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Research on the Framework of Mathematics Self-Study Capabilities of Vietnamese High School Students

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Abstract---In general, self-study is one of the most promoting factors contributing to learning efficiency. In this report, the objective aims to build a framework of the math self-study ability of high school students. The research methodology relates to theoretical analysis through domestic and foreign studies on the overall students' ability and Mathematics self-study capabilities; the interview includes 52 subjects (8 education experts and 44 maths teachers teaching in high schools). The final result indicates that the competency framework proposed is appropriate, necessary, and feasible for students to study on their own, helping to improve the student's math performance. In detail, the basic competencies are Motivation, awareness, and attitude of Mathematics self-study, Knowledge of self-study in Mathematics; the Ability to generate self-study in the specific content of Mathematics.

Keywords---competency framework, self-study capacity, self-study in mathematics.

Introduction

In today's contemporary world, globalization and modernization have required the research process to follow several new standards. Thus, Vietnamese education needs to make more innovations in training to promptly meet the increasing social demands for qualified, dynamic, creative, sensitive people. In terms of educational renewal, the Ministry of Education and Training of Vietnam has launched a campaign for the overall revolution in all levels and disciplines. The orientation of the movement focuses on strong changes in the educational process from equipping knowledge to developing the comprehensive quality and capacity of learners (Mahayukti et al., 2017; Suarsana et al., 2018). According to the General Education Program in 2018, one of the aiming goals in current education is " Helping students continuously develop the necessary qualities and competencies for employees, civic awareness and personality, self-study ability

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and long-term learning, capability to choose a career based their scopes and interests, conditions and circumstances to continue their career, vocational training or participation in the society workforce, adaptation to changes in the context of globalization and the new industrial revolution”.

To hit the mark, students' self-study ability plays an essential and fundamental role. Hence, the teacher can be an expert in attracting attention, stimulating, and motivating students to work on their own in the learning process. Although the self-study ability of learners is still in developing steps, this element is an internal force determining the study routes and final result. Besides, the lecturer's role is the external force, the agent, the guide, the organizer, the director for the students to self-study (Perera & John, 2020; Caponera & Losito, 2016; Crosnoe et al., 2010). In this way, it is crucial to transmitting "Teaching self-study" for students in general and for teaching Mathematics in particular. Currently, the teaching process is a process of personalizing student learning, teaching students how to access knowledge and research by themselves. Based on the studies (Toan, 2004; Artzt, 1999; da Ponte & Chapman, 2015), the author proposed a framework for the math self-study ability of high school students.

Theoretical Framework

Self-study ability

Toan (2004), claimed: “Self-learning is thinking, directed brainstorming, using intellectual abilities (observation, comparison, analysis, synthesis, etc), or even muscle practice (in study tools) with human own qualities, motivations, emotions, personal life and worldview (honesty, objectivity, progressive intelligence, willing, perseverance, patience, science passion, unafraid of difficulties) to occupy a certain field of human knowledge, making that major in control.” Consequently, self-study has included numerous self-directed, active, and highly conscious manipulations of the learners.

Tuyen (1999), supposed that: "Self-study is an independent activity that captures the learners' knowledge, skills, and also historical - social experience in general". The author's study is from the perspective of learners' awareness, which is completely independent of acquiring knowledge, techniques, and results from the previous resources. In 1994, Dang Hoat Vu said “Self-study is a series of cognitive activities of an individual to master the system of knowledge and practices conducted by the learners themselves in or outside the lesson or separately data from program and textbook. Self-study closely relates to the teaching process, but requires a high level of independence and personal nuance”.

