Problem solving of student with visual impairment related to mathematical literacy problem

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Abstract. The student with visual impairment, total blind category depends on the sense of touch and hearing in obtaining information. In fact, the two senses can receive information less than 20%. Thus, students with visual impairment of the total blind categories in the learning process must have difficulty, including learning mathematics. This study aims to describe the problem-solving process of the student with visual impairment, total blind category on mathematical literacy issues based on Polya phase. This research using test method similar problems mathematical literacy in PISA and in-depth interviews. The subject of this study was a student with visual impairment, total blind category. Based on the result of the research, problem-solving related to mathematical literacy based on Polya phase is quite good. In the phase of understanding the problem, the student read about twice by brushing the text and assisted with information through hearing three times. The student with visual impairment in problem-solving based on the Polya phase, devising a plan by summoning knowledge and experience gained previously. At the phase of carrying out the plan, students with visual impairment implement the plan in accordance with pre-made. In the looking back phase, students with visual impairment need to check the answers three times but have not been able to find a way.

1. Introduction
In recent decades, problem-solving skills have been considered a critical aspect of mathematics education [1]. In fact, problem-solving is a basic competency in 21st-century skills [2] [3]. In the mathematics education, problem-solving is the heart of mathematics which means that all aspects of mathematics originate in problem-solving [4] [5]. Mathematical learning that focuses on problem-solving can make students understand the essence of the math material under study [6] [7] [8]. Based on this, problem-solving in mathematics learning has three important points, namely problem solving as the main objective of mathematics learning, problem-solving as a process in mathematics learning, and problem-solving as basic skills that must be possessed when one learns mathematics [9].

The importance of problem-solving in mathematics learning requires that students have that ability. Problem-solving is an important activity in mathematics learning since problem-solving abilities gained in math lessons can be used in solving other problems in the real world [10]. Students’ ability to solve problems can be seen based on how students solve problems. One of the problem-solving phases is the Polya phases. The Polya phases provide a useful framework for problem-solving that has a heuristic conceptual problem-solving feature. Meanwhile, the mathematical problem is quite good in training problem-solving abilities in the real world that is the problem of similar mathematical literacy.
PISA [11]. Mathematical literacy is an individual’s capacity to formulate, employ, and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena. It assists individuals to recognize the role that mathematics plays in the world and to make the well-founded judgments and decisions needed by constructive, engaged and reflective citizens [12]. The statement also corresponds to the expert's disclosure that the mathematical literacy as the ability to use mathematical knowledge and experience in solving real-life problems [11][13][14].

Problem-solving and mathematical literacy problems are two important things in mathematics learning. They have a relationship in scoring students for the challenges of life in the future. Supply students in developing problem-solving abilities in real life. Therefore, The Organization for Economic Co-operation and Development (OECD) through the Project for International Student Assessment (PISA) examines students 15-year-old related to literacy content, mathematical literacy one of them. The selection of normal children studied by the OECD indicated that normal children are a top priority in education. In fact, based on the Salamanca Statement and the Framework for Action that education is for all, which means education is appropriate for all children, whether the child is normal or who has special needs [15]. The Salamanca statement has been followed up by various countries including Indonesia by holding an inclusive school.

The existence of inclusive education is an alternative to equate the rights of normal children and children with special needs in education. In such a way as to be able to provide the provision of competence of children with special needs in the future when the plunge in the community. One of the children with special needs that need attention is children with visual impairment. Children with visual impairment are children who have total blindness and low vision. Children with visual impairment of the total blind categories in obtaining information utilize the sense of hearing and the sense of touch. Meanwhile, children with low vision categories are still able to use the sense of sight to obtain information, but they must use visual aids. In the learning process, 80% of information is obtained through sight [16]. For visually impaired students this manner of receiving information is a challenge since they both experience the world differently than people with full vision [17].

Students with visual impairment, the total blind category cannot use the sense of sight as a means of obtaining information to make them need special attention. Whereas, almost all mathematical material is presented in visual conceptions such as statistics, geometry, arithmetic [18][19]. Thus, students with visual impairment of the total blind category will have difficulty in learning mathematics. However, students with a visual impairment conceive the estimation of volume, surface area, and length better, in concrete concepts and concepts that are familiar to them, when compared to sighted students [20]. This makes the process of solving the problem of students with visual impairment are totally blind category interesting to study.

