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The Impact of Problem-Solving Methods, Learning Styles, And Initial Mathematical Abilities on Mathematical Problem-Solving Abilities of Tenth-Grade Students in SMA Negeri 1 Waisala Maluku

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ABSTRACT : This research aims to analyze the impact of students' different mathematics problem-solving ability using the problem-solving method, and the relationship between the ability and students' learning styles and initial mathematical abilities. This research is conducted in SMA Negeri 1 Waisala Maluku. The sample comprises 67 tenth-grade students divided into three classes determined by the multi-stage random sampling technique. The method used in this research is pseudo-experiment. To collect relevant data, several instruments are used. They are (1) initial mathematical ability, (2) mathematical problem-solving ability, and (3) auditory, kinesthetic, and visual learning styles. The methods used are problem-solving and expository. Based on the research findings, (1) After their initial mathematical abilities are controlled, the mathematical problem-solving abilities of students taught using a problem-solving method are higher than that of students taught using an expository one; (2) After their initial mathematical abilities are controlled, the mathematical problem-solving abilities of students with an auditory learning are higher than that of students with a kinesthetic learning style; (3) After their initial mathematical abilities are controlled, the mathematical problem-solving abilities of students with an auditory learning are lower than that of students with a visual learning style; (4)After their initial mathematical abilities are controlled, the mathematical problem-solving abilities of students with a kinesthetic learning are lower than that of students with a visual learning style; and (5)After the students' initial mathematical abilities are controlled, there are an impact of the interaction between learning methods with learning styles and students' mathematical problem-solving abilities.

KEYWORDS: *Problem-solving Method, Expository Method, Initial Mathematical Ability, Mathematical Problem-solving Ability, Auditory Learning Style, Kinesthetic Learning Style, Visual Learning Style*

I. INTRODUCTION

Students' mathematical problem-solving abilities should be optimized and acquire serious attention in the learning process as essentially, one of the learning objectives is to encourage students to solve mathematical issues independently. Therefore, in the context of mathematics, students are required to solve various mathematical problems and challenges. Building upon rigorous computation, students can produce logical reasonings upon all challenges given by theachers in a learning activity at the class or daily faced. Nevertheless, it remains a mere expectation due to multiple problems that occur, particularly problems related to the implementation of learning methods, diverse characteristics of students, and students' learning style teachers may not acknowledge. The problems are overlooked, especially by the mathematics teacher who teaches the tenth-grade students in SMA Negeri 1 Waisala and thereby bringing about the students' low mathematical problem-solving abilities. On the one hand, the educational curriculum demand teachers to implement problem-solving methods, be familiar with students' learning styles, and elevate students' initial mathematical abilitybecause the three aspects are pivotal in enhancing students' problem-solving ability.

Responding to that issue, the problem-solving method is one of the problem-solving methods that mitigate students' low problem-solving abilities. Pristiwanto (2016:127-134) argues that the problem-solving method has a positive impact on students' learning achievement. Rubiyani (2016:116-121) clarifies that the implementation of the problem-solving method has a significant impact on the improvement of students' mathematics learning achievements. In short, implementing the problem-solving method in the tenth-grade students in SMA Negeri 1 Waisala can optimize their mathematical problem-solving abilities.

In addition to the essential learning methods, there are other pivotal aspects i.e. auditive, kinesthetic, and visual learning styles since learning styles pertain to students' internal and external conditions to apprehend the information received. Similarly, Bire*et al*. (2014:168-174) and Waskitoningtyas (2017:36-43) argue that visual, auditorial, and kinesthetic learning styles have an impact on learning achievements and problem-solving abilities. Relying upon the arguments, learning styles have a close linkage to students' problem-solving abilities in a classroom learning process.

Firmansyah (2017:55-68) and Purwaningrum and Sumardi (2016:155-167) clarify that there is initial mathematical abilities have a significant impact on learning outcomes. Problem-solving abilities are thus a part of learning outcome so it is crucial for teachers to analyze students' initial abilities as the initial information and find a suitable learning method to implement and thereby generating an optimum problem-solving ability. Meanwhile, Rizal *et al*. (2016:172-185) conclude that the implementation of the expository method in the learning by 8.70% is categorized as intermediate, that by 56.52% is categorized as high, and that by 34.78% is categorized as extreme with a mean score of 78.93. The figures inform that initial mathematical abilities and the expository method have an impact on mathematical problem-solving abilities.

