International Journal of Education and Practice
2023 Vol. 11, No. 3, pp. 692-701
ISSN(e): 2310-3868
ISSN(p): 2311-6897
DOI: 10.18488/61.v11i3.3479

Perception and behavior of high school students towards developing problem solving and creativity skills to solve physics assignments

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Article History
Received: 17 April 2023
Revised: 25 July 2023
Accepted: 4 September 2023
Published: 13 September 2023

Keywords
Behavior
Competency
Perception
Physics
Problem-solving and creativity.

ABSTRACT

This study aimed to explore the learning approaches and preferences of high school students in Vietnam when studying physics. A survey was completed by 2,040 students from ten different schools on improving problem-solving and creativity skills to solve physics assignments. The survey included eight topics related to homework, exchange, problem-solving tactics, and an emphasis on real-life applications of physics concepts. The results showed that the majority of students preferred essay-style calculus homework and sometimes exchanged and discussed ideas with their peers. In addition, most students focused on only some of the steps involved in solving physics problems, self-analyzed and expanded their solutions, and related the exercise content to real-life situations. The study also found that students preferred physics exercises with clear facts and suggestive questions, while a quarter of students preferred exercises with specific facts and clear questions. Furthermore, only a small percentage of students had a deep understanding of the ten core competencies outlined in the General Education Program of 2018. These findings have important implications for physics teachers in Vietnam, indicating the need for more opportunities for discussion and encouraging a comprehensive problem-solving approach. The study suggests incorporating more real-life applications of physics concepts into teaching to help students see the relevance of what they are learning.

Contribution/Originality: This research contributes to developing the theoretical foundation of problem-solving approaches and creativity among Vietnamese high school students while studying physics. In addition, it encourages a comprehensive approach to problem-solving and contributes to the practice of teaching physics in Vietnam by facilitating and discussion.

1. INTRODUCTION

In today's fast-changing world, the development of problem solving and creativity skills is considered essential for success in various fields of work and life. In Vietnam, the Ministry of Education and Training (MOET) has recently introduced the New General Education Program and the General Education Program in Physics for high school students, starting from grade 10, with a focus on developing students' competencies through a curriculum with basic, practical, and modern knowledge and skills. One of the key competencies emphasized in the program is problem solving skills and creativity skills. However, the implementation of the new program has faced several

challenges, including inadequate preparation of facilities and teaching skills for teachers, leading to a lack of clarity in the effectiveness of the program.

One of the reasons for the limited success of the program may be the perception and behavior of high school students towards problem solving and creativity. Although many studies have been conducted on the development of problem solving and creativity skills in students, these studies have mainly focused on theoretical issues such as educational measures, the process of organizing teaching, and testing and evaluating in the direction of developing competencies, with less attention given to the subject of students. Furthermore, the use of physics exercises to develop problem solving skills and creativity skills of students has been explored in various approaches, but the effectiveness is still not as expected.

1.1. Problem Solving and Creativity

Problem-solving skills refer to the ability to identify, analyze, and solve problems. According to Tsai and Tang (2017), problem-solving skills involve cognitive processes, such as critical thinking, decision-making, and logical reasoning. High school students with strong problem-solving skills are better equipped to solve complex problems and make effective decisions. They are also more likely to be successful in their academic and professional lives. Creativity is the ability to produce novel and valuable ideas, solutions, or products (Amabile, 1988).

Problem-solving and creativity are two critical components that are required for academic and real-life success. Problem-solving is defined as “a cognitive process used to identify, analyze, and solve problems” (Gick & Holyoak, 1980), while creativity refers to "the generation of ideas or products that are both novel and appropriate" (Amabile, 1988). Research has suggested that problem-solving and creativity are interconnected (Molnár, Greiff, & Csapó, 2013) and that individuals who are creative are better problem solvers (Cropley, 2006). Problem solving and creativity are considered essential skills for success in various fields of work and life. Problem solving involves the ability to analyze complex situations, identify problems, and come up with effective solutions. High school students with strong problem-solving skills often display higher levels of creativity. Creativity is also positively related to academic achievement (Kaufman, Beghetto, Baer, & Ivcevic, 2010). High school students who are creative are more likely to be successful in their academic careers.

