

# Some Measures for Creating Creative Capacity for Students in Teaching Physics in High School

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**Abstract:** Teaching is oriented towards the development of learners' capacity, in which the development of creative capacity is identified as an important goal in Vietnam's education and training development strategy. To meet this requirement, in the process of organizing teaching, it is necessary to form for students the ability to think creatively and independently when solving learning tasks or problems arising in learning. The article focuses on analyzing concepts, manifestations, influencing factors, and proposes some measures to develop creative capacity for students. The theory has been built with experiments at high schools, using case study methods to evaluate the effectiveness of implementation.

**Keywords:** Creativity, capacity, creative capacity, development of creative capacity.

## 1. Introduction

Creativity is one of the leading characteristic capabilities of human beings, an important factor and a great driving force that governs and directly affects the development of all aspects of social life. Currently, the world in general and Vietnam in particular are entering the industrial revolution 4.0, which has brought humanity from an industrial economy to a knowledge economy. To meet this innovation requirement, the Vietnamese education sector needs to train people who not only have good technical expertise but also have the ability to creatively apply knowledge and skills into production practice, output and life. The theory of creative learning has been presented by many studies, which describe the creative process, the creative levels of the learners [1, 2]. In Vietnam, many studies have focused on developing students' creative capacity in the process of organizing teaching. These studies have shown the positive influence of creative capacity on the quality of students' learning process as well as applying knowledge into practice [3, 4]. However, at present, the application of theories of creative teaching to

develop creative capacity in teaching physics in high schools has not been much researched. Teaching practice also shows that teachers today face many difficulties in implementing capacity development-oriented teaching in a general and creative capacity in teaching physics in particular. That showed, within the framework of this article, we introduce some necessary measures to develop students' creative capacity in teaching physics in high schools.

## 2. Theoretical Background

### 2.1 Capacity, Creativity and Students' Creative Capacity

*Capacity:* F. E. Weinert states that: "Capabilities are the technical skills acquired or acquired by individuals to solve specific situations, as well as social readiness and motivation... and the ability to apply problem-solving strategies in a productive way responsible and effectively in flexible situations" [5]. French psychologist Denyse Tremblay based on the concept of "lifelong learning" that: "Competence is the ability to act, achieve success, and demonstrate progress through the ability to mobilize and use effectively results of the individual's integrated

resources when dealing with life's problems" [6]. In Vietnam's general education program, "Capacity is an individual attribute formed and developed by inherent qualities and the learning and training process, allowing people to mobilize synthetically knowledge, skills and other personal attributes such as interest, belief, will, etc., to successfully perform a certain type of activity, achieving desired results under specific conditions" [7]; According to Dang Thanh Hung: "Capacity is an individual attribute that allows an individual to successfully perform certain activities and achieve desired results in specific conditions" [8]. Thus, the concept of capacity is a combination of activities based on the general mobilization of knowledge, skills, and other personal attributes such as attitudes, interests, beliefs ... to solve problems or to do a good job in a given context.

*Creativity*: According to the Vietnamese dictionary, "Creativity is creating new material and spiritual values, finding new solutions, not being constrained or dependent on what already exists" [9]; According to the author Le Nam Hai, Ha Thi Hoai Thuong: "Creativity is a personality attribute expressed through new and strange ideas and unique products that are not only valuable to the individual but also to society" [10]. Thus, according to us, "Creativity is the activity of creating new things, coming up with new, unique, useful and effective ideas that are suitable to circumstances, valuable to individuals and society."

*Creative capacity*: Vygotsky said: "Creative capacity is a personality attribute, a combination of psychological qualities by which people based on their knowledge-experience capital and dominant divergent thinking (analytical analysis), compare, synthesize and evaluate) generate and select new, original, and rational problem-solving ideas on an individual, near-society or global level" [11]. According to this author, creativity manifests when people are faced with problematic situations, able to come up with solutions, and choose the most unique and reasonable solution to the problem posed. Author Pham Thi Bich