Optimizing students' problem-solving abilities by considering the learning style of the tenth-grade students and teachers in SMA Negeri 1 Waisala, we refer to some information regarding the problem-solving method, expository method, initial mathematical abilities, and learning styles. The reference is also used to help us find the solution to sustainably enhance teachers' performances in learning processes.

II. LITERARY STUDIES, RESEARCH FRAMEWORK, AND RESEARCH HYPOTHESES

1. Mathematical Problem-solving Abilities

Some literature relevant to mathematical problem-solving abilities is NCTM (2000:52), Wahyudi (in Simorangkir, 2014:30-34), and Mujis and Reynolds (2008:338). The literature confirms that problem-solving abilities are an integral part of mathematical learnings which relates to daily activities. Creative and innovative problem solving should be embedded in students from early, allowing them to face challenges as their future promises variety and problems which should be resolved.

Mathematical problem-solving abilities are not merely about answering problems which are put in a mathematical style but also answering problems which require an extensive and deep thinking process. Responding to that, students should be equipped with problem-solving abilities, including (1) numeric abilities, (2) spatial abilities, (3) visual abilities, (4) commutative abilities, (5) logical abilities, (6) analytical reasoning abilities, (7) sequence and pattern computation abilities, and (8) deductive reasoning abilities. The abilities are the main indicators and if students have the indicators, they have mathematical problem-solving abilities.

2. Problem-solving Method

Mariati (2012:153-160), Murray, Oliver, and Human (in Huda, 2013:273), Djamarah and Zain (2013:91), and Rubiyani (2016:116-121) convey that the problem-solving method constitutes a learning activity which pertains to confronting students with problems and assigning them to be more active than their teachers using the following steps i.e. (1) teachers introduce a problem, (2) teachers propose the problem to students, (3) students look for necessary data, (4) teachers assess students' answers, (5) teachers evaluate students' answer correctness, (6) teachers draw conclusion, (7) teachers give another challenge or problem to students, and (8) teachers close the activity.

The implementation of the problem-solving method notably aims to prompt students to make ideal and more critical ideas and show more flexibility to follow learning processes. The problem-solving method is proven effective to escalate students' thinking, especially to improve mathematical problem-solving abilities. Some characteristics of the problem-solving method are thus allowing students to think and act independently and openly and encouraging students to well construct their logic. In other words, the problem-solving method allows teachers to design a student-centered learning process in which students will actively discuss some close-to-reality problems, learn by experiences, make experiments, and find new knowledge which can help them increase their problem-solving abilities.

3. Expository Method

Sanjaya (2006:179), Mudjiono (2006:172), Miarso (2004:530-531), and Mulyana (2007:114-115) define the expository method as a teacher-centered teaching method as teachers are more active than students. The teaching steps in the expository method are (1) teachers introduce the learning material, (2) teachers deliver the learning objectives and make students ready, (3) teachers demonstrate the knowledge and abilities, (4) teachers give assistance, (5) teachers check students' understanding and give feedback, (6) teachers give opportunities for students to do advanced training and implementation, and (7) teachers close the activity.

The essential reason why teachers implement the expository method is their perception of teachers' responsibilities for delivering the learning materials. As learning material deliverers, teachers act as the information sources and attention centers for students. Students will learn more persistently if their teachers give the learning materials using the expository method. Unfamiliar with certain knowledge, students will focus on the material being given to gain understanding. In the expository method, teachers giving explanations to students directly indicates a good learning process but on the other hand, teachers giving assignments without specific and clear explanations indicates a poor learning process as students will not necessarily do the assignments because they perceive vague directions and objectives regarding the assignments.

4. Initial Mathematical Abilities

Sutikno (2004:67-68), Effendi (2016:165-176), Haeruman*et al*. (2017:157-168), and Purwaningrum and Sumardi (2016:155-167) describe initial mathematical abilities are students' understanding of the materials about to study even with minimum capacities under the following indicators which are (1) able to identify identified elements, (2) able to compose a mathematical model, (3) able to implement problem-solving strategies, (4) able to explain problems specifically, and (5) able to give meanings to mathematics in life.

The basic apprehension regarding students' initial mathematical abilities is that the majority of students cannot solve mathematical problems due to the poor initial mathematical abilities gained by students through learning processes or the poor initial mathematical abilities the students have before learning processes. Students may gain initial mathematical abilities to certain topics by self-learning at home or at school through which they investigate the learning materials which will be given in the future meeting.

