

ASSESSMENT OF MATH PROBLEM SOLVING ABILITY OF HIGH SCHOOL STUDENTS: A CASE STUDY IN VIETNAM

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**Abstract**

Currently, in Vietnam, the education sector directs: Mathematical problem-solving capacity is considered one of the core competencies that need to be fostered and developed for learners. Understandably, students' ability to solve math problems is the ability to mobilize and promote all their knowledge, skills and experiences to solve math-related problems. In order to have a scientific and practical basis in making recommendations on policies and teaching methods to develop students' ability to solve math problems. In order to have a scientific and practical basis in making recommendations on policies and teaching methods to develop students' ability to solve math problems, we conducted a survey with 600 students and 75 teachers at high schools in Ho Chi Minh City, Vietnam. Research results show that the ability to solve math problems is composed of 4 main components, and this ability of high school students in Vietnam is still relatively low, mostly medium. This result is the basis for us to give suggestions for developing math problem solving ability in high school students.

**Keywords:** Problem solving; Math problems; Capacity development; Math problem solving ability

## 1. INTRODUCTION

Teaching and learning have evolved over the years, although the use of lectures remains the dominant mode of instruction in educational institutions (Felder & Brent, 2005). In the current trend, the trend of global and digital integration, students increasingly need to be equipped with the necessary skills and competencies to be able to meet the requirements of society (Trung & Truong, 2023). In many countries around the world, problem-solving capacity has long been identified as a central competency and goal in education. Specifically, in 1980, the American Association of Math Teachers affirmed in their program of action that math problem-solving competence should be at the heart of mathematics teaching in schools and required high school students to Schools must be taught to build mathematical knowledge through problem solving (following Dossey, 1992). Recognizing this issue, in recent years, Vietnamese education has been tending to shift from a content-oriented education to an education oriented to comprehensively develop learners' capabilities and qualities. In order to concretize the above goal, the Ministry of Education (2018) has identified the ability to solve math problems as one of the core core competencies of the new high school program, which needs to be fostered and developed for students. Mathematical problem-solving capacity of students is the ability to mobilize and promote all knowledge, skills and experiences to solve math-related problems (Thuyet, 2016). Tai (2015) argues that students' ability to solve math problems is a combination of competencies (knowledge, skills) that students use when solving a certain problem.

It can be seen that, developing problem-solving capacity in general and mathematical problem-solving capacity in particular is a very urgent issue. We carry out this topic for the purpose of building a practical and scientific basis in making recommendations for teaching and developing math problem solving capacity for high school students. To conduct this study, we answered the following questions:

What is Math Problem Solving?

What components constitute the ability to solve math problems?

What is the current situation of high school students' ability to solve math problems in Vietnam?

## 2. Literature overview

### 2.1 Math problem solving ability

According to OECD (2013), it can be understood that problem solving competence is the ability of an individual to understand and solve a problem situation when the solution is not clear. According to Toan (2012), Problem solving is an intellectual activity that is considered to be the most complex and highest level of awareness, because it is necessary to mobilize all the intellectual capacities of the individual. Meanwhile, Nguyen (2013) said that problem-solving capacity is the ability of an individual to mobilize, flexibly and organize knowledge and skills with attitudes, emotions, and motivations. .. to understand and solve problems in certain situation effectively and with positive spirit. Mathematical problem-solving capacity of students is the ability to mobilize and promote all knowledge, skills and experiences to solve problems related to Mathematics (Thuyet, 2016). Tai (2015) argues that students' mathematical problem-solving ability is a combination of competencies (including knowledge and skills) used by students when solving a problem. Besides, Tuan (2002) said that problem solving ability includes students' skills, thinking and actions; Similarly, Branford (1984) said that knowledge, skills and experience are the core elements to form students' problem-solving capacity.

From the above points of view, we believe that the ability of students to solve math problems is: the ability of students to coordinate and apply their own experience, knowledge and skills in subjects to successfully handle problems Maths, as well as problematic life situations with a positive attitude.