Dao believes: "Creative capacity is considered the ability to find new things, new solutions, the ability to detect and solve highly effective problems in learning, the ability to discover the unknown, not yet, and create the unknown, the not-yet, unconstrained, depends on what is known, already there, does not think in the same way" [3]; According to author Nguyen Van Phuong, "Creative capacity is the ability to create new material and spiritual values, find new ways, new solutions, new tools, and successfully apply existing knowledge into new circumstances in a particular field of activity". Thus, it can be understood, "Creative capacity is the ability to create valuable new things thanks to existing qualities and the process of learning and training. Encourage students to create new ideas, new findings, strange, original and reasonable. Thus, it can be understood, "Creative capacity is the ability to create valuable new things thanks to existing qualities and the process of learning and training. Encourage students to create new ideas, new findings, strange, original and reasonable. Thus, it can be understood, "Creative capacity is the ability to create valuable new things thanks to existing qualities and the process of learning and training. Encourage students to create new ideas, new findings, strange, original and reasonable".

## 2.2 Expressions of Students' Creative Capacities

In the learning and research process of students, creativity is the highest requirement of the four cognitive levels, which are knowing, understanding, applying, and creating.

According to I. Ia. Lence, there are 7 characteristics of creative capacity [12]: Having the ability to self-transfer knowledge and skills to a new situation. The more distant the connection between the new situation and the old knowledge, the higher the level of creativity. Seeing new problems in the "proper" terms of familiarity. See the structure of the object under study. See new functionality of familiar objects. Develop new methods, in principle different from

known familiar solutions. See many possible solutions, choose the optimal solution, and proceed to solve the problem. Create a unique solution method despite knowing new methods.

William Benn suggested that creative people have the following characteristics: [13]: Always looking for ways to do things that work. Those who dare to break the model, break the limits to find new solutions, new ways of doing things (the model can manifest as a set of principles or a frame of reference). Develop curiosity, and always ask why. Generate new and unique ideas, those who dare to act.

According to Pham Thi Bich Dao [3], and Nguyen Van Phuong [4], it can be seen that creative capacity in students manifests as follows: Knowing how to ask valuable questions to clarify situations and abstract ideas; identify and clarify new and complex information and ideas from different sources of information; Analyze independent sources of information to see trends and credibility of new ideas. Eager to explore and actively solve problem-provoking situations. Consider things and phenomena from different perspectives; forming and connecting ideas; research to change the solution before the change of context. Know how to find quick and accurate answers to teachers' questions, uncover key issues, and find hidden meanings in questions, exercises or a certain situation. Proposing new ideas, and new solutions for creative problems in physics. Proposing questions for problems to learn, and tasks to be solved. Love, eager to learn; raised many new ideas in the process of learning and life; not afraid to be wrong; thinking out of the way; creating new elements based on different ideas. Know how to flexibly present a problem, offer many solutions; know how to combine thinking manipulation and judgment methods to make the most concise and accurate conclusions. Apply knowledge and skills in practice in a new way. Always evaluate, self-assess, adjust learning results quickly, and suggest directions for improvement.

It can be seen that the above author's research on the expression of the creative capacity of students leans more towards the ability but has not paid attention to the expression of qualities, personal characteristics and emotional expression of students. Therefore, in this study, we propose some expressions of the creative capacity of high school students in learning as follows:

- Eager to explore and actively solve problem-provoking situations.
- Likes to argue, refute, has faith and will to carry out his ideas.
- Ability to collect and process information from multiple sources; synthesizing — generalizing in a new way; if you have your own opinion, your interpretation is different from what is known about a phenomenon, a physical process.
- Know how to propose hypotheses, design experimental plans, and choose the optimal plan to test the hypothesis of the problem to be studied.
- Proposing new ideas and new solutions for creative problems in physics.
- Proposing questions for problems to be researched, and tasks to be solved.
- New plans can be built, different from known familiar ones; such as designing new models, and new experimental equipment.
- Seeing the function of a familiar instrument, experimental equipment, accomplishing many different goals, and vice versa, much different experimental equipment can be used to accomplish one goal.
- Apply knowledge and skills in practice in a new way.
- Always evaluate, self-assess, adjust learning results quickly, and suggest directions for improvement.