Before continuing a lesson, teachers should consider students' initial mathematical abilities. Besides, teachers should also prioritize students' initial mathematical abilities before continuing the lesson.

5. Auditory Learning Style

Each individual has a different style in receiving and studying information. Individuals with an auditory learning style focus their attention on auditory aspects. Their auditory learning ability stimulates them to think effectively and efficiently when they are learning. According to Meier (2002:95), DePorter and Hernacki (2009:118), Wahyuni (2017:128-132), and Marpaung (2015:84), an auditory learning style is students' tendency of learning style in which they prefer to listen and discuss verbally, self-talk, and self-listen when learning. The indicators are (1) frequently self-talking when doing things, (2) easily disturbed by noise, (3) mouthing when reading, (4) reading aloud andlistening to their voices when reading, (5) repeating and imitating voices, (6) finding hard to write but easy to talk, (7) talking rhythmically, (8) being communicative, (9) fonding of music, (10) learning by listening and memorizing what has been talked about better than memorizing what has been seen, (11) inclining to talk, discuss, and explain elaboratively, and (1) inclining to read aloud than to write something down.

One of the mathematical learning strategies for students with an auditory learning style is to motivate them to participate in a classroom learning process. Mathematics, with its distinctiveness in the form of numbers, symbols, formulae, postulates, theorems, geometry, and others causes teachers not to give detailed explanations, bringing about confusion in students. By students' active participation in which they question what they do not understand and teachers' willingness to give detailed explanations, a learning process will run better and hence students can comprehend the materials quickly.

6. Kinesthetic Learning Style

Individuals with a kinesthetic learning style build upon physical or motor strength as the primary achievement than an auditory or visual one. Kinesthetic individuals prefer physical activities to listento and read or observe. Therefore, some experts such as DePorter and Hernacki (2009:118-120), Meier (2002:92-94), Lestari (2012:1-7), and Marpaung (2015:84-85) explain that a kinesthetic learning style constitutes individuals' ability to perform something by moving, working, touching, doing, responding to physical attention, doing sports persistently, learning while playing, and nurturing a strong willing to do something. The indicators are (1) speaking more slowly, (2) touching partners to get attention, (3) preferring to stand near to someone with whom individuals with a kinesthetic learning style speaking, (4) moving actively, (5) learning by practices and experiments, (6) memorizing while walking and observing, (7) using fingers to pointing at the part being read, (8) preferring body languages, (9) being unable to sit quietly in a long period, (10) making decisions based on feelings, (11) tapping a pen, fingers, or foot when listening to teachers or others speaking, and (12) sparing time to do sports and other physical activities.

Students with a kinesthetic learning style prefer learning integrated with physical activities. In mathematics, learning processes integrated with physical activities come with some concepts i.e. practicing to make the geometry, measurement, and others. Doing specific movements in learning processes allows students with a kinesthetic learning style to understand the materials given easily. Furthermore, students with the type of learning style learn independently without others assisting. Psychologically, students with a kinesthetic learning

style directly move to a certain object which influences their mind and experiences. The experiences can be a reference or base to develop students' abilities in other aspects.

7. Visual Learning Style

Multimedia-based learning may significantly benefit students with a visual learning style. Students find it more comfortable and engaging when they are confronted with a real object. To deal with this type of student, teachers should prioritize multimedia-based learning overa verbal explanation.

Meier (2002:97-99), Prabowo and Ristiani (2011:72-87), DePorter and Hernacki (2009:116), and Ahmadi and Supriyono (2004:84) mention a visual learning style as a type of learning with which students focus their eyes or vision to understand a certain object. The indicators are (1) being neat and organized, (2) speaking fast, (3) making a plan, (4) being able to see/read writings in their head, (5) memorizing what is seen better than memorizing what is listened to, (6) memorizing by imagining, (7) preferring written instructions, (8) loving reading, (9) making scratches when learning, (10) adoring pictures/paintings, (11) identifying what should be spoken but being unable to express it in words, and (12) preferring demonstrations than speeches.

Today mathematics is synergized with a visual learning style. Visual individuals read the information which is concrete and real. In terms of mathematics, mathematical characteristics are better to be expressed under concrete and real condition and thus more influence students with a visual learning style. It frequently occurs that when learning materials, either mathematics or other lessons are not well designed in accordance with students' learning styles, the learning outcomes are reportedly low. Therefore, the characteristics of learning materials, students, and learning methods should be sinergized to achieve the learning objectives.

