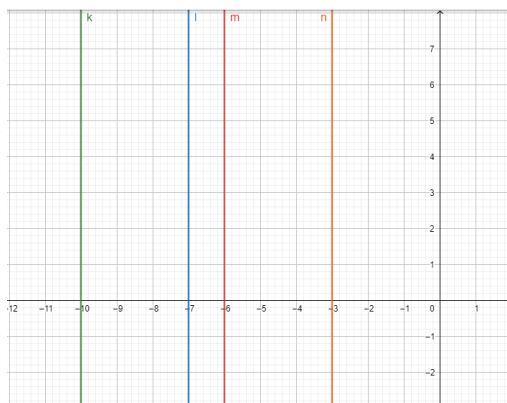
RESULTS AND DISCUSSIONS

Results

The research subject is given the problem with no specified universal set. The first problem given is as follows: If the next two consecutive lines pass through the point $(c, 0)$ and $(d, 0)$, determine the value of c and d based on pictures 1.

All students did not verify the truth of problem number 1 and worked it immediately. Based on answer analysis and

direct observation, the research subject presume that the problem number 1 can be resolved and must have an answer, without looking for a substantiation or statements that support the answer. In addition, all students presume that the problem given by the researcher as a teacher is a problem that must possess an answer.



Picture 1. Cartesian Coordinate Problem Number 1

In problem number 1, all research subjects wrote the answer immediately without writing out the information contained in the problem, the desired aim in the problem and opting or looking for the possible strategies. In answering these problem, all research subjects did not provide the inference based on universal set, they only wrote down the answer asked in the problem. However, 7 research subjects write the wrong answer in the problem number 1. An example of 7 students who wrote the wrong answer can be seen in Figure 2.

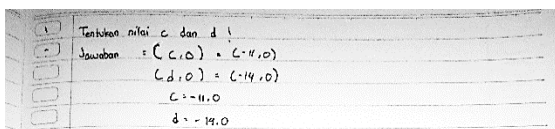


Figure 2. A Wrong Answer Example of 7 Students in Problem Number 1

The correct answer is $c = -2$ and $d = 1$ if the universal set is the set of real numbers. If the universal set is the set of natural, positive, and odd integers, then c

$= \emptyset$ and $d = 1$. If the universal set is the set of negative and even integers, then $c = -2$ and $d = \emptyset$. If the universal set is the set of irrational numbers, then $c = \emptyset$ and $d = \emptyset$. However, the students' answer is $c = -11$ and $d = -14$. The seven research subjects possess the same answer as Picture 2.

While two research subjects answered the problem correctly. However, two research subjects answered the problem directly and did not give an inference based on the desired aim of the problem. A correct answer example of two students can be seen in Figure 3.

Dua garis selanjutnya melalui $(-2, 0)$ dan $(1, 0)$ seperti pada garis selanjutnya.

Figure 3. A Correct Answer Example of Two Students in Problem Number 1

The research subject answered correctly but did not provide specific inference regarding the values of c and d . Two research subjects possess the same answer as Picture 3. The truth-seeking behavior of the students has not emerged in solving problem number 1, because students who have truth-seeking behavior will write down the universal set at identifying problems and determining goals steps, moreover it also provides an answer inference with various possible universal set that determined in the prior stages.

The second problem given to research subjects is as follows: In figure 4 there is line k thru points A and B . Point A possesses the coordinate point $(11-2d, 5)$ while point B is at the coordinate point $(-2e+1, 2)$. Then line l thru point B and C , point C possesses the point $(3, 6+4f)$. Determine the value of d , e and f !