In the research “Help students know how to learn and how to self-study, Education magazine No. 146/2006” (2006), Nguyen Gia Cau mentioned, “Self-learning is a process of self-actualizing knowledge acquisition and skills training without the guidance of teachers and the control of educational and training institutions”. According to those above statements, the researchers have provided the core characteristics of self-study. However, each concept digs into different aspects of self-study such as forms, results, thereby referring to the initiative in applying the individual's capacity to reach knowledge. In general, the authors

affirm that the form of self-study is to actively achieve the learning goals and tasks by oneself - with a personal engraving (Bacolod-Iglesia et al., 2021; Ha, 2021). Hence, a successful self-study also depends on the cognitive nature, incentives, and efforts of each person. In my opinion, the concept of self-study can be understood from several viewpoints such as a completely independent activity, without the help of teachers or a learning process about the teacher's support. Although there are a variety of analyses, we can summarize some common points of self-study:

- A form of independent, active, and self-conscious cognitive activities at a high level of learners.
- The process in which the target of the learner transforms themselves, enriches their values by intellectual and muscular manipulations, within to the will, energy, and passion of the individual.
- The method of self-exploration, self-questioning, self-study to grasp the problem, deepen understanding, even be creative to find out a different result or conclusion.
- A methodology of seeking knowledge by oneself, transforming, and enriching one's values through specific practices with available knowledge, improving the spirit of inquisitiveness to learn and achieve a certain goal.

In summary, self-learning can be classified as “an activity of self-contained human knowledge for individuals through discipline, activeness, and initiative of the learner in the process of study”. From the presented concepts, my perspective choose to understand “Self-study capacity is the ability to identify learning tasks voluntarily and proactively; setting the own learning goals requiring efforts to strive for appliance; implement effective learning methods; adjust mistakes and limitations when performing learning tasks through self-assessment feedback from teachers and friends; actively search for support when having difficulty in the process.”

Mathematics self-study framework

In terms of competence performance, this concept is usually analyzed in a specific study field. The student ability in general and Mathematics self-study, in particular, is an abstract concept that is open, multi-component, stratification structure, containing not only knowledge and skills but also motivations, attitudes, beliefs, and responsibilities. Therefore, the capacity to study Mathematics in one-self can include 3 components:

- Appropriate incentives, awareness, and attitudes to self-study Mathematics;
- Knowledge of the Mathematics self-studying problems;
- The ability to self-study in a specific content of Mathematics

Each of the above elements can be expressed in different practice skills through the self-learning ability. The performance of students can reflect the spirit and attitude to self-study, illustrating the comprehension of the process, how to develop self-study approaches; the level of mastery of specialized skills in that field is a measure of students' self-study ability (Chauvot, 2009; Weigl, 2009; Suryasa et al., 2019).

Awareness and attitude of self-study in mathematics

Firstly, determining the incentive and angle of self-study is an essential and decisive factor. The actual self-learning motivation can come from various resources, not only internal factors but also external inspirations or engagements. However, although assessing students' motivation and self-study attitude is not a simple mission for the lecturers, there are some aspects referred to examined this study process:

First: Awareness and attitude of self-study play a decisive role in the outcomes of the learning process.

No matter how good the teacher is, if the students do not learn by themselves and do not take over knowledge by themselves, then as time goes by, the knowledge they gain will quickly fade away. Teachers need to take advantage of every opportunity to help students understand the role and meaning of self-study in the learning process and every aspect of real life.

Second: Be proactive, positive, and self-disciplined while self-studying.

There are several students, even during class hours, chatting and doing personal tasks instead of paying attention to the learning tasks assigned by their teachers. At home, unless there are reminders from parents, they will not study. Even if they do sit at the desk, they may lack concentration, self-discipline and always find ways to avoid doing the assigned learning tasks. Therefore, considering proactivity, positivity, and self-discipline while self-studying is an important factor in assessing students' learning motivation and attitude.

Third: Actively looking for problem solutions instead of waiting for solutions brought by others.

To be specific, with each assignment, each content knowledge, or with each problem arising from the learning process as well as real-life, students need to actively come up with their ideas and look for solutions as well as solve problems by themselves instead of relying on other people's help. In other words, students should think before they ask somebody else for help.

Fourth: Complete assignments and homework assigned by the teacher.