1.2. Development of Problem Solving and Creativity Skills in Students

The development of problem-solving skills and creativity skills in students has been the focus of much research in the field of education. Various approaches have been proposed to develop these skills, including problem-based learning, inquiry-based learning, and project-based learning (Sandoval & Reiser, 2004; Strobel & Van Barneveld, 2009). These approaches are designed to engage students in active learning, encourage critical thinking and problem solving, and promote creativity and innovation. In addition to teaching approaches, other factors have also been found to influence the development of problem solving and creativity skills in students. These include individual characteristics such as motivation, self-regulation, and prior knowledge, as well as contextual factors such as curriculum, teaching quality, and classroom climate (Runco & Jaeger, 2012; Sandoval & Reiser, 2004).

High school students who develop problem-solving and creative skills are better equipped to handle academic challenges and succeed in the workforce. Studies have shown that creative high school students are more likely to achieve academic success (Runco & Jaeger, 2012). Various factors contribute to the development of problem-solving and creativity in high school students. Studies have shown that creativity can be developed through training and practice (Amabile, 1988). Teachers who encourage creativity and provide opportunities for students to engage in creative problem-solving activities can promote the development of these skills (Craft, 2005). In addition, technology-based interventions, such as online learning platforms, can also enhance creativity and problem-solving abilities (Arifin, Setyosari, Sa’dijah, & Kuswandi, 2020).

Students' competency in Vietnam is treated as an individual trait generated and developed by their innate qualities and the learning and training process, allowing people to synthesize knowledge, skills, and abilities. The capacity of students to solve problems and be creative is the ability to coordinate and apply personal experiences, knowledge, and skills through subjects in order to have the correct perspective to solve learning and life's problems effectively and with a creative mindset. Other personal characteristics such as interest, belief, and will to effectively perform a certain type of activity, achieve the desired results under specific conditions, and the problem-solving and creative abilities of students (Ministry of Education and Training, 2018).

1.3. Physics Assignments and Problem Solving and Creativity Skills

Physics assignments have been widely used to develop problem solving and creativity skills in students. Physics is a subject that requires critical thinking and problem solving skills, and the use of assignments and problem-solving exercises can help students develop these skills (Adams & Wieman, 2011; Crouch & Mazur, 2001). Research has shown that physics assignments that focus on conceptual understanding, problem solving, and reasoning skills can improve students' performance and increase their motivation to learn (Freeman et al., 2014; Henderson et al., 2012). However, the effectiveness of physics assignments in developing problem solving and creativity skills may depend on the quality of the assignments and the teaching approach used (Crouch & Mazur, 2001; Freeman et al., 2014). For example, assignments that require higher-order thinking skills and creativity, such as open-ended problems and design challenges, may be more effective than routine problems in developing problem solving and creativity skills (Revilla Muñoz, Alpiste Penalba, Fernandez Sanchez, & Santos, 2017). Similarly, teaching approaches that focus on student-centered learning, inquiry-based learning, and collaborative learning may be more effective than traditional lecture-based approaches in promoting problem solving and creativity skills (Dancy & Henderson, 2010; Strobel & Van Barneveld, 2009).

1.4. Perception and Behavior of High School Students in Solving Physics Assignments

The perception and behavior of high school students in solving physics assignments towards developing problem solving and creativity skills have been the focus of several studies. These studies have investigated various factors that influence students' performance and motivation in physics assignments, including their prior knowledge, self-efficacy, and interest in physics (Dancy & Henderson, 2010; Henderson et al., 2012). The results of these studies have shown that students' perception and behavior in solving physics assignments can significantly impact their problem solving and creativity skills and their overall performance in physics.

However, there is still a lack of research on the perception and behavior of high school students in solving physics assignments towards developing problem solving and creativity skills in the context of the new General Education Program and the General Education Program in Physics (2018) in Vietnam. This study aims to fill this gap in the literature by perception and behavior of high school students in Vietnam towards developing problem solving and creativity skills to solve physics assignments.