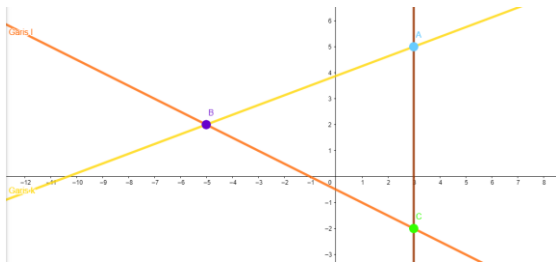


Figure 4. Cartesian Coordinate Problem Number 2

Based on the results of the student answer analysis, some student verified the truth based on the IDEAL problem-solving theory, but the students did not verify the universal set. There are the four of nine research subjects who check the information contained in the problem. While the other research subjects do directly on strategies and answer.

In problem number 2, there are four research subjects who do four stages of the IDEAL problem-solving theory, but the students do not check the universal set. The students did not write down the universal set in the stage of identifying problem and determining goal. An answer example of four students for the problem number 2 can be seen in Figure 5.

The inference related to the universal set are not written by the students. Based on that statement, the students do not behave truth-seeking, especially towards the universal set contained in problem number 2, the students presume that the universal set of the problem number 2 is the set of real numbers.

While the other 4 research subjects resolved the problem number 2 using the stages of the identifying problem, exploring possible strategies and implementing strategy. The students overlook the defining goal step. The students have done the identifying problem step, but they did not notice the universal set in the problem. There are two of four students who answered the problem mistakenly. An example of two students who wrote the wrong answer can be seen in

Figure 6.

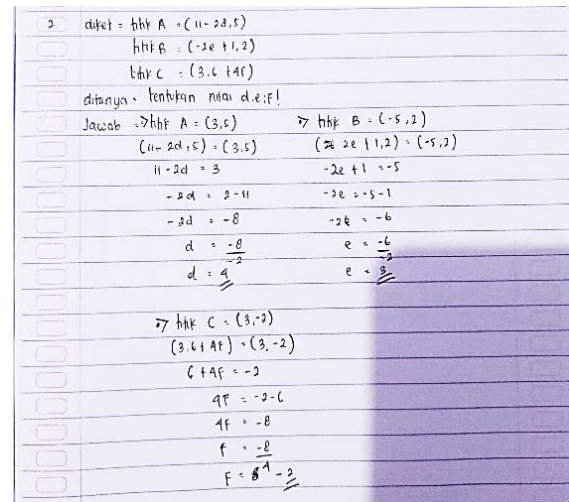


Figure 5. An Answer Example of Four Students For the Problem Number 2 Based on IDEAL Problem Solving Theory

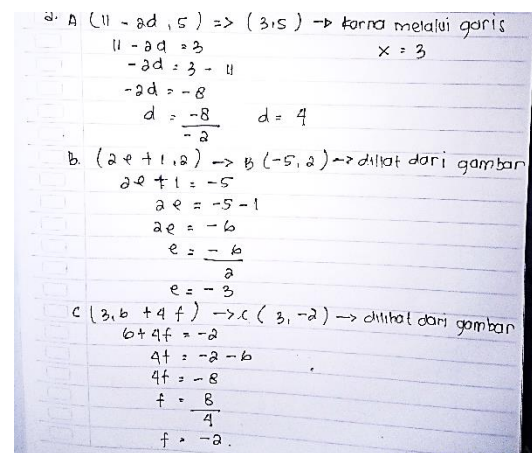


Figure 6. A Wrong Answer Example of Two Students in Problem Number 2

The correct answer will be $d = 4$, $e = 3$ and $f = -2$ if the universal set is the real number set. If the universal set is the positive integer and natural number, then $d = 4$, $e = 3$ and $f = \emptyset$. If the universal set is the negative integer, then $d = \emptyset$, $e = \emptyset$ and $f = -2$. The problem solution is $d = 4$, $e = \emptyset$, and $f = -2$ if the universal set is the even number set. If the universal set is the odd number set, then $d = \emptyset$, $e = 3$ and $f = \emptyset$. If the universal set is irrational number set, then $c = \emptyset$ and $d = \emptyset$. However, the student answers is $d = 4$, $e = 3$ and $f = -2$. Two research subjects possess the same answer with Figure 6. In

addition to the two research subjects who answered mistakenly, there were two other subject who write down the right answer. An answer example of two students for the problem number 2 can be seen in Figure 7.

