Build Character of Hard Work through Problem Solving Strategies (Intelligent Guessing and Testing in Mathematics)

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Abstract. In the process of learning mathematics, problem-solving activities is an essential part. Several strategies can be used in this activity including intelligent guessing and testing. This strategy has characteristics that are very potential to develop the character of student as hard work. It is a way for success. In solving the problem, a participant can complete the task in the allotted time, using all abilities or power to achieve goals and trying to find various alternative solutions when faced with obstacles. These activities show the indicator of hard work. The more often students practice using this strategy, the more trained students in developing hard-work character themselves.

1. Introduction
At present, mathematics not only focuses on knowledge but also on the learning process. Moreover, the demands faced in the era of technological development are very large and the competition is very tight. Therefore, mathematics is not feasible if only classified as a discipline in the classroom. NCTM argues that in an ever-changing world, those who understand and can do math will have more opportunities and choices in determining their future. Mathematical competence opens doors to productive futures. A lack of mathematical competence keeps those doors closed [1]. Based on this, all students should have the opportunity and support needed to study math in depth with understanding. A good understanding of mathematics will open the door to a productive future. Conversely, a weak ability in mathematics will leave the door closed.

Interestingly, mathematics can also bring up the character of hard work. This is needed in a person when he finishes work. People who work hard must have an attitude of not giving up easily. When facing challenges or obstacles, he will continue to carry out these tasks in achieving a goal. Hard work is an attitude or action that shows a serious effort in overcoming various obstacles to complete a job as well as possible [2]. There is usually a lazy attitude that keeps people away from an action. Therefore, the character of hard work should be applied early. In other words, this is very important for students to determine success.

Furthermore, the most basic things in mathematics are understandable. Students should gain experience that math makes sense every day. Teachers have to believe in the potential of each learner as well. In essence, mathematics is closely related to the mindset by paying attention to the process. If it is taught correctly then mathematics can be used as one means to build the character of hard work.
One of the crucial aspects in mathematics is problem-solving activities which are related to build character. As this activity can improve students’ ability to face daily problems although not all problems are mathematical. Besides, it is very influential on the ability of students in solving a problem. For instance, a drum has a volume of 83 liters. Joni has two tubular containers to drain the contents of the drum completely. The first container can contain as much as 7 liters of water and the second container can contain as much as 5 liters of water. What is the most efficient way for him to empty the contents of the drum using the two containers?

There are two initial answers obtained: (1) four times the first container and eleven times the second container; (2) nine times the first container and four times the second container. The correct answer is the second option because it is the most effective way with a total of thirteen times pouring. In this case, students are required to not only try, but must also be based on reasoning.

The above problems are classified as open problems encountered in daily life. Students can use guessing and checking strategies in solving these problems. Indirectly, they will work hard in finding every possible answer that fulfills. Then students will check each of these possibilities with curiosity until finding the right answer. Based on the background of the problem, the author wanted to examine how the formation of characters can be built through a guess and check strategy in mathematics.

2. Result and Discussion
2.1 Build Character of Hard Work
Character is interpreted as a way of thinking and behaving is typical for every individual to live and work together in family, community, nation and state environment. Individual who have good character are individuals who can create decisions and ready to take responsibility for any consequences of his decision [3]. In other words, character is a fundamental value that is found in individuals who differ from one another.

Aristotle states that good character as life by doing actions concerning for to one's self and others. We need to control ourselves/ our desires, our desire to do good for others. Meanwhile, according to the ministry of education writes that character is a human behavior that is related to God Almighty, self, fellow human being, environment and nationality embodied in mind, attitude, feeling, religious norms, law, etiquette, culture, and customs. People whose behavior is by following per under the norms are called human beings of noble character [4].

Thomas provides a way of thinking about the proper character for values education: the character consists of operative value and value in action. We proceed in our character, as a value becomes a virtue, a reliable inner disposition to respond to situations in a good and moral way [5]. Based on this character can be said that character is the result of a process.

One way to build character is to integrate it into learning, so that the evaluation tools also need to be provided and designed separately. Therefore, characters can be integrated into mathematics rather than separate subjects. It aims to avoid cognitive assessment only. Mathematics can help students to think quickly in solving a problem. Students are trained to combine their knowledge, skills, and understanding to finally solve the problems faced well. The values that form the character of the empirical assessment of the center curriculum is: religious, honest, tolerance, discipline, hard work, creative, independent, democratic, curiosity, the spirit of nationality, love the country, appreciate achievement, friendly/ communicative, love peace, love to read, care about the environment, social care, and responsibility. In this paper, we will focus on hard work.

Work is an obligation for every human being. If someone wants something then he has to work first. In order to obtain maximum results, it must be done by working hard. Working hard is a tireless attitude that is full of motivation to get what you want. Someone is said to work hard if he does not give up in completing his task. Learners must be trained to be able to work hard by showing a real effort in overcoming various learning obstacles and finishing tasks as well as possible. Hard work is a positive mindset with a great deal of effort or endurance. Mustari stated that hard work can be characterized as
follows: (i) completing the task in the allotted time, (ii) using all abilities or power to achieve goals, (iii) trying to find various alternative solutions when faced with obstacles [2].