There are other interesting things in the testing conducted by OECD, the subject of testing ie 15-year-old students. 15-year-olds can follow the trajectory to be constructive, reflective and able to make good decisions and opinions [12]. However, views on the development of children, students age 12 or at the Junior High School level VII entered the early stages of the development of logical thinking, abstract and rational [21]. This means that at this stage the child can be directed to abstract things like mathematical concepts. Children can make decisions based on the information they have received. Children are able to make rational excuses based on decisions taken. Thus, it is very suitable to know how the process of solving problems at the first grade level of schooling grade VII.

1.1 Problem Solving
Problem-solving can be interpreted as a process starting from the minute students are faced with the problem until the end when the problem is solved [22]. This means when the student is faced with a problem and the student is trying to solve the problem to find the solution to the problem then the party can be said in the process of solving the problem. Another definition states that problem-solving is the cognitive process focusing on changing the given state to the final state where the solution procedure is not clear [23]. Problem-solving is an important thing students must have in the 21st
Problem-solving in the 21st century requires individuals to find solutions to complex problems [24]. The problem-solving process in mathematics can help students be a good problem solver. This means problem-solving in mathematics can help students solve more complex problems. There is no specific method of solving in Mathematics, but the process of problem-solving is a systematic thing that can be seen in general. Thus, Polya formulates four basic phases in the problem-solving process:

- Understanding the problem, in this phase students should be able to answer questions, such as "What is unknown", "What is asked" and "how the solution" to the problem.
- Devising a plan, in this phase developing a plan and establishing the worker's steps to get a solution based on what is already known: previous student experiences are important.
- Carrying out the plan, in this phase algebraic manipulation activities, simplifying and using other math skills are indispensable.
- Looking back, students review the results have been obtained, check the results that have been obtained as requested and apply the solution to the problem under other circumstances [22].

1.2 Mathematical Literacy Problem

Mathematical literacy is an individual's capacity to formulate, employ, and interpret mathematics in a variety of contexts. It includes mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena. It assists individuals to recognize the role of constructive, engaging and reflective citizens [12]. Important points contained in the definition of mathematical literacy is how the concepts, procedures, and facts of mathematics are used as a tool to solve problems that occur. Simply literacy mathematics is the knowledge to know and apply basic math in our daily lives [13]. That sense identifies that students who have good math literacy will be able to solve real-world problems using mathematical principles well too. Problem-solving on mathematical literacy problems begins with realistic problems. The process of solving mathematical literacy problems ranging from identifying realistic problems and formulating problems mathematically, employing certain mathematical procedures to obtain mathematical results, which then reinterpret them as the initial problem [22].

Based on this description, problems related to mathematical literacy are real life problems similar to PISA and solutions that use concepts, faculties, procedures and mathematical principles.

The ability of mathematical literacy is indispensable to students in facing 21st-century competition. In the 21st-century mathematics skills are treated as the ability to use math in answering real-world problems [26]. 21st-century mathematics is no longer just interpreted as arithmetic, but as a tool to solve problems in the real world. There is a common thread between 21st-century mathematics and mathematics literacy, both of which focus on mathematics as a tool for solving real-world problems. This means students who will be able to survive in the 21st-century global competition that is students who have good mathematical literacy skills. Problem-solving processes related to mathematical literacy need to be studied in order to capture student literacy skills.

2. Method

This research used the qualitative method with descriptive research type. The strategy used is case study strategy. The subject of the study was one student from a junior secondary school of inclusion. The student is in grade VII who has a visual impairment that is categorized as total blindness. The data from this study comes from the results of related tests of mathematical literacy problem and the results of in-depth interviews. The test assigned to the study subjects amounted to one mathematical literacy problem similar to that of PISA. Data collection techniques in this study by providing written tests of mathematical literacy problems on the subject of research. The question of written test first has been changed into the form of writing braille. Furthermore, an in-depth interview was conducted with the research subjects. The results of written test and interview transcripts were analyzed, then described the problem solving based on the Polya phase relating to mathematical literacy issues.