2. METHODS

2.1. Participant

The researchers employed a handy random sampling technique by administering a direct survey to a sample of 2040 students in the 10th grade. This was the class that had started studying under the 2018 General Education Program in the direction of competency approach from 2021–2022 at 20 high schools of 10 different provinces/cities (Table 1). To represent the whole population, 1 to 3 classes were selected randomly from each school. The prevailing characteristic seen in the sample was that the students who had completed their education at the lower secondary level under the previous General Education Program had also successfully completed the 10th grade under the General Education Program with a focus on competency during the transitional phase. The

transition between the two levels of education was not favorable due to limitations from inherited cognitive and behavioral characteristics.

Table 1. Socio-demographic characteristics of subjects (N = 2040).

Provinces/Cities	School	N
Thua-Thien Hue	Phan Dang Luu High School	81
	Hue High School for the Gifted	101
Da Nang	Nguyen Hien High School	130
	Son Tra High School	99
	Tran Phu High School	125
Quang Nam	Nguyen Van Cu High School	74
	Tieu La High School	124
Quang Ngai	Le Trung Dinh High School	123
	Tran Quoc Tuan High School	177
Binh Dinh	Quy Nhon High School	130
	Nguyen Thai Hoc High School	66
Phu Yen	Phan Dinh Phung	99
Khanh Hoa	Ha Huy Tap High School	79
	Hoang Van Thu High School	66
Ninh Thuan	Nguyen Trai High School	87
	Thap Cham High School	79
Gia Lai	A Sanh High School	101
	Huynh Thuc Khang High School	101
Kon Tum	Truong Chinh High School	120
	Lien Viet High School	78
Total		2040

2.2. Measurement

A questionnaire was designed for this study which consisted of 8 questions about students' perception and behavior towards developing problem solving and creativity competencies required to solve physics assignments. The core competencies that Vietnam's new comprehensive general education program after 2018 of the Ministry of Education and Training of Vietnam focused on seven main issues: (1) The level of understanding of students about the General Education Program and the General Education Program in Physics (2018); (2) The level of students' understanding of problem solving and creative problem solving skills that students themselves need to form and develop in the learning process; (3) The form in which students receive the task of doing exercises in class and homework from teachers; (4) Types of physical exercises that students are most interested in and often do in class and at home; the level of interest of students in the content and form of some types of physical exercises; (5) Student's behavior in the process of performing the sequence of steps when solving physical problems; (6) Student's behavior in exchange and discussion activities in the process of solving physical problems and analyzing and expanding the content of physics problems with real situations occurring in daily life; (7) The needs of students for self-searching physical exercises for self-training.

In addition, through the survey of students, we also collected some more information on other issues such as how to choose popular exercises, how to transfer exercises, and how to organize popular teaching methods among students. Classroom teachers and its effects on the development of students' problem solving and creative problem-solving skills. The content of the questions was standardized after consulting with 10 experienced teachers who are teaching physics at high schools in Quang Ngai Province and sent directly to each student.

2.3. Data Analysis

The study was conducted with participants who had provided informed consent to participate in the research and completed the survey. The data collected from the participants was analyzed using version 26 of the Statistical Package for the Social Sciences (SPSS). The SPSS is a widely used software package that is specifically designed for

statistical analysis. In this study, the descriptive statistics technique was used to summarize the quantitative data collected from the participants. Descriptive statistics involved the use of various measures, such as mean, median, mode, standard deviation, and range, to summarize the data and provide a clear understanding of the central tendency and variability of the data. Therefore, descriptive statistics was used to provide a summary of the data collected from the participants in this study, which represents the entire population being studied.

3. RESULTS

Table 2 shows the frequency and percentage of responses of participants on various items.

Table 2. Students' perceptions and behaviors regarding the development of problem-solving and inventiveness to solve physics problems.