### *2.3 Important Factors Contributing to the Development of Creative Capacity for Pupil*

There are many factors affecting and affecting the process of developing students' creative capacity. In the process of impact, we need to determine the influencing factors in order to build the best pedagogical impact on the process of developing the pedagogical capacity of the learners. Here are the five most important factors affecting the development of creative capacity in students:

- To develop creative capacity for students must mention that the first factor is “the ability to think independently”, that is, the ability to self-study to find their solution and students have their ideas. Independent thinking will easily absorb knowledge in the learning process. Independent thinking is important because it is the foundation of creativity and innovation.
- The second element needed is “interest”. Interest sparks creativity and creativity spurs new interest. When students are interested, their cognitive ability will be high and from there, they will have a desire to perceive new things and apply new things to real life.
- The third factor is “scientific skepticism”, students will always ask: Why? Is it right? Is this or this method optimal? Is there any more optimal solution? ... From there, they try to find answers that will contribute to developing creative capacity for themselves.
- The fourth factor that promotes the development of Creative capacity for students is the ability to work in groups. Through group activities, collaboration skills between members, between students and teachers are enhanced. Students will be together to discuss, collect information, process information, and plan to perform the proposed task. Through performing tasks, students' cooperation, diligence, responsibility, creativity, etc. will be

promoted.

- Another factor is also needed for the developing creative capacity of students must have “solid basic knowledge”, basic knowledge is the foundation for creativity because any creative process starts from the reproduction of what is known, so it is necessary to Must have the solid basic knowledge.

### *2.4 Some Measures to Develop Creative Capacity for High School Students*

On the basis of comparing behavioral manifestations and factors affecting the development of students' creative capacity, we develop impact measures to foster creativity for students as follows:

(1) Measure 1: Use questions to stimulate creative inquiry

Using questions in the learning process is one of the positive measures that stimulate students' thinking, exploration, and creativity. Thought-provoking questions are questions that pose to students a new cognitive task, encourage and require them to try their best intellectually, self-reliantly find the answer by applying comparative thinking, analyze, synthesize, and generalize, thereby acquiring new knowledge and practicing research methods, problem-solving methods, and the joy of discovery. This is a process of creative exploration in learning so that students can self-reliantly detect and resolve conflicts, and creatively acquire new knowledge.

Example: When finishing the lesson of Momentum — Law of Conservation of Momentum, the teacher will ask the question of whether humans can conquer the universe, the natural world, or not. How can humans reach distant planets? After the students' discussion, the teacher played videos of missile launches recorded on the internet. Since then, the teacher asked the question, in order to realize that the rocket launch dream, building and launching water rockets is interested in many young people. As an

engineer, let's build water rockets from simple materials available. Before the problem is posed, students will promote their intellect, research, explore and create to create desired products based on known knowledge.

## (2) Measure 2: Guide students to self-study

Self-study is brainstorming, thinking, and using intellectual abilities (observing, comparing, analyzing, synthesizing...) to creatively occupy a certain scientific field and transform the field, it becomes your property. Self-study helps to improve student learning outcomes and the school's educational quality, which is a specific manifestation of the innovation of teaching methods in high schools. Students' self-study skills can be classified into four groups: orientation skills; planning skills; planning skills; skills to test, evaluate and draw experience. Solutions to develop self-study and self-research capacity for high school students include:

- Guide students to collect references and methods of reading documents according to subject specifics: Before going to class, teachers to guide students on how to pre-read new articles in the document, students need to:
  - Record in the study book the questions that you want to be answered;
  - Take notes on important concepts and definitions;
  - Summarize formulas and important contents in the study book. For a class time, depending on the content of each lesson, some learning worksheets can be used to teach by the small group cooperative method; or you can use the problem-solving method of alternating questions on the basis that students have read books to acquire knowledge. Teachers also need to guide students how to take notes to understand and reproduce knowledge easily and deeply.
- Organize for students to acquire knowledge by themselves from the perspective of a

“researcher”: Students can play the role of “researcher” in the form of doing research assignments, writing essays, or doing small projects, and the teacher introduces reference materials for students to study based on. Then the groups will report their products in front of the whole class for other groups to comment and supplement. Teachers comment on results, answer questions and draw experiences for groups.