3. Result and Discussion
Problem-solving of a student with visual impairment related to mathematical literacy is described based on Polya phase. Problems related to mathematics literacy similar to PISA that corresponds to the 7th grade of Junior High School. The problem similar to PISA as follows:

**Theme: Telephone Communication**

Mr. Robert is the father of Anita who works as an Indonesian ambassador in Spain. While Anita remains in Indonesia, precisely in the city of Surakarta. They often communicate by phone. However, there is a time difference between Indonesia and Spain. For example, in Indonesia showed at 09.00 WITA (Indonesia Central Time/ UTC + 8) then In Spain showed at 03.00 local times. If Mr. Robert called Anita at 23:00 local time, how much time was shown at Anita's house?

Based on the problem, students will solve the problem until the discovery of the solution, then the process of solving student problems is described by Polya's phase. Students' answers are displayed in part according to the phase of the Polya.

### 3.1 Understanding the Problem

Based on Figure 1 shows the student's answer about what is known and asked. The known thing in the matter is written in the coded braille. Spain is given code "S" and "I" for Indonesia. Writing time was shortened without writing completely. At 09.00 written 9 and 03.00 written 3. Questions asked on the matter also written with the code S = 23 at what time in Surakarta. Writing answers in braille still have some errors. The errors are spelling errors and punctuation marks on braille. Write a symbol in braille there must be a mistake let alone by writing conventionally from right to left [27]. The errors found in the student's answers are not fatal. Based on interviews with teacher companion students said the students are not yet proficient in reading and writing braille. But for simple writing still able to follow. So in the practice of this study, researcher help student by reading the problem three times. Without the help of information through hearing, student seems confused. Regardless of student writing errors, students can understand the problem with a well-proven student is able to know what is at the core of the problem. Based on the picture 1 the student has gone through the process of solving the problem in Polya phase, that is understanding the problem.

**Figure 1. Photograph of Answer Writing Test in The First Activity**

*Table 1. The Result of First Activity Interview*

| Code | Interview Result |
|------|------------------|
| R    | “How many times have you read the question?” |
| A1   | “Twice Sir”      |
|      | (after that the researcher read out the questions three times) |
| R    | “Do you already understand about the problem?” |
| A2   | “Yes Sir”        |
| R    | “What do you understand from the problem?” |
| A3   | “Time in Spain at nine am, in Indonesia at three am, if in Spain 11 at night, ask what time in Surakarta?” |
Table 1. The Result of First Activity Interview

| Code | Interview Result |
|------|------------------|
| R    | “Now, let me explain what you wrote” |
| A4   | “S = 9, I = 3, S - I = 6, S = 23 then in Surakarta?, its S is Spain Sir, I same as Indonesia, so in Spain at 9 o’clock then in Indonesia at 3 o’clock, I keep looking for it is the time difference spanyol same indonesi, 6 hours.” |
| R    | “Well if that’s what you mean s = 3 and so on?” |
| A5   | ”If in Spain at 11 o’clock then in Surakarta what time, so that’s what asked” |
| R    | “Why did you immediately write down the time difference between Spain and Indonesia?” |
| A6   | “That’s to find the answer sir. It used to be told Mr. X (the name of his teacher) there are students here who participated in swimming championships abroad. It’s also different. That’s why I wrote it right now” |
| R    | “Does it mean to have problems like this?” |
| A7   | “Yes Sir” |
| R    | “Then, after knowing the time difference?” |
| A8   | “Because the clock is first in Indonesia, so stay on add the difference earlier with the hour in Spain” |

Interview Activity 1 in Sections A2, A3, A4, and A5 indicates that the student has done the first process in Polya phase that is understanding the problem. Understanding the problem that a student does is to read twice by fingerling problems in braille. The student understanding of the problem is reflected in the students understand what is known and to ask and how to find the solution [22]. Based on the result of the student’ test and interview, a student with visual impairment in solving problems based on Polya phase, understanding the problem can be said well. Understanding this problem, students read twice by touching the text and through hearing three times. Information gleaned through the sense of touch and touching of the hearing can make students understand the problem. The first thing a student should do is understand the real-world problem and then formulate it into a math problem. Making connections between real-world problems and math problems is the hardest part. This activity requires critical thinking. This makes solving problems related to mathematical literacy problems useful in developing real-world problem-solving. So students can have basic skills of the 21st century