Handwritten mathematical work for problem number 2. It shows three systems of linear equations and their solutions for variables d , e , and f .

System 1: Titik A = $(11 - 2d, 8)$, Titik B = $(-2e + 12)$, Titik C = $(3, 6 + 4f)$

System 2: Titik A = $(3, 8)$, Titik B = $(-5, 2)$, Titik C = $(3, -2)$

System 3: $(11 - 2d, 8) = (3, 8)$, $(-2e + 12) = (-5, 2)$, $(3, 6 + 4f) = (3, -2)$

Solving for d : $11 - 2d = 3$, $-2d = 3 - 11$, $-2d = -8$, $d = 4$

Solving for e : $-2e + 12 = -5$, $-2e = -5 - 12$, $-2e = -17$, $e = 8.5$

Solving for f : $6 + 4f = -2$, $4f = -2 - 6$, $4f = -8$, $f = -2$

Figure 7. A Correct Answer Example of Two Students in Problem Number 2

Eventhough the answer is right; the students do not write the inference of the universal set. The students write down immediately the calculation results that have been done.

There is a research subject who answered incorrectly and did not do the stages of IDEAL problem-solving theory. The student write down immediately the answer without showing the calculation that have done. The research subject answer can be seen in Figure 8.

Handwritten mathematical work for problem number 2. It shows three coordinate points without any calculations.

Titik A = $(9, 5)$

Titik B = $(-1, 2)$

Titik C = $(3, 10)$

Figure 8. The Wrong Answer in the Problem Number 2

The research subject only wrote down the coordinate in accordance to the figure in the problem number 2. Based on those results, it shows the student does not check the truth of the information and goal contained in problem number 2.

Based on the data analysis result, there are nine findings in this research. The findings are (1) the students do not verify the universal set contained in the

problem number 1 and 2, (2) the students determine all the information in the identifying problem stages of the problem number 2, but this is not done in the problem number 1, (3) the students do not do the determining goal stage in the problem number 1, (4) the students do the determining goal stage in the problem number 2 by looking for the problem asked, but they do not determine and write down the universal set, (5) the students do not choose and explore the strategies used in the problem number 1, so they do not write down the formula and step to resolve the problem (6) The students write down the formula and step to resolve the problem number 2 eventhough it is done separately by working the problem, (7) the students carry out the fourth stage of the IDEAL problem solving, namely implementing strategy on the two problem given by using all the information contained in the problem except the universal set, (8) the students do not write down the inference and all solutions based on the universal set that has been determined on the two problem given, and (9) the students do not do the last stage of the IDEAL problem solving theory, which is looking back and evaluating the results.

Discussions

The first stage of the IDEAL problem solving theory is identifying the problem, which is a stage to understand the gist that is the fundamental of the problem (Annizar et al., 2020). At this stage, the students should write down all information in the problem, included the universal set of the problem. However, they only indicated the information in the problem number 2 and did not write out the universal set on all problem given. If the students behave truth-seeking, they will try on to surmise the universal set of

the problem and look for the possibilities of the universal set in that problem. The observation results denote that all students did not try to guess the universal set in the problem, they wrote down directly the information contained in the problem and worked on it. They write out merely the information on problem number 2, because they assume that the problem number 1 only requires an answer. Based on the interview results, all students still do not comprehend the definition of the universal set because their teacher never elucidate about it.

The second stage is defining goal. At this stage, the students should write out all the things asked and determine the settling of each possible universal set that has been stipulated beforehand. They did not write out the universal set of the problem in the prior stage so in this stage, they did not likewise write the solution of the probable universal set. If the students behave truth-seeking, they will write out the possible universal set of the problem that are linked with the variable contained in the problem. The observation results indicate that a few students determine the goal of the problem, the students only be valid to solve the problem number 2. The research subjects were given an elucidation and also an understanding of the universal set and asked question "Mention any numbers set that you savvy!", most of them answered the set of natural, whole and integer numbers. The universal sets possess many possibilities, this is not just three number sets.