Example: After studying Kinetic and Potential Energy, before studying Mechanical, the teacher asks students to study and learn first about how to convert energy in the form of kinetic energy to potential energy and vice versa with prompting questions such as: what principle does the roller coaster work on? Why does the stake dig deep into the ground when a stone falls from above and hits the stake? What would be the height of the sandbag hanging from a tree branch if a rock moving with great enough velocity were to hit it? Find the relationship between kinetic and potential energy when an object of mass  $m$  falls from a height of  $z_1$  to a height of  $z_2$ , or when a spring pendulum is moved from a position of deformation  $x_1$  to  $x_2$  due to an elastic force. Then, the representatives of the groups report the results of their group's research. The other groups commented and added. The teacher closes the answer option to questions and introduces the new lesson Mechanical. Thus, students have built the content of the law of conservation of mechanical energy from their knowledge of kinetic and potential energy.

## (3) Measure 3: Use creativity exercises

Creative exercise is a type of exercise used to foster the qualities of creative thinking (flexibility, flexibility, originality, ...). Learners who want to solve the problem must apply their knowledge flexibly and creatively in each specific case, and must have new and independent proposals that cannot be deduced simply from the knowledge they have learned. Using creative exercises will stimulate students' ability to

explore and be creative in discovering scientific knowledge through actual phenomena from creative exercises. The unexpected factors (excess, missing, wrong data; not following the pattern,...) and creativity in creative exercises have partly limited the situation of learning by learning, rote learning, and mechanically solving exercises exist in most students today. The requirements of the creative exercise help children think more actively, argue more and be more confident,

Example: We consider the problem of an object moving in a straight line, accelerating uniformly from rest and reaching a speed of 2 m/s after traveling a distance of 10 m, the object's acceleration is 0.5 m/s<sup>2</sup>. Determine the motion of the object during acceleration? Not only is this exercise redundant, but the facts are also mutually exclusive, leading to different results for the quantity to be searched. By assumption, the acceleration of the motion can be calculated:  $a = \Delta v / \Delta t$ ,  $\Delta t = t = \Delta v / a = (v_t - v_0) / a = 4s$ . By assumption, the distance traveled can be calculated by:  $S = at^2 / 2$ ,  $t = \sqrt{2S / a} = 6,32s$ . Obviously, the problem has one of three factors:  $vt$ ,  $S$ ,  $a$ ; and these three facts are inconsistent, violating the proven equality:  $v_t^2 - v_0^2 = 2aS$ . The creativity here is that students must recognize the unusualness of the problem, point out the contradictions between the data, and be able to suggest ways to adjust the data to get the common problem.

#### (4) Measure 4: Using experiments in teaching

Experiments are an important means of students' cognitive activities, through experiments students can acquire the necessary scientific knowledge in order to improve their capacity so that they can influence and improve their knowledge. In teaching physics, experiments have a positive role in students' cognitive activities, reflected in the aspect of providing knowledge, training manual manipulation, and affecting students' senses. Students can reproduce

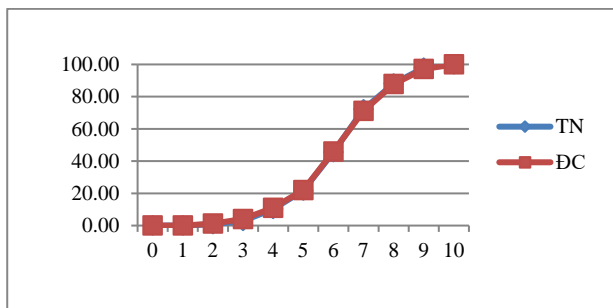
knowledge related to the lesson content or explore and discover new knowledge through manipulations of activities on objects. This is considered a creative activity in student learning, from arranging experiments, observing experimental progress, and commenting on experimental results, students acquire knowledge, skills and apply creativity created in production practice and life.

Example: When studying the phenomenon of light refraction, through experiments, students not only observe the phenomenon of light refraction (fracture of light rays at the interface between two media) but also collect data about the angle of incidence and the corresponding angle of refraction, creating the basis for drawing the law of light refraction. From there, students can apply in practice by launching a javelin so that they can hit a fish swimming in the river.

#### (5) Measure 5: Practical experience

Experiential learning is a continuous process that draws from experience to create knowledge. That is, the source of the knowledge that students have comes from practice, not theory. For a long time, in teaching, teachers have equipped students with dogmatic knowledge from books, but have paid little attention to their knowledge and practical experience in life activities. Experiential learning is the implementation of learning activities associated with practice to orient and create conditions for students to observe, think and participate in practical activities, thereby encouraging, motivating, and creating conditions for them to actively research, find new solutions, create new things based on the knowledge they have learned in school and what they have experienced in real life, thereby forming their consciousness, quality, life skills, and student capacity.