III. RESEARCH METHODOLOGY

This research is conducted to students selected by class without randomization. The selection categorizes the research type into experimental research using the ANCOVA analysis which involves several variables which are problem-solving abilities as the dependent variable (Y), initial mathematical abilities as the X variable, learning methods (A) as the treatment variable which comprises the problem-solving learning (A_1) and the expository method (A_2), and learning methods (B) as the attributive variable consisting of auditory learning style (B_1), kinesthetic learning style (B_2), and visual learning style (B_3). The research design is indicated in Table 1.

Table 1. 2×3 factorial research design

Learning Style	Learning Method (A)			
	Problem-solving Method (A_1)		Expository Method (A_2)	
	X	Y	X	Y
Auditory (B_1)	X	A_1B_1	X	A_2B_1
Kinesthetic (B_2)	X	A_1B_2	X	A_2B_2
Visual (B_3)	X	A_1B_3	X	A_2B_3

The research population is the tenth-grade students in SMA Negeri 1 Waisala who are grouped into three learning groups. The population comprises two classes of three learning groups. The description of the number of students based on class is indicated in Table 2.

Table 2. The Number of Students in the Population

No.	Class	Number of Students
1	X_1	27
2	X_2	19
3	X_3	21

To determine the research sample, we take two classes under the assumption that all students' abilities are homogenous; while one class for instrument trials. Using the multistage random sampling technique, the research samples consists of Class X_1 and X_2 as the experimental class and Class X_3 as the instrument trial class.

Instruments are the measurement tool used to measure the research variables. The research instruments comprise (1) the instrument measuring problem-solving abilities with determined indicators, (2) the instrument measuring students' learning styles with determined indicators, and (3) the instrument measuring initial mathematical learning abilities with determined indicators.

The data collected in this research are the data of mathematical problem-solving abilities acquired using multiple-choice tests given at the end of learning activities, the data of students' learning styles acquired using questionnaires distributed before learning activities, and the data of initial mathematical abilities acquired

using multiple-choice tests given right after the learning activities are started. Before used, the instruments are tested in Class X_3 and further tested for their validity and reliability.

The data analysis technique used is an inferential analysis. The descriptive analysis technique is used to gain the description of the characteristics of a distribution of the value of the respective variables researched. The description is based on the mean, median, and modus. Besides, data variants are also computed. The data distribution, based on the grouped data frequency distribution table is visualized in the form of a histogram.

A two-way ANCOVA includes (1) Normality test, (2) Homogeneity test, (3) Linearity test, and (4) Slope homogeneity test for each Group A_iB_j (Kadir, 2015:432). Before hypotheses are tested, prerequisite tests i.e. normality, homogeneity, linearity, and slope homogeneity tests are conducted.

IV. FINDINGS AND DISCUSSION

Based on the research findings, after their initial mathematical abilities are controlled, the mathematical problem-solving abilities of the students taught using the problem-solving method are different from that of the students taught using the expository method. The difference is due to the preeminence of the problem-solving method if it is compared to the expository method. The first method prompts students to solve problems in a quick and rigorous way; while the second inclines to be a teacher-centered method and thereby reducing the activeness of the students in self-problem-solving. The difference is supposed to bring about different problem-solving abilities as well if the implementation of the method is correct.

Responding to the issue, Mariati (2012:153-160) proposes the same argument, "The problem-solving method focuses on students. With the method, they are allowed to easily construct knowledge, look for ideas relevant to essential concepts, develop the ideas, and strengthen the concepts. Besides, students will be more confident and self-reliant, fulfill their intellectual needs, find more information, identify problems, and find the solution to the problems." This method is student-centered so teachers act as facilitators who assist students in problem-solving. The method is efficient and easy to reinforce students' problem-solving abilities. Dimyati and Mudjiono (2006:172) clarify, "The word 'expository' was derived from the word 'exposition' which means giving a description and explanation to describe or explain a certain intention or objective." An extensive description and explanation are essentially crucial. However, in mathematics, they give a slight contribution because students' understanding and paradigms are different from those of teachers. Consequently, sometimes students should ask for another repeated explanation, and teachers should re-explain or continue the learning process due to limited time allocation. The second situation, theoretically, results in students who do not understand the materials given as teachers have dominated the learning activities. Moreover, when prompted to the situation in which they have to solve problems by themselves, they will attempt to find solutions in accordance with their abilities.