It is a duty as well as a regular task of teachers to check if students have completed the homework assigned. However, for various reasons, teachers cannot keep an eye on every student in the class and they are also unable to acknowledge: How many percentages of the homework assignments do students solve by themselves? Which parts are assisted by references, friends, or parents? Nevertheless, if students often do not complete assignments and homework that teachers assigned to them, teachers need to consider the attitude, knowledge, and conditions of students' self-study to timely come up with plans and solutions to help students.

Fifth: Actively participating in idea contribution and in group activities.

Actively raising opinions to contribute to lessons and enthusiastically participating in group activities are signs of a good attitude towards self-study, which should be timely praised and encouraged by teachers. That behavior not only benefits that one student, but it also has an impact of encouraging and motivating self-learning on each of the students in the class.

Information about self-study in mathematics

Self-study skills are always associated with particular content knowledge. However, what do students self-study? What is the purpose of self-study? When should students self-study? How can students self-study? These are questions that are not easy to answer for a student who does not know enough information about self-study. This process of self-study skills contain the following particular steps:

First: Understanding the steps to self-study a particular content knowledge.

Step 1: Ask and answer these questions by yourself: What is the objective of self-study? Do you want to self-study? Or is it under some kind of external pressure?

Step 2: Find out what needs to be self-study to determine the specific requirements and problems that need to be solved.

Step 3: Find a solution to solve the posed problem.

Step 4: Present the solution to solve the problem.

Step 5: Exploit, develop, expand the problem, and self-study in different aspects.

Step 6: Evaluate, summarize lessons learned from the process of self-studying.

Second: Developing the habit of determining goals and the ability to identify content knowledge to self-study which may stem from the needs arising in the learning process or real life.

Students should always ask the question: why? That type of question is an indicator that students always have the habit of searching and discovering problems arising in the learning process or in real life that need to be solved. That habit requires students to observe, analyze... to detect difficulties, challenges and conflicts. Thereby, they can figure out the goals and content knowledge to self-study. For example, the goals can be:

- Filling in knowledge gaps;
- Perfecting a solution or a problem-solving method;
- Organizing knowledge about a subject or a topic;
- Experiencing a learning activity;
- Meeting the needs of understanding, supplementing, and obtaining new knowledge about logic as well as methods that are apart from the training program at school.

Third: Ability to collect, learn and search materials.

Regarding each self-study task (which can be assigned or based on their own needs), after learners set work goals and determine lessons to learn by themselves, many of them are still confused about how to choose materials, learn

and search documents, especially when they deal with content knowledge derived from personal needs arising in the learning process or real life. Students do not know where to start, what material to choose, where to get material, how to learn, etc (Campbell, 1996; Tatto et al., 2020). Therefore, teachers need to organize meetings like seminars, for example, to discuss self-study including guiding students on how to collect, learn, and search materials and providing detailed examples.

Fourth: Ability to build, manage and adjust self-study plans.

Regarding each self-study lesson, after setting work goals and determining lessons to learn by themselves, students need to know how to build a self-study plan. To be specific, the process of developing, managing, and adjusting a self-study plan normally follows the following sequence:

- First of all, students outline what are the main tasks in self-studying a particular lesson.
- Then, students estimate the minimum time that each task can be completed and the minimum total time required to complete all tasks.
- It is necessary to carefully answer these questions for each learning task: When do I self-study? Where can I study? Which materials, tools, and methods of self-study are included?
- If students have difficulty in terms of content knowledge, study conditions, and so on, they need to know which person they will ask for help.
- Students should be determined to complete every learning task, and do not let the self-study plan be interrupted or canceled for unconvincing reasons.
- The listed steps are in a self-study plan's general outline. Therefore, students need the ability to timely adjust their self-study plans to suit reality in terms of content knowledge, conditions, and methods during the self-study process.

Self-study skills in particular content knowledge - mathematics

The most vivid expression of competence in general and mathematical competence, in particular, are the skills. Normally, with each lesson, students always go through the steps in sequence: identifying the problem, solving the problem, presenting the solution to the problem, deeply exploiting the problem, and finally evaluating the solution found and learning lessons from it. Based on that, self-learning skills include the following 5 basic skills:

First: The ability to identify particular questions and main problems to be solved in self-study lessons using mathematical language.