Example: When making a mini generator to light a led. With this activity, students understand what they have learned about magnetic fields, and the variation of magnetic fields through a closed circuit applied in generating electric current. But in order to light up

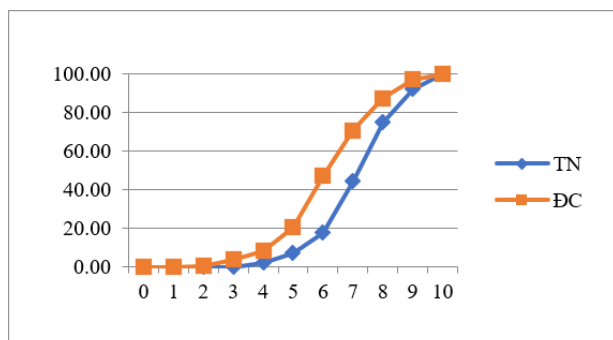


**Fig. 1 Cumulative frequency distribution of entrance test.**

an LED, students also have to analyze and apply much other knowledge such as: Ohm's law for the whole circuit, the resistance of conductors, etc. Through these activities, students are trained. capacity to design and organize activities, and the ability to apply learned knowledge and skills into practice.

### 3. Results and Discussions

Based on the theory built, we have developed a system of teaching plans in the direction of fostering creative capacity for students and conducted pedagogical experiments at high schools in Dong Nai province. during the period from 01/2021 to 01/2022 with a total of 490 students participating in the experiment. Experimental results show:

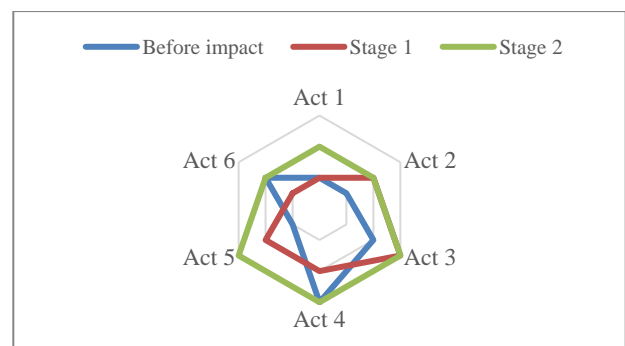


**Fig. 2 Cumulative frequency distribution of the output test.**

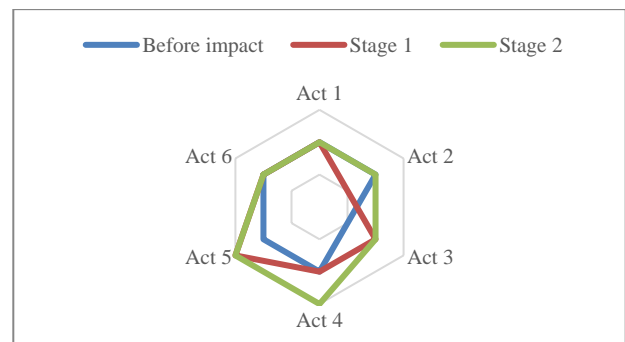
Before the actual process, the learning quality in the two groups of experimental and control classes was similar, there was no big difference in learning results. However, after the experiment, the learning quality of the experimental class improved significantly compared to the control class. Statistical indicators of

the T-student test confirmed that the difference between the two groups was due to the impact process.

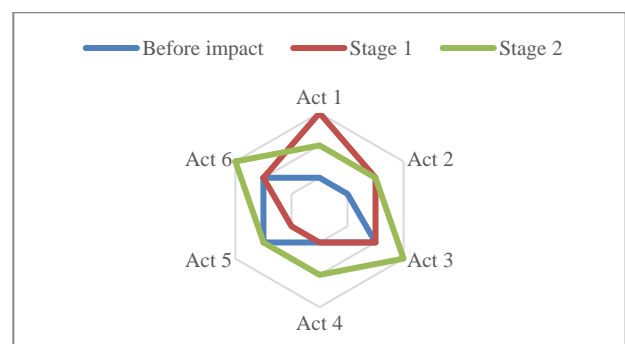
To assess the development of students' creative capacities, we use the case study method. In the experimental group, we selected a group of students as a representative sample to conduct observations, research, and collect data from the quality criteria of the components of the built creative capacity. The results of assessing students' creative capacity at three-time points before, during, and after the experimental process of the selected group of students are described by the following diagrams:



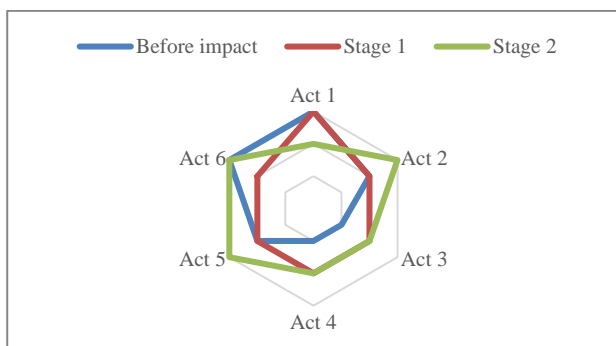
**Fig. 3 The expression level of Dao Phi H.**



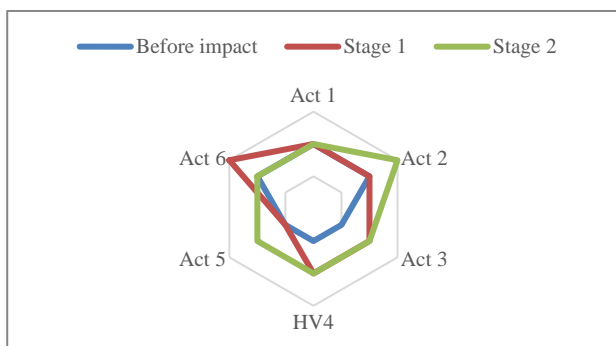
**Fig. 4 The expression level of Vo Le Hong P.**



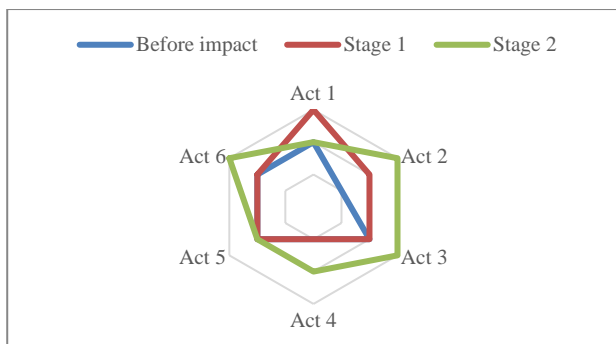
**Fig. 5 The expression level of Nguyen Van D.**



**Fig. 6 The expression level of Cao Thuy D.**



**Fig. 7 The expression level of Vo Khanh V.**



**Fig. 8 The expression level of Chau Ho Sy P.**

The diagrams for teachers, although there is fast and slow development in some behaviors in different students, in general, the students' creative capacity has developed, and map area is in different areas. The later stages of all selected students have developed and expanded compared to the previous periods. It confirms that the implementation of the measures has brought positive results, and the teaching and learning activities have developed the creative capacity of students.

In addition to the positive results, the student's ability graph also showed a number of behaviors with rapid development, in addition to some undeveloped

and slow development behaviors. This shows that the impact measures are not really effective for certain behaviors. Some students have slow growth. Therefore, further research is needed to perfect measures suitable for affecting specific behaviors and students.

## 4. Conclusions

Creativity in learning in students is an activity of self-directed exploration and research to solve problems in the process of acquiring new knowledge. Fostering and promoting students' creativity in teaching physics is currently an important and urgent task for the country's education. To promote creativity for students in teaching physics, it can be organized by many different measures such as using questions to stimulate creative inquiry, guiding students to self-study — self-study, using creative exercises, using experiments in teaching, practical experience, or a harmonious combination of the above measures to promote acumen in thinking, the ability to creatively apply knowledge in the classroom. new situations. The research results have shown the feasibility and effectiveness of the built measures. Within the limit of one article, we do not expect to fully present all the work done or to thoroughly solve all the problems. However, to be able to perfect the measures and develop for the training of different capacities, it is necessary to continue to carry out the research the next time.

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