The third stage is exploring possible strategies. At this stage, the students write down the formulas or steps used to gain the answers that are in accordance with the problem aim. In problem number 1, they should write out the number pattern that is formed the information problem that has been known. The stu-

dents have written strategies or stages in problem number 2 related to one variable linear equation. Most of the students answered that the problem number 1 did not require a means to obtain the answer, and some of them also answered that they did not regard the number pattern formed at the coordinate points in the figure, they presume that the settling of the problem is a negative integer. Meanwhile, in solving problem number 2, most of the students answered correctly and some of them write the false answer because they were not scrupulous to resolve the problem.

The fourth stage is implementing the strategy. At this stage, the students write down the solution of the problem based on the goal that has been determined previously. Most of the students looked perplexed in working on the problem number 1, this is acquired based on the direct observation results. They accomplish difficulty in problem number 1 because they have never been taught to resolve that problem, they only find out if the problems were related to the number pattern material after an interview was conducted. Meanwhile, in solving problem number 2, most of the students did directly on the problem, and some of them recite the problem for twice to ensure that the problem goal is true.

The last stage is looking back and evaluating the results. The students who have truth-seeking behaviour should write out the inference and all settling based on the universal set that has been defined. In this stage, students should look back their results, but they garner directly their results. Based on the observations, a few students reread the problem and corrected their results but they did not write down the conclusions that in accordance with the problem goal and the universal set. At the time of the interview, they did not evaluate the results

because they believe that their answer was true according to their understanding.

Based on results acquired, it can be said that the truth-seeking behaviour has not emerged in 8th grade junior high school students. All students presume that the problem given by the teacher are the correct problem and the universal set contained in the problem is always the real number set. So, they do not try on the truth in the problem, mainly regarding the universal set. Most of the students did not show all stages of the IDEAL problem-solving theory. The stage that is not often carried out is looking back and evaluating the results. All students did not write the inference after finishing the problem in the two problems given. In the first stage, they did not check the universal set, so they did not assign the universal set in the final stage.

The results obtained in this research are in accordance with the research results conducted by Kurniati, Purwanto, As'ari and Dwiyanana (2019) which convey that prospective mathematics teachers have not possessed truth-seeking behaviour in solving the non-routine problem. There are three constituent that predispose a person's truth-seeking behaviour, namely attitude, subjective norms and controlled behaviour (Ajzen, 1991). In this case, the students do not possess leery from the problem that do not have the universal set, so the students directly work on the problem without checking the comprehensiveness of the information in the problem. Thus, the attitude shown by the students has not presided to critical thinking behaviour. In addition, the rut of the students taking on routine problem from the teacher affects the students' truth-seeking behaviour. The third factor is controlled behaviour in students who are attuned to presume that the universal

set is always the real number set.

CONCLUSIONS

The truth-seeking behaviour of 8th grade junior high school students when solving Problems with No Specified Universal Set Given (PWNSUS) did not check the information truth contained in the problem, especially related to the universal set. However, the students carried out the stages contained in the IDEAL problem solving theory, eventhough they did not use all stages. In addition, the students did not give the inference that are in accordance with the problem goal after calculating the problem.

Based on this research result, the counsel given is to apply mathematics learning that focuses on critical thinking behaviour, mainly on the truth-seeking component, as well as habituation of giving non-routine problem, one of them is Problem with No Specified Universal Set Given (PWNSUS) in every mathematics lesson. In addition, the students have to be given the problem that can improve problem solving skills, especially based on the IDEAL problem solving, because the problem solving skill possessed by students cannot be obtained instantly (Ulya, 2016). For further research, it is expected to provide the examples of working on non-routine problem, especially the Problems with No Specified Universal Set Given (PWNSUS), so the students can show the critical thinking behavior, mainly in terms of truth-seeking.

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