### 2.2 Components of mathematical problem-solving abilities

Regarding the components of problem-solving capacity, some authors mentioned such as Jeal-Paul et al (2006); Do & Bui, 2019; Nhu, 2016; Le & Hoang, 2015. According to Jeal-Paul et al. (2006), problem solving competence includes understanding the problem situation, interpreting it, planning and reasoning. Le & Hoang, 2015 also said that the competencies that create the capacity to solve math problems include: the ability to recognize and understand problems; Capacity to establish problem space; Capacity to plan - implement solutions and Capacity to evaluate and reflect on solutions. Similar to Le & Hoang, 2015, some other authors such as Do & Bui, 2019; Nhu, 2016 said that the main competencies that constitute the capacity to solve math problems include the ability to recognize and detect problems (Students need to identify the given information, the information they need to find, learn the relationships, the facts in the problem completely and accurately); Ability to choose, propose ways and solutions to solve problems (including analyzing, arranging, connecting discovered information with known knowledge and providing solutions, choosing the best solution to the problem); Capacity to implement the problem solving process (including using relevant knowledge, experience, and mathematical skills to present solutions and implement problem solving, adapting solutions to reality when there are changes); Ability to test, evaluate, generalize and apply practice (including evaluating the implemented solution and the problem posed; reflecting the value of the solution; confirming the knowledge and experience gained after solving the problem; thereby building a new problem).

Thus, through the above studies, we believe that students' ability to solve mathematical problems is composed of the following components:

- (1) Ability to recognize and detect problems;
- (2) Ability to choose and propose solutions to solve problems;

- (3) The capacity to implement the problem-solving process;
- (4) Ability to test, evaluate, generalize and apply practice.

### 3. Data and methods

To conduct the research, we conducted a random survey of 600 students and 75 teachers in 06 high schools in, HCMC during the period from 4/2021 to 2/2022. We chose Ho Chi Minh City because it is the largest city in Vietnam, accounting for about 12% of the country's population, and is also one of the pioneers in applying positive educational methods. Therefore, the results of the assessment of the current situation as well as the solutions implemented in Ho Chi Minh City will be the basis for other localities to refer to and implement.

In order to have reliable research results, the research uses assessment of the current situation of students' ability to solve mathematical problems through 2 groups of objects, (i) students self-assess, (ii) teachers evaluate students. The criteria for measuring problem solving competence include the following contents:

**Table 1.** Indicators to measure students' ability to solve math problems

No	Assessment criteria
<b>1</b>	<b><i>Ability to recognize and detect problems</i></b>
1.1	Identify problem situations that need to be solved
1.2	Collect and organize the information contained in the problem
1.3	Explain the meaning of the information contained in the problem
1.4	Ask questions to clarify the issue
1.5	Share your understanding of the problem with your classmates
1.6	Responding to shared issues
<b>2</b>	<b><i>Ability to choose and propose solutions</i></b>
2.1	Analyze and connect discovered information with known knowledge
2.2	Suggest many ways to solve the problem
2.3	Share with your friends how to solve the problem
2.4	Discuss shared solutions
2.5	Choose the best solution to solve the problem
2.6	Establish a detailed process for problem solving
<b>3</b>	<b><i>Ability to perform problem solving</i></b>
3.1	Full problem summary (figures, diagrams, mathematical symbols)
3.2	Describe a specific problem-solving process
3.3	Record the requirements of the problem to be solved
3.4	Present a suitable solution
3.5	Accurately apply mathematical formulas and theorems
3.6	Evaluate, detect errors, make adjustments and make adjustments
<b>4</b>	<b><i>Ability to evaluate, generalize and apply practice</i></b>
4.1	Evaluate the work after implementation, indicate the cause of the results obtained
4.2	Comment and evaluate your work
4.3	Suggest a better solution to improve problem solving efficiency
4.4	Suggest a new problem
4.5	Apply the solution to real life
4.6	Generalizing how to solve the problem

The scales measure students' ability to solve math problems, designed according to a 5-level Likert scale (from 1 to 5), respectively: completely not good; not good; medium; Good; Very good. The above scales are tested for reliability through Cronbach's Alpha coefficient. The analysis results show that all the Cronbach's Alpha coefficients of the above scales are > 0.8, the item-total correlation > 0.5 so the above scales ensure the reliability requirements.

In order to achieve the set objectives, the study uses descriptive statistics method combined with comparative difference test. The obtained results are presented in the form of tables and graphs. The tool to support data analysis is IBM's SPSS 26 software.

## 4 Result

### 4.1 General assessment of high school students' ability to solve math problems

The students' ability to solve math problems is shown through four criteria: recognition ability; Ability to choose and propose solutions; Ability to perform problem solving; Ability to test, generalize and apply in practice. These competencies are assessed through two groups of subjects: self-assessment students; teachers evaluate students. The results of the evaluation of teachers and students are detailed in Table 2.

For the ability to recognize and detect problems, both teachers and students rate them at about 3 points (equivalent to the medium), this is the ability with the highest score in the 4 components of the ability to solve Math problems. Meanwhile,

the ability to evaluate, generalize and apply practice is assessed as 2.71 scores by teachers and 2.67 scores by students themselves, this is the ability with the lowest score out of the 4 component competencies of the ability to solve math problems.