Identified after their initial mathematical abilities are controlled, students' mathematical problem-solving abilities with an auditory learning style are different from students' mathematical problem-solving abilities with a kinesthetic learning style. Theoretically, the difference is because students with an auditory learning style are more preeminent in understanding the information delivered by teachers than students with a kinesthetic learning style. The first group of students relies on their hearing sense in understanding information. This implies that the expository method is best used for students with an auditory learning style.

In line with the finding, Mejer (2002:95) gives this supporting confirmation, "Our auditory mind is much stronger than what we think it is." In other words, individuals who build upon their hearing abilities can stimulate their logic extensively and deeply to generate certain creativeness. In response to an auditory learning style, teachers should manage a verbal learning activity for the students with the learning style. According to DePorter and Hernacki (2009:118-120), "Kinesthetic individuals nurture the following characteristics: (1) responding to physical attention, (2) speaking in a slow manner, (3) learning by manipulatives and practices, and others."

Students' mathematical problem-solving abilities with an auditory learning style are different from those with a visual learning style after their initial mathematical abilities are controlled. The underlying issue is that students with an auditory learning style understand the information in a slower manner than that with a visual learning style. Furthermore, students with an auditive learning style greatly depend on their hearing sense in understanding information. Therefore, the expository method is supposed to highly support students with an auditory learning style. However, quantitatively, students with a visual learning style have higher problem-solving abilities than that with an auditory or visual learning style after the initial mathematical abilities of the two groups are controlled. The evidence indicates that students with a visual learning style have higher problem-solving abilities. Mejer (2002:95) supports it by conveying, "Our auditory mind is much stronger than what we think it is. Our ears constantly receive and store auditory information even without our notion." Furthermore, Mejer (2002:97-99) explains that students with a visual learning style can learn more effectively by "observing". In conclusion, students with a visual learning style nurture an ability to observe information yet in a classroom learning activity, students with an auditory learning style will achieve better.

The findings also indicate that students' mathematical problem-solving abilities with a kinesthetic learning style are different from those with a visual learning style after the initial mathematical abilities of the two groups are controlled. The underlying issue is that students with a kinesthetic learning style understand the information in a slower manner than that with a visual learning style. Furthermore, students with a kinesthetic learning style greatly depend on their motoring ability in understanding information. Therefore, quantitatively, students with a visual learning style have higher problem-solving abilities than that with an auditory or visual learning style after the initial mathematical abilities of the two groups are controlled. The evidence indicates that students with a visual learning style have higher problem-solving abilities. In a classroom activity, the materials given are to encourage students to solve problems in an intellectual way. It implies that, theoretically, the focus to exercise logic, creativity, and problem-solving ability in a classroom activity can only be adopted by students with an auditory learning style. Meanwhile, students with a kinesthetic learning style and preferring motions or physical activities are best supported by the materials or lessons engaged with physical activities.

Supporting the findings, Ramlah*et al*. (2014:9) mention that kinesthetic intelligence is individuals' ability to use all parts of their bodies to express either ideas or emotions or to use their hands to produce or transform a certain object. Referring to the statement, students with a kinesthetic learning style are more active if given sports-based lessons since they build upon physical strengths than if they are given reasoning-based lessons or lessons which construct logic.

Finally, the interaction between learning methods and learning styles has an impact on students' mathematical problem-solving abilities after their initial mathematical abilities are controlled. The impact may occur because students with an auditory, kinesthetic, and visual learning style achieve differently. That situation is triggered by students' initial abilities or learning methods applied. Besides, there is a mutual relationship between learning styles and learning methods, extensively impacting students' problem-solving abilities.

V. CONCLUSION

1. The mathematical problem-solving abilities of students taught using the problem-solving method are higher than that of students taught using the expository method after the initial mathematical abilities of the two groups are controlled.
2. The mathematical problem-solving abilities of students with an auditory learning style are higher than that of students with a kinesthetic learning style after the initial mathematical abilities of the two groups are controlled.
3. The mathematical problem-solving abilities of students with an auditory learning style are lower than that of students with a visual learning style after the initial mathematical abilities of the two groups are controlled.
4. The mathematical problem-solving abilities of students with a kinesthetic learning style are lower than that of students with a visual learning style after the initial mathematical abilities of the two groups are controlled.
5. The interaction between learning methods and learning styles has an impact on students' mathematical problem-solving abilities after their initial mathematical abilities are controlled.

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