3.2 Devising a Plan

Visible to the students’ work through Figure 1 that in addition to the known and asked questions, the student looks for and write the time difference between Spain and Indonesia. This indicates that student start planning problem solving and the students' initial plan is to find the time difference between the two countries. This is also reinforced by the results of interviews on A6, A7, and A8 that students have done the devising a plan. Devising a plan, student summons the knowledge gained from experience with similar problems [22]. The experienced student received was conveyed by previous teachers on issues based on reality. Problems conveyed by teachers by taking samples from the student to make the student understand the core problem. So that the essence of math material taught can be well understood by students [6] [7] [8]. Based on the results of a written test of student and interviews, the student with visual impairment in problem-solving based on the Polya phase, devising a plan by summoning knowledge and experience gained previously. The knowledge and experience of the student are gained through the process of learning in the process. Mathematics learning in the classroom has included examples of real-world problems to solve using mathematical concepts, facts, procedures, and principles. Collaborating information from previously acquired knowledge and experience with new information from problems to find solutions is critical to the 21st-century problem-solving.
3.3 Carrying Out the Plan

Figure 2. Photograph of Answer Writing Test in The Second Activity

Seen in Figure 2 that the student finds the solution to the proposed problem. The solution has been planned then student writes in braille. Writing answers using the code, \( S + 6 = 23 + 6 = 5 \). \( S \) is a code from Spain then added with six. 6 is the time difference between Spain and Indonesia. Then \( S \) is substituted with twenty-three and added by six to five. The workmanship of the student has succeeded in doing according to plan and in accordance with mathematics principle.

Table 2. The Result of Second Activity Interview

| Code | Interview Result |
|------|------------------|
| R    | “Try to explain what you write?” |
| A9   | “\( S + 6 = 23 + 6 = 5 \), so like last sir, because in Indonesia first 6 hours and in know in Spain at 11 pm. I counted 11 nights plus 6 hours, he answered at five in the morning (pointing fingers, counting from twelve, one, two, three, four, five)” |
| R    | “Why do you write down your answer briefly, like at 23:00, you write 23 only?” |
| A10  | “I am still learning braille sir” |

In the interview section, A9 illustrated that the previously prepared plan is well implemented by the student. The student explains in detail the purpose of the written answer. In fact, student reinforces the argument by giving a calculation mark by using a finger. Based on the result of the students' written test and interview, the student with visual impairment in solving the problem based on Polya phase, carry out the plan, the student carries out the plan according to the pre-made [22]. The plan is structured systematically based on mathematical principles. The use of mathematical principles in solving real-world problems well is one indicator of 21st-century skills. This means that in carrying out the plan the student has been able to perform of problem-solving leading to 21st-century skills.

3.4 Looking Back

Figure 3. Photograph of Answer Writing Test in The Third Activity

In Figure 3 shows the student's last answer. It appears that in Figure 3 the student concludes what he has done. The conclusion says at five o'clock in the morning. The student's conclusions do not seem so
precise. Five o’clock in the morning is not the final answer to the question. Still, need one more phase to solve the problem.

Table 3. The Result of Third Activity Interview

| Code | Interview Result |
|------|------------------|
| R    | “Is your work done?” |
| A11  | “It’s finished Sir” |
| R    | “How many results?” |
| A12  | “Five o’clock in the morning at Anita’s house, when in Spain at eleven o’clock” |
| R    | “Are you sure the answer is at five in the morning?” |
| A13  | “Sure sir” |
| R    | “Have you checked your answer?” |
| A14  | “Already sir, I check twice (then students re-read their work)” |
| R    | “Try reading again? (researchers tried to assert)” |
| A15  | “Just a moment sir, (students start reading from scratch, from the given problem)” |
| R    | “It’s done?” |
| A16  | “(Silent. Looks doubt on students, students scratching their head)” |
| R    | “(researchers read out the problem)” |
| A17  | “Just a moment sir (visible students feel the problem and answer again. The student face looks serious, there are wrinkles on the forehead Students write back.)” |

Figure 4. Photograph of Answer Writing Test in The Fourth Activity

In Figure 4 there is an additional answer to the previous answer. The previous answer is added with 1. Visible with the addition of the answer the student actually has found the solution. The solution requires a variety of other knowledge related to the problem posed.