Besides, the test results on the difference in the scores of the competencies assessed by students themselves and by teachers also show that  $P.value > 0.05$ , therefore there is no statistically significant difference. In other words, the evaluation results of the two subjects above are similar.

Thus, it can be seen that the math problem solving ability of high school students in Vietnam is relatively low, at medium and below medium levels.

**Table 2.** Students' problem-solving ability

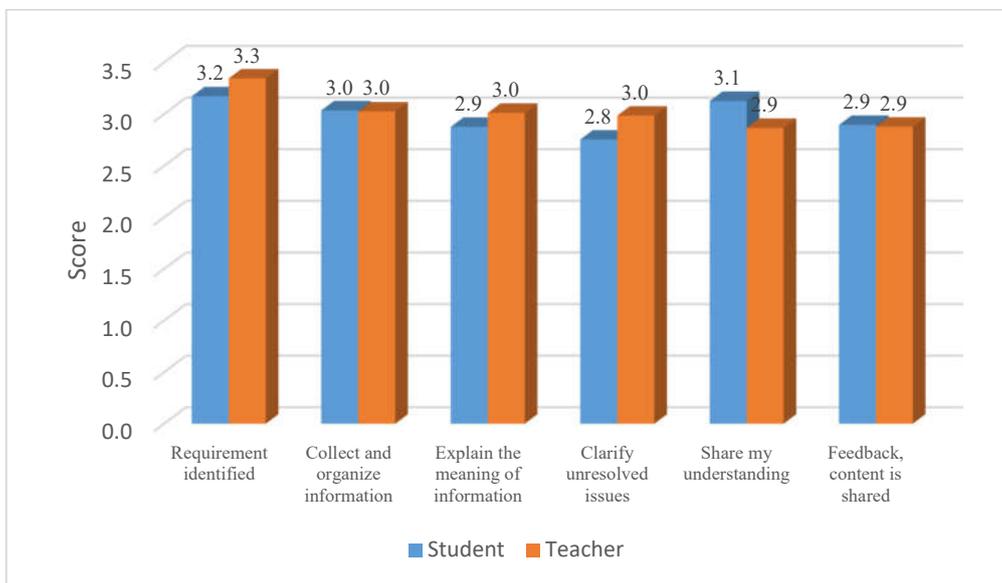
Content	Student		Teacher		T-Test	
	Mean	SD	Mean	SD	t	P.value
Ability to recognize and detect problems	2.98	0.71	3.02	0.53	-0.495	0.621
Ability to choose and propose solutions	2.93	0.67	2.80	0.41	1.703	0.089
Ability to perform problem solving	2.89	0.70	2.78	0.38	1.383	0.167
Ability to evaluate, generalize and apply practice	2.67	0.72	2.71	0.48	-0.432	0.666

*Note:* Student's ability to solve math problems is measured by 5 levels, from completely bad - very good, corresponding to a score from 1 to 5, the average score measures the student's ability. The higher the average score, the better the student's problem-solving ability.

#### 4.2. Assess each component competency of the student's math problem-solving ability

##### *Ability to recognize and detect problems*

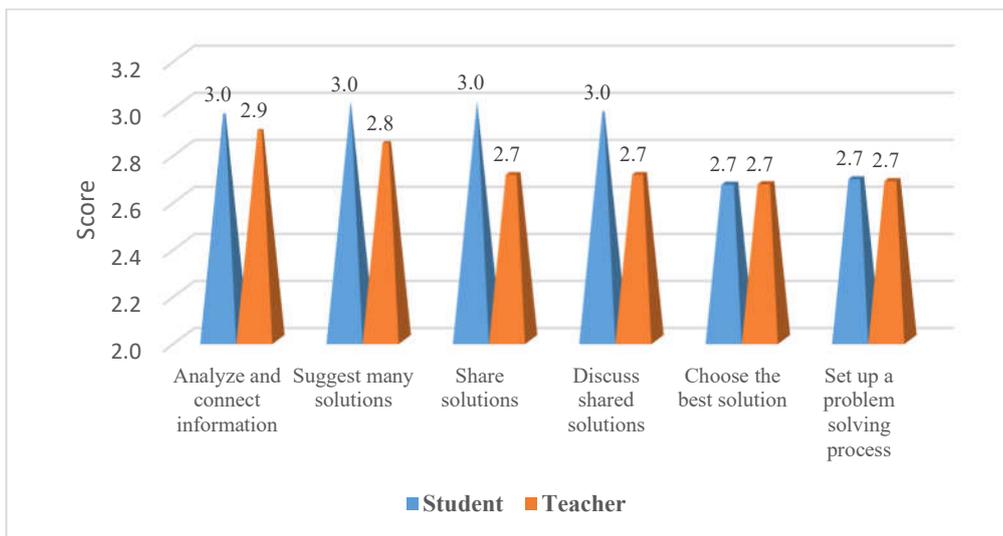
The students' ability to recognize and detect math problems is shown through 6 main contents, the evaluation scores of students and teachers for these 6 contents are described in detail in Figure 1. Among the 6 contents of capacity to recognize and detect problems, the content "Identifying the requirements of the problem and the problem" has the highest score (students are 3.2 scores, teachers are 3.3 scores). The content measurement score of "Feedback, content is shared" has the lowest score, both teachers and students rate this content at 3 scores. Thus, the contents of the ability to recognize math problems of high school students are rated at a medium level by teachers and students.