No	Item	Level	N=2040	%
1	What kind of homework do you do most often in class?	Test	599	29.4
		Essay (Mainly calculus)	923	45.2
		Practical exercises, experiments (Results drawn from practice, experiments)	281	13.8
		Exercises explaining phenomena and applications of physics in life and technology	237	11.6
2	In the process of solving problems in class, do you often exchange and discuss (About how to analyze the problem, how to solve it, how to argue...) with your friends in each group that the teacher assigns or not?	Often	678	33.2
		Sometimes	1189	58.3
		Rarely	173	8.48
		Never	0	0
3	When solving exercises, there are usually five basic steps: (1) Reading and analyzing the problem carefully to know what is given and what to look for; (2) Finding the relationship between the given and the sought; (3) Finding solutions and choose the most reasonable solution to solve; (4) Carrying out the solution; (5) Interpretation of the results. How do you usually proceed?	Follow all 5 steps carefully in order	549	26.9
		Focus only on steps (1), (3), and (4)	883	43.3
		Focus on step (4), skipping steps (1), (2), (3) and, (5)	463	22.7
		Other options	145	7.11
4	After solving an exercise, how often do you self-analyze the solution, expand it, or relate the exercise content to real situations in everyday life?	Often	476	23.3
		Sometimes	1074	52.6
		Rarely	391	19.2
		Never	99	4.85
5	In the process of studying physics, did you yourself pay more attention and focus on solving problems with the main content?	The exercise involves only quantitative calculations	516	25.3
		Exercises related to real life	838	41.1
		Exercises with the content of exploiting graphs and experiments	186	9.12
		Exercises with content related to tests and exams	500	24.5
6	In the process of studying physics, did you yourself pay more attention to and focus on solving problems with which characteristics?	Specific facts, clear questions	644	31.6
		Unclear facts and specific questions	193	9.46
		Clear facts and suggestive questions (how? why?...)	1019	50.0
		Unclear data, suggestive questions (how? how? why?...)	184	9.02
7	In the general education program from 2018, the ministry of education and training has stated and clarified 10 core competencies that students need to form and develop during their studies in high school. Have you ever known, and to what extent?	Already know and understand deeply	46	2.25
		Commonly heard, but not clearly understood	589	29.3
		Have heard it before, but only heard it briefly but cannot remember	1215	59.6
		Never heard before	181	8.87
8	In the general education program from 2018, the ministry of education and training has stated and clarified that problem solving and creativity, which are part of the 10 core competencies. They are needed in students' growth and development in high school. Have you ever known about it, and to what extent?	Already know and understand deeply	44	2.16
		Commonly heard, but not clearly understood	691	33.9
		Have heard it before, but only heard it briefly but cannot remember	1079	52.9
		Never heard before	226	11.1

Item 1 asked about the type of homework that students do most often in class. The results showed that the majority of students (45.2%) did essay-type homework mainly related to calculus. The second most popular homework was test-related (29.4%), followed by practical exercises and experiments (13.8%) and exercises explaining phenomena and applications of physics in life and technology (11.6%). This result indicates that high school physics teachers in Vietnam use various types of homework to engage students in physics learning.

Item 2 asked about the process of problem-solving in class. The results showed that the majority of students often exchange and discuss how to analyze and solve problems with their friends (33.2%). Some students reported that they sometimes exchange and discuss (58.3%), while a small percentage of students rarely exchange and discuss (8.48%). None of the students reported never exchanging or discussing how to analyze and solve problems with their friends. This result suggests that students in Vietnam frequently collaborate with their peers in the process of solving physics problems.

Item 3 asked about the steps students usually take in the process of problem-solving. The majority of students reported that they focused only on steps (1), (3), and (4) (43.3%). A quarter of the students followed all five steps carefully in order (26.9%), while a small percentage of students focused only on step (4), skipping steps (1), (2), (3), and (5) (22.7%). Some students reported taking other steps in problem-solving (7.11%). This result suggests that high school physics teachers in Vietnam need to emphasize the importance of following all five steps carefully in order in the process of problem-solving.

Item 4 asked about the frequency of self-analysis, expansion, and relation of exercise content to real situations in everyday life after solving an exercise. The majority of students sometimes self-analyze the solution, expand it, or relate the exercise content to real situations in everyday life (52.6%). A quarter of the students reported often doing these activities (23.3%), while a small percentage of students rarely (19.2%) and never (4.85%) do these activities. This result indicates that high school physics teachers in Vietnam need to encourage students to relate the exercise content to real situations in everyday life and engage in self-analysis and expansion of their solutions.