Table 4. The Result of Fourth Activity Interview

| Code | Interview Result |
|------|------------------|
| A18  | “It’s finished Sir” |
| R    | “The answer remains at five in the morning?” |
| A19  | “Not Sir. The answer is 4 am. Earlier I forgot that still in WITA (Indonesia Middle Time). Surakarta entered in WIB (Indonesia West Time).” |
| R    | “Sure this time the answer at 4 am?” |
| A20  | “Sure sir. I thought long ago, recall the difference between time and WITA. The answer I checked 3 times sir” |
| R    | “What do you think is the time difference between WIB and WITA?” |
| A21  | “Difference time one hour, first an WITA Sir” |
Based on interviews on the A14, the student makes the process of looking back the answer twice. Examination by finger reading the answer in braille. Then, in the interview in section A15 the student solidifies the answer by reviewing the answers that have been written. The researcher tried to dig deeper information on the student because the solution given by the student is not yet a final solution. At first, the student remained confident about the solutions found (A14 and A15). However, after the student re-read the problems and answers and the researcher read about the faces of the doubts and gestures of the body that signal doubts (A15 and A16). Afterwards, the student appears seriously continuing to work on (A17). There is an indication that the student forgot to change the time at the time of western Indonesia first (A19). The forgetfulness that occurs may be the inaccuracy of the students themselves and because student obtains information only from the sense of touch and hearing without involving the sense of sight then something is missing from the information. As has been disclosed that in learning 80% of information is obtained from sight [15]. This can result in the loss of some information that will lead to the brain. Regardless of what the pupil resumes work and finds the final solution to the problem (A19)(A20)(A22)(A23). Even student check the answer back three times. However, the student has not been able to find another way to solve the problem. So it can be concluded that at the stage of problem-solving phase fourth Polya that is looking back, students check again by groping the answer as much as 2-3 times [22]. However, the student has not been able to find other ways to solve the problem. Checking answers repeatedly identifies that the student is thinking about how they are being used accordingly or not. This means students in the stage of looking back students experience the process of metacognition.

4. Conclusion

Based on the objectives and data analysis that has been done by the researcher can be concluded that solving problem of literacy based on Polya’s phase can be passed by the students with visual impairment well, although there are some deficiencies. In the phase of understanding the problem, the student read about twice by brushing the text and assisted with information through hearing three times. The student with visual impairment in problem-solving based on the Polya’s phase, devising a plan by summoning knowledge and experience gained previously. At the phase of carrying out the plan, students with visual impairment implement the plan in accordance with pre-made. In the looking back phase, students with visual impairment need to check the answers three times but have not been able to find a way. At the solving of problems based on the Polya’s phase undertaken by the student with visual impairment, it is found that solving the problem leads to the solving of 21st-century skills problems. In the phase of understanding the problem and looking back, it is identified that there are 21st-century skills of critical thinking and metacognition.

Some things seem to need to be addressed for the advancement of mathematics education for the visually impaired. The problem solving for the blind is good enough because of the problem solving oriented learning by taking the real world problem. For that reason, teachers should provide more such learning. By giving a problem in a real context it will develop student problem-solving abilities. The material essence in mathematics learning can be well received by students. Second, students with visual impairment who obtain information from other than the senses of vision should develop abilities.
in braille literacy. Basically when writing and reading braille or good braille literacy skills then problem solving related to math literacy will also increase.

Based on the results and findings of the study there are several suggestions that researchers recommend. The phase of understanding the problem, students should read the problem or listen to the problem repeatedly so that the students really understand their problems. Write down all the information that is on the issue in braille to minimize the forgotten information. Imagine the problems facing real as happened thus forming an internal representation of the problem. The phase of devising a plan, students should read the back issues to examine plans that have been made before carrying out his plans. Students must plan more than one, when the first plan fails then the next plan can be used. The phase of carrying out the plan, the plan that has been prepared is applied in detail and thorough. This is so that errors in calculations can be minimized. Students must understand what is written, meaning that students know the reason for each step of work in solving the problem. The phase looking back, students should re-understand their problem, then read the information that has been written. Contemplating the plan made whether it has been appropriate or not to solve the problem at hand. Check each calculation that has been made. Check each calculation that has been made. Checking the final answer whether in accordance with the solution of the issue at hand.

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