**Figure 1:** Students' ability to recognize math problems

##### *Ability to choose and propose solutions*

Students' ability to choose and propose solutions is shown through 6 main contents, the competency scores of these 6 contents through teacher's assessment range from 2.7 to 2.9 score, while students' self-assessment ranges from 2.7 to 3 scores. We found that the ratings of students and teachers were similar. Among the above contents, learning the content "Information connection analysis" has the highest score (2.9 -3.0). In addition, the content "Students fully set up the problem solving process" and "select the best solution" had the lowest scores (2.7 scores). Thus, the specific contents of the ability to choose and propose solutions of high school students are assessed as medium and below medium by teachers and students.

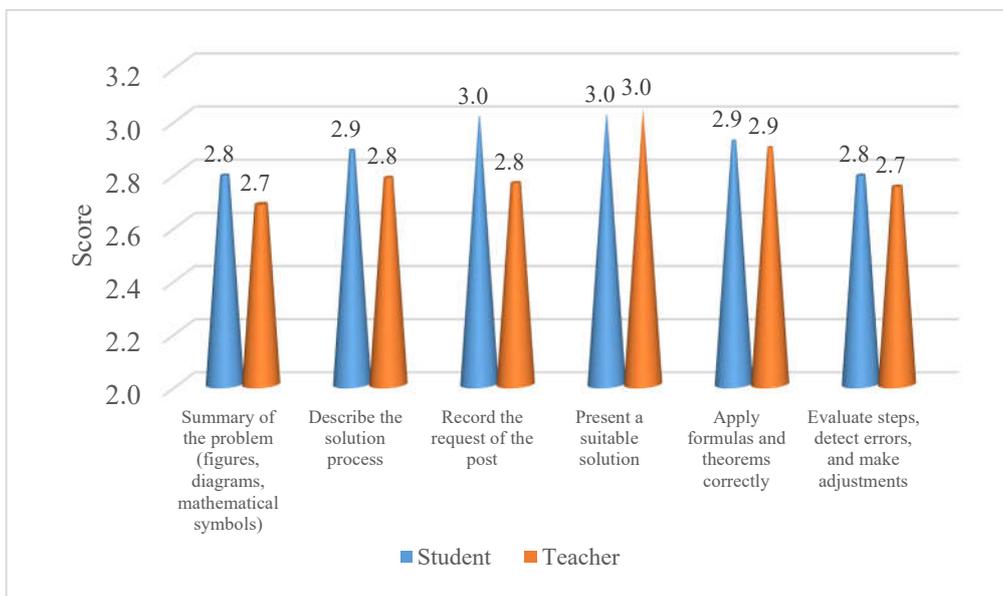


**Figure 2:** Ability to choose and propose solutions

***Ability to perform problem solving***

Students' ability to perform problem solving is demonstrated through 6 main contents (Figure 3), the competency scores of these 6 contents through teacher's assessment and students' self-assessment range from 2.7 to 3.0 scores. We found that the ratings of students and teachers were similar. Among the contents of the above skills, the content "presenting the appropriate solution" has the highest score (3.0). Meanwhile, the content "summarizing the problem with figure, diagrams, symbols" and the content "evaluating steps, detecting errors, correcting errors" had the lowest scores (2.7 - 2.8 scores).

Thus, the specific contents of the ability to choose and propose solutions of high school students are rated as medium and below medium by teachers and students.