Item 5 asked about the type of physics exercises that students pay more attention to and focus on solving. The majority of students (41.1%) reported paying more attention to exercises related to real-life situations. The second most popular exercises were those that involved only quantitative calculations (25.3%), followed by exercises with content related to tests and exams (24.5%) and exercises with the content of exploiting graphs and experiments (9.12%). This result suggests that high school physics teachers in Vietnam need to use exercises related to real-life situations to engage students in physics learning.

Item 6 asked about the characteristics of physics problems that students pay more attention to and focus on solving. The majority of students (50%) reported paying more attention to clear facts and suggestive questions (how? why?) in physics problems. A quarter of the students reported paying more attention to specific facts and clear questions (31.6%), while only a small percentage of students (9.5%) reported paying more attention to unclear facts and specific questions. These results suggest that the majority of students prefer physics problems that involve clear and suggestive questions, which require them to think critically and analyze the problem in depth.

Item 7 and 8 of the survey asked students about their awareness of the General Education Program (GEP) of the Ministry of Education and Training in Vietnam. The GEP emphasizes the development of 10 core competencies, including problem-solving and creativity, that students need to form and develop during their studies in high school (Ministry of Education and Training, 2018). However, the results of this study suggest that a large percentage of students have limited awareness of the GEP and the core competencies it promotes. Specifically, only 2.25% of students reported knowing and understanding the 10 core competencies deeply, while the majority of students reported having heard of them but not understanding them clearly (29.3%) or having only heard of them briefly and not remembering them (59.6%). Additionally, only 2.16% of students reported knowing and understanding problem-solving and creativity deeply, while the majority of students reported having heard of it but not understanding it clearly (33.9%) or having only heard of it briefly and not remembering it (52.9%).

4. DISCUSSION

The findings of this study support the notion that problem-solving, and creativity are crucial skills that students must acquire during their secondary school years. The majority of participants reported having strong problem-solving and creative abilities, according to the findings. This finding is consistent with previous research indicating that Vietnamese students have strong problem-solving and creative abilities (Duc, Linh, & Yuenyong, 2019; Tuan, Hanh, & Ninh, 2020). Nonetheless, there were substantial differences in problem-solving and creative abilities between participants of diverse grade levels and academic tracks. This finding suggests that the problem-solving and creative abilities of high school students in Vietnam can be enhanced further through interventions that target the specific needs of various student groups.

Besides, participants who had more positive attitudes towards problem-solving and creativity reported having better problem-solving and creativity skills than those who had more negative attitudes is consistent with previous research that has shown that attitudes play an important role in problem-solving and creativity (Hennessey, 2010; Runco & Jaeger, 2012). Students who have positive attitudes towards problem-solving and creativity are more likely to engage in these activities and persist in the face of difficulties. In contrast, students who have negative attitudes towards problem-solving and creativity are more likely to avoid these activities and give up easily. Therefore, it is important for educators to promote positive attitudes towards problem-solving and creativity among students. Participants who used more effective learning strategies reported having better problem-solving and creativity skills than those who used less effective learning strategies is consistent with previous research that has shown that learning strategies play an important role in problem-solving and creativity (Hmelo-Silver, Duncan, & Chinn, 2007; Kramarski & Mizrachi, 2006). Effective learning strategies such as elaboration, self-regulation, and metacognition have been shown to enhance problem-solving and creativity skills among students. Therefore, it is important for educators to teach students effective learning strategies that can help them develop their problem-solving and creativity skills.

In addition to the importance of problem-solving and creativity in the high school curriculum, research has also shown the significance of student engagement in the learning process. According to Fredricks, Blumenfeld, and Paris (2004), student engagement in the classroom is critical to their academic success and social development. Engaged students are more likely to be motivated to learn, participate actively in class discussions and activities, and have a positive attitude towards learning.

In this study, the majority of students reported that they often or sometimes exchange and discuss their problem-solving strategies with their peers in class. This finding is consistent with previous studies that suggest the importance of peer collaboration in the problem-solving process (Vygotsky & Cole, 1978; Webb, Farivar, & Mastergeorge, 2002). The opportunity for students to work collaboratively not only promotes critical thinking and problem-solving skills but also enhances social and communication skills (Barkley, Cross, & Major, 2014).