Regarding each self-study lesson (whether it is an assigned task or comes from personal needs), acknowledging and detecting problems that need to be solved using mathematical language is an important part of the self-study process as it plays a crucial role in achieving success (Wong et al., 2002; Montecinos et al., 2002). This part usually requires the following steps:

- Analyze the mathematical problem and find out the prior knowledge related to the lesson and subject to self-study.
- Identify objectives to be achieved.
- Transform objectives to be achieved into particular questions and problems that students need to figure out ways (or options) to solve using mathematical language.

Second: Skill for promoting mathematical thinking and reasoning ability in finding solutions to problems posed by self-study lessons, which includes the following skills:

- Promote the ability of mathematical thinking and mathematical reasoning in proposing and choosing ways, solutions to solve problems.
- Use relevant mathematical knowledge and skills (including tools and algorithms) to solve problems.

Third: Skill for effective communication, mathematical language, and solution presentation to the problems found, which contain the following skills:

- Listen, read, and take note of necessary mathematical information presented in mathematical texts or information that is spoken or written by others.
- Present and express (spoken or written) mathematical topics, ideas, and solutions in interaction with others.
- Effectively use mathematical language (digits, letters, symbols, charts, graphs, logical links,...) in combination with the common language or body language when presenting, explaining, and evaluating mathematical ideas in interaction (discussion or debate) with others.
- Show confidence when presenting, expressing, asking questions, discussing, and debating content knowledge and ideas related to mathematics.

Fourth: The ability to use self-study material in a variety of ways.

From each problem, each self-study content, once they have found the solution, figured out how to solve the problem, many students put their pens together and consider the task completed (Carr et al., 2008; Riihimäki et al., 2003). However, the answer that was found may not always be the best way to solve the problem. Is there another way to solve it? What can we learn from the issue we just solved? Students who constantly ask themselves these questions demonstrate not only a strong motivation and attitude toward learning but also have the necessary skills for self-study. Exploiting self-study content in various ways is typically described as follows:

- Relating the results you just obtained with your existing understanding to establish new knowledge or a new overall outcome.
- Looking at the results just obtained in the most extreme cases.
- You can change one or more data points in self-study content to make a new finding or new content to solve.

- And you can investigate various approaches and methods for resolving the issue.

Fifth: The assessment ability outcomes following each process of self-studying a specific topic.

Assessment is an important part of the self-learning process. Self-evaluation improves creativity and self-control in students. According to [Chau \(2020\)](#), education in the 21st century is an “individual-oriented” education; as a result, the educational goal has undergone significant changes to train people with the ability to make self-determination; each learner will be required to have all of the following qualities: self-study, self-organization, self-determination, and at last self-development. To be able to make their own decisions about their learning, students have to understand the level of their learning results in comparison to the teaching goals, which requires them to know how to self-assess and have self-assessment capacity ([Shankar et al., 2020](#); [Nguyen et al., 2016](#)).

Certainly, meaningful learning must include assessment of the students themselves, as only students who understand how to study can best accommodate their requirements and recognize what they want to learn. The student’s self-assessment is based on the answers to these questions:

- Have all of the self-study content's specific questions and problems been addressed? Where is there uncertainty, ambiguity, or unresolvedness?
- Did the results just obtain realize the objectives and requirements established before self-study?
- What new scientific and methodological knowledge have you gained as a result of self-study content?
- Is the problem-solving strategy the best one? Is there any other way to assist in the resolution of the problem that has been set?
- Is there anything to learn about creating and managing a self-study strategy, including time, space, method, and targets?

Method

Testing purpose

The purpose of the test is to collect information about the essentiality and feasibility of the proposed guideline, and to use that details to correct unsuitable qualifications, and confirm the reliability of the competencies force is assessed.

Testing content

Testing content includes:

- Are the suggested capabilities truly necessary for the improvement of high school students' math self-study ability?
- Are the suggested capabilities truly possible for the improvement of high school students' math self-study ability?