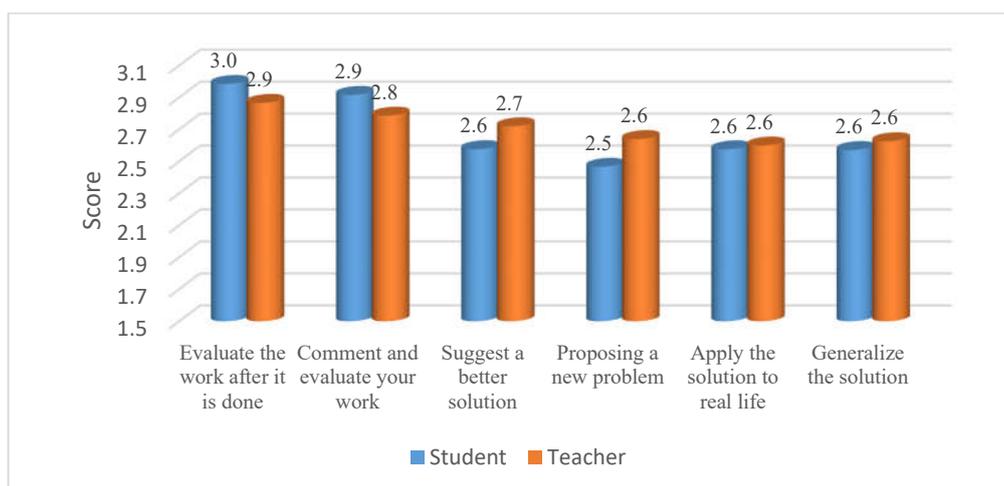


**Figure 3:** Ability to perform problem solving

***Ability to evaluate, generalize and apply practice***

Students' ability to evaluate, generalize and apply practice is shown through 6 contents (Figure 4). The competency scores of these 6 contents through the assessment of the teacher and the students' self-assessment ranged from 2.5 to 3.0 scores, it can be seen that the evaluation level of students and teachers is similar. Among the contents of the above ability, the content "Evaluating your work after doing it" has the highest score (2.9 - 3.0), followed by "reviewing your work" (2.8 - 2.9 scores). ). Meanwhile, the remaining content has relatively low scores (ranging from 2.5 to 2.7 scores).

Thus, the specific contents of the assessment ability, generalization and practical application of high school students are assessed by teachers and students as average and below average.



**Figure 3:** Ability to evaluate, generalize and apply practice

## 5. Discuss

The analysis results show that the mathematical problem solving ability of high school students is still very low. The students' ability to solve math problems is mainly medium and below medium. To explain the above problem, we believe that currently in Vietnam, the traditional teaching method is still the mainstream. For traditional teaching methods, students' acquisition of learning is passive and less creative (Batista, 1990; Alzahrani, 2018). Alzahrani, 2018 argues that Traditional teaching methods consider the learner's mind as a "sponge" teachers expect that learners will absorb all the information they provide, this leads to passive learning. In addition, Biggs & Tang (2011) argue that traditional teaching methods may not be suitable for the present because it does not help students develop abilities and skills. In addition to the problem caused by the traditional learning method above, currently, the content in the general education curriculum in Vietnam is considered too heavy in terms of both content and breadth of knowledge (Lan, 2016). The fact that an educational program is too heavy also puts pressure on completing the regulations which can lead to academic overload. Therefore, it becomes difficult to apply other active teaching methods to develop students' capacity. Gillies (2008) argues that teachers may have difficulty deciding how to incorporate active learning into a prescribed curriculum (Gillies, 2008). Or, the content found in the textbook is not suitable for teachers to structure it according to active teaching methods. Besides, in some cases, teachers still have the situation of teaching in a crammed way, leading to students being pressured, difficult to absorb and less interested in learning (Do, Nguyen & Gia, 2022).

Thus, with the above reasons, we believe that these are the main reasons leading to the low ability of high school students to solve math problems in Vietnam.

## 6. Conclusions and recommendations

The analysis results show that the mathematical problem solving ability of high school students in Vietnam is still very weak. In the content of the ability to solve mathematical problems, students only have the skills to determine the requirements of the given problem and can synthesize the necessary knowledge to solve that problem, however, this ability of the students is still at a medium level. Other skills such as assessment, discussion, criticism and application of it in practice are still very weak. From the above research results, in order to be able to meet the requirements of society as well as not to be left behind in the process of international integration.

The application of active learning methods to develop students' competencies and skills, especially the ability to solve mathematical problems, is an urgent task. To do this, educators need to build a more appropriate educational program in the direction of reducing load and reducing pressure. At the same time, to be able to apply active learning methods, teachers at educational institutions need to be trained in both expertise and skills, fully equipped with necessary teaching support tools.

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