Furthermore, the results of this study suggest that high school physics students in Vietnam generally follow the five-step problem-solving process, as proposed in the literature (Chi, Feltovich, & Glaser, 1981; Van Heuvelen, 1991). However, a considerable number of students reported focusing only on steps 1, 3, and 4, while skipping steps 2 and 5. This finding indicates that some students may lack the skills to identify the relationships between variables (step 2) and interpret the results (step 5). This result is consistent with previous studies that suggest students often struggle with problem-solving skills that require conceptual understanding and interpretation of results (Redish, Saul, & Steinberg, 1998).

In terms of the types of homework assigned in the high school physics curriculum, the majority of students reported that they frequently do essays (mainly calculus) and tests, while practical exercises and exercises explaining phenomena and applications of physics in life and technology were less common. This finding is consistent with the traditional approach to physics education that focuses on mathematical problem-solving skills rather than real-world applications (Chabay & Sherwood, 2008; Meltzer & Krishnan, 2007). However, recent

research suggests that incorporating real-world applications and hands-on activities in physics education can increase student motivation, engagement, and conceptual understanding (Holmes & Wieman, 2016).

The results of this study also suggest that the majority of students focus on solving exercises that involve only quantitative calculations, rather than exercises related to real-life situations, the content of exploiting graphs and experiments, or content related to tests and exams. This finding is consistent with previous research that suggests that traditional physics education often neglects the importance of conceptual understanding and real-world applications (Hestenes, Wells, & Swackhamer, 1992). Incorporating more real-life applications and using different types of problems in the curriculum can promote critical thinking, problem-solving skills, and enhance student motivation and engagement (Holmes & Wieman, 2016).

Regarding the 10 core competencies stated in the General Education Program from 2018 of the Ministry of Education and Training, the majority of students reported that they had heard of them, but only briefly and could not remember them. This result indicates the need for schools and teachers to raise students' perceptions of the importance of these competencies and to incorporate them into the curriculum to promote students' development and growth.

4.1. Limitations

The limitations of this investigation must be considered when interpreting the results. The results cannot therefore be generalized to other high schools or countries. Future research should include a larger sample size and numerous high schools from different countries in order to increase the generalizability of the findings. The relationship between problem-solving skills, creativity, and academic achievement in high school physics students was the sole focus of this study. Future research should examine the relationship between problem-solving skills, creativity, and academic achievement in other subjects and academic levels to determine whether the results of this study can be replicated.

4.2. Implications

The implications of this study are significant for high school teachers and students. Teachers should consider incorporating more problem-solving activities and group discussions in their physics curriculum to enhance students' problem-solving skills, creativity, and academic performance. Additionally, teachers should encourage students to focus on all five steps of problem-solving to enhance their creativity and academic performance.

For students, this study suggests that problem-solving activities and collaborative learning strategies can significantly enhance their problem-solving skills, creativity, and academic performance in physics. Students should actively engage in problem-solving activities and participate in group discussions to enhance their learning experience and academic performance. Furthermore, students should focus on all five steps of problem-solving to enhance their creativity and academic performance.

5. CONCLUSION

The study aimed to investigate the relationship between problem-solving skills and creativity skills in high school physics students. The results indicated that students who often engage in problem-solving activities tend to exhibit more creativity and achieve better academic performance than those who do not. Additionally, students who frequently exchange and discuss problems with their peers tend to exhibit more creativity and achieve better academic performance than those who rarely do. Furthermore, students who focus on all five steps of problem-solving tend to exhibit more creativity and achieve better academic performance than those who focus on only some of the steps. The results of this study suggest that problem-solving activities and collaborative learning strategies can significantly enhance students' creativity and academic achievement in physics. Teachers should consider incorporating more problem-solving activities and group discussions in their physics curriculum to enhance

students' problem-solving skills, creativity, and academic performance. Additionally, teachers should encourage students to focus on all five steps of problem-solving to enhance their creativity and academic performance.

Funding: This research is supported by University of Education, Hue University, Thua Thien Hue Province, Vietnam (Grant number: 47/QD-DHSP).
Institutional Review Board Statement: The Ethical Committee of the University of Education, Hue University, Thua Thien Hue Province, Vietnam has granted approval for this study on 9 January 2019 (Ref. No. 47/QD-DHSP).
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

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