Survey method

The author used survey questions with four levels of rating: 1-Very necessary, 2-Necessary, 3-Moderately necessary, and 4-Not necessary.

Subject, location, and time survey

Scope: 52 people completed the questionnaire (including 8 education experts and lecturers; 44 high school math teachers) 8 education experts, from universities and academic institutions, are still currently researching (Hanoi National University of Education, Vietnam National University - University of Education, Thai Nguyen University, Hong Duc University, National Academy of Education Management); 44 high school math teachers in Hai Phong and Hai Duong provinces in Vietnam: Tran Phu High School, Ngo Quyen High School, Vinh Bao High School, Thai Phien High School, Kinh Mon High School, Chi Linh High School. The survey is conducted in the 2019-2020 period school year, as well as the beginning of the 2021 school year.

Analyzing and explaining

We gathered survey information from answer sheets and recorded consultation sessions. To calculate the ranking system, we use mathematical-statistical software. The data processing tool is used methodologies based on mathematical-statistical analyses to calculate the value of the weighted arithmetic mean \bar{X} of the levels to be evaluated for a criterion that must be evaluated using the following formula:

$$\bar{X}_j = \frac{\sum_{i=1}^n f_i x_i}{\sum_{i=1}^n f_i}$$

Including:

j is the ordinal number of the criteria (activities to be assessed);

\bar{X}_j is the average value of the assessed levels for the criterion number j (the activity number j that need accessing);

x_1, x_2, \dots, x_n the number of levels to rate a criterion that needs accessing (there are n rating levels).

f_1, f_2, \dots, f_n is the quantity of people rating the criteria corresponding to rating levels (x_1, x_2, \dots, x_n).

The survey results are processed according to the average value and classified according to the rating scale as follows:

$$1.0 \leq \bar{X} \leq 1.66: \text{not necessary/ not feasible};$$

$$1.67 \leq \bar{X} \leq 2.33: \text{necessary/ feasible};$$

$$2.34 \leq \bar{X} \leq 3.0: \text{very necessary/ very possible}.$$

Therefore, we have a foundation on which to calibrate high school students' self-study ability basis in Mathematics.

Research Result

Based on statistical data, opinions are formed regarding the necessity and feasibility of three main expertise components of high school students' ability to self-study Mathematics.

Table 1
Results of a survey to analyze necessity and feasibility of a high school students' Math self-study competency framework.

Method	Quantity/ Proportion	Level			Average score	N = 52 No.
		Very necessary	Necessary	Not necessary		
Motivation, awareness, and attitude toward self-study in mathematics.	Quantity	40 58.82	10	2	2.73	1
	Proportion		14.71	2.94		
Mathematical self-study knowledge	Quantity	38	13	1	2.71	2
	Proportion	55.88	19.12	1.47		
The ability to self-study a specific topic in Mathematics.	Quantity	35	15	2	2.63	3
	Proportion	51.47	22.06	2.94		

The survey result shows that: Opinions on the urgency of the three proposed skills are highly valued, with the capacity "Inspiration, awareness, and attitude to self-study in Mathematics" rated as the most immediate, with the highest score average $\bar{X} = 2,73$. The ability "Knowledge of self-study in Mathematics" comes in second with a score of $\bar{X} = 2,71$. The result demonstrates the importance of knowledge in self-study. Currently, education is rapidly changing; the methods of teaching and learning are evolving to better suit the digital age; likewise, during the Covid-19 pandemic, the issue of self-study requires even more attention. The ability rated as immediate in the 3rd place is "Skill for self-studying a specific content in Mathematics" with $\bar{X} = 2,63$. The results show that all Math teachers and education experts who participated in the survey agreed with the suggested framework of capabilities, and all the above is necessary and feasible for students to self-study Mathematics.

Conclusion

The research findings are similar to the assumptions in (Dung & Quyen, 2019; Quyen, 2020; etc). This research proposed a framework of Mathematics self-study ability for high school, which is an essential foundation for future research to develop pedagogical measures for students' improvement of Mathematics self-study capacity for high school students who meet the requirements of Vietnam's educational innovation.

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