2.2 Intelligent Guessing and Testing Strategy

In solving a mathematical problem, we can use a strategy or a combination of several solving strategies. There are ten strategies in problem-solving. They are: working backward, finding a pattern, adopting a different point of view, solving a simpler analogous problem, considering extreme cases, making a drawing, intelligent guessing and testing, accounting for all possibilities, organizing data, logical reasoning [6]. In this paper, we focus on intelligent guessing and testing strategy. This strategy is usually used to get an overview of a problem-solving by experimenting with the information given. It is often considered easy and can be done by everyone. In mathematics, this strategy has the foundation of reasoning, not the origin of trial. This can also lead us to a comprehensive solution based on reasoning. The step that can be done is to try all possibilities systematically or you can also try to choose the most relevant based on certain concepts or rules. In this case, the initial ability influences the way students use this strategy. Examples of using the strategy of guessing wisely and testing it on everyday problems are as follows: in estimating the level of maturity of a dish, for carpenters in estimating the size and shape of a piece of wood then testing it and modifying it in solving construction problems, for a lawyer to determine the possibility of innocence to his client.

2.3 Build Character Through Problem-Solving Strategy

The role of the teacher is to help students understand the meaning of words or terms that appear in a problem so that their ability to understand the context of the problem can continue to grow. It needs to be improved students' skills in problem-solving which is the ability to deal with various problem-solving techniques and strategies. To introduce a certain strategy to the students required careful planning. It is difficult for teachers to be able to introduce any the influence of heredity and the influence of the environment that distinguishes with others and is manifested in attitudes and behavior in everyday life. We use the term character not to distinguish it from other terms, such as disposition or personality, but more to attend to the kinds of social–emotional development promoted and nurtured through learning in educational contexts [7]. Building character through problem-solving strategies in mathematics can be seen from the following examples

**Problem Solving Task:**

Find the $3 \times 3$ magic square using the numbers 1 to 9 where the number of each row, column, and two main diagonals are the same! [8]

**Discussion:**

The above problem can be solved by using guessing and checking strategy. In problem solving there are four stages namely understand the problem, devising a plan, carrying out the plan and looking back. The use of guessing and checking strategies already exists at the second step. If a student is wrong in working on the beginning step, he will find it difficult to enter the next stage. For instance, the answer of pre-service teacher can be seen below:

**Complete the task in the allotted time**

A participant immediately worked on the problem after it was given. He did not want to waste the time. Then, he found the information and wrote what is known and what is asked correctly on his answer sheet. It points out that people who work hard try to take the minimum amount of time given to accomplish any task. This is an important principle, and it has helped to be more efficient in their life.

**Using all abilities or power to achieve goals**

Next, a participant used a guessing check strategy to solve the problem. He was not just using a trial and error. However, he had enough knowledge from previous experience. Besides, the participant also used mathematical concepts such as the concept of numbers. The subject did not give up easily when he had not found the answer. He kept thinking and trying until he found the right answer with curiosity. Then, subject checked the results of the settlement by trying to add up the numbers compiled and see the suitability of the answers at each stage of problem solving. The difficulties which student face will
make them more determined to achieve objectives learning and to win against all the odds. It takes many obstacles for one success.

*Trying to find various alternative solutions when faced with obstacles*

The subject tried to find a number that is the sum of each row, column or diagonals in various ways. For instance, the subject remembered the concept of a square that is related to the problem because the size of the box is 3x3 so he is interested in taking integers multiples of three because each square has four equal sides. Finally the subject found the number is fifteen. After that, he determined the position of each number. He divided fifteen by three, then he got five. Therefore, the position of five was on the center. A participant also collected the odd and even number. He had tried several times to find the correct answer as shown below:

|   |   |   |
|---|---|---|
| 2 | 7 | 6 |
| 9 | 5 | 1 |
| 4 | 3 | 8 |

The process of trial and error will not always work. Sometimes it fails. Therefore, the process using a sharp analysis is indispensable to the use of this strategy. In solving this problem, students will be motivated and add to their curiosity after a few attempts by substituting numbers that might meet the set requirements. In addition, there is a process of reasoning when students find the answer is not right. Therefore, it takes the direction of the teacher, so that students do not give up quickly and the learning process becomes fun. In other word, students drilled to work hard.

The problem solving strategy above is consistent with Soejadi who argue that mathematics as an educational vehicle can not only be used to achieve a single goal, such as educating students, but also useful for forming student personality [9]. Many people believe that learning mathematics has certain values that are very important in shaping and developing the character of students. Characters developed in this regard are to develop of hard work.

2.4 Result

Based on the above explanation, it is found that in the use of problem-solving strategies there are various indicators of hard work character founded. For more details, you can see the table below:

| No | The indicator of hard work                                                                 | Activities in problem solving                                                                 |
|----|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| 1  | Complete the task in the allotted time                                                   | Write down the information exactly after reading the question given.                        |
|    |                                                                                            | Answering question by not exceeding the specified time                                      |
| 2  | Using all abilities or power to achieve goals                                            | Remember the concepts or principles related to the problem                                 |
|    |                                                                                            | Use problem solving strategies                                                              |
|    |                                                                                            | Re-checking every result obtained.                                                         |
|    |                                                                                            | Does not give up easily when experiencing difficulties.                                    |
| 3  | Trying to find various alternative solutions when faced with obstacles                   | Use more than one method in answering questions                                             |
|    |                                                                                            | Find the answer to the problem correctly                                                   |
3. Conclusion
To sum up, it can be concluded that the formation of characters can be through the use of problem-solving strategies, intelligent guessing and testing. The use of guessing and checking strategies will motivate and elicit students’ curiosity. Moreover, student don’t give up and cultivate the character of hard work. In addition, what is needed now is how teachers should know the students that they are teaching. Student should understand if mathematics can grow good character for them especially hard work.

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