IMPROVING EMPIRICAL COMPETENCE FOR STUDENTS IN HIGH SCHOOL IN VIETNAM

Pham Thi Huong[1] *, Pham Nhu Quynh[2]

[1] *Center For Digital Learning, Vinh University Cyber School, Vinh University, Vietnam*

[2] *Biology Department, College of Education, Vinh University, Vietnam*

ARTICLE INFORMATION

Journal: *Vinh University Journal of Sciences*

ISSN: *1859-2228*

Volume: 52

Issue: 1B

Corespondance:

phamhuongdhv@gmail.com

Received: *28 October 2022*

Accepted: *06 December 2023*

Published: *20 March 2023*

Citation:

Pham Thi Huong, Pham Nhu Quynh (2023). Improving empirical competence for students in high school in Vietnam. ***Vinh Uni. J. Sci.*** *Vol. 52 (1B), pp. 51-60*

doi: 10.56824/vujs.2022ed19

ABSTRACT

Improving experimental competence for students is an essential mission in general education nowadays, helping students initially establish scientific research capacity and is a part of cognitive capacity of scientific knowledge, especially in the study of natural sciences such as biology, physics and chemistry. In this article, theoretical and practical research methods have been used in combination with pedagogical experiment on 85 students, of which 43 students and control over 42 tenth grade students at a high school in Vietnam. The data processed by SPSS 20.0 software shows that using empirical exercises in teaching will significantly improve the students' experimental competence. The level of students' experimental capacity increased in the experimental class compared to the control class, the results before and after the experiment of the experimental class also changed positively. The initial research result indicates the role of empirical exercises in enhancing the experimental capacity of students, the study also suggested the process of using experimental exercises in teaching to improve students' experimental capacity. The findings of the research could be important in proposing solutions to improve the academic performance of students in high schools, not only in the area of teaching biology but also extending into other subjects.

Keywords: Experimental competence; experimental exercises; high school students; Vietnam.

1. Introduction

These days, we are witnessing the world changing profoundly in every aspect. The third and fourth industrial revolutions followed successively, the thriving knowledge economy has brought tremendous development opportunities, and also posed considerable challenges for each country. In order to ensure sustainable development, many countries have constantly innovated their education to improve the quality of human resources, equip future generations with a strong cultural foundation and high adaptive capacity against all variations of nature and society. Educational innovation has become an urgent need and a global trend. In this context, Vietnam has renovated the general education program to create a fundamental and comprehensive change in the quality and effectiveness of general education, contributing to the divert of

education from knowledge transfer to a comprehensive development education, both in terms of quality and competence, ultimately boosting the potential of each student (Vietnam Ministry of Education and Training, General Education Program, Overall Program, Circular No.32, Promulgation of general education program. 2018 , pp. 3-7).

Practicing theoretical or experimental exercises gives students the opportunity to deepen their knowledge and practice the skills related to the content of the lessons introduced to students earlier (Robert J. Marzano, 2011). In teaching ecology, author Bethanie Carney Almrot gave laboratory assignments with different descriptions of toxicological ecology, based on specific learning objectives. The interviews showed that students' participation in the natural science research includes the following activities: proposing hypotheses, identifying appropriate variables, collecting and analyzing data, presenting conclusions both in written and oral forms, are preferred and more successful. Students can also gain a deeper understanding of the mechanics of materials and object specificity, which is primarily based on the design of descriptive experiments (Bethanie Carney Almrot, 2015).

In particular, according to Nico Schreiber and partners, empirical competence is a part of scientific capacity, which plays a role in acquiring knowledge (Schreiber, N., Theyssen, H. and Schecker., 2009). Teaching through experimentation will maintain better knowledge and awareness for students, significantly improve the ability to answer questions at a higher level, increase the flow of knowledge over time and enhance students' learning interest (Dresner et al., 2014). Experimental competence is also the basis for forming professional competence (Bakytzhan A. Kurbanbekov et al., 2016).

The general education program and biology curriculum, specified in Circular No.32, 2018 of Vietnam, identify that after studying biology, Vietnamese high school students must have the ability to learn the natural world, namely:

- Propose problems related to the living world
- Make judgments and formulate hypotheses
- Create implementation plan
- Implement the plan
- Write, present reports and discuss (Vietnam Ministry of Education and Training, General Education Program, Overall Program, Circular No.32, Promulgation of general education program, 2018, 3-7).

The experimental competence of high school students includes three components, according to Nico Schreiber and partners:

- Planning: If an unknown phenomenon is discovered, researchers will first develop questions that allow more precise clarification or more relation to reality.
- Implementing: Designing a plan, putting forward the expected steps and following the given steps.
- Evaluation: After the implementation, the results of the study must be shown with tables, analyzed, evaluated and explained (Schreiber, N., Theyssen, H. and Schecker., 2009).

Hammann (2004) proposed a model of competence development, in which the experimental process consists of three components: hypothetical research, experimental research and data analysis (Hammann, M., 2004). Hammann classified levels of experimental competence into four levels from low to high as shown in Table 1.

Table 1: *Experimental competence levels (Hammann, M., 2004)*

	Level 1	**Level 2**	**Level 3**	**Level 4**
Hypothetical research	Experiments without hypothesis	Experiments with nonsystematic hypothesis	Experiements with systematic hypothesis	Experments with systematic hypothesis and successful review of hypothesis
Experimental research	Use nonsystematic change factors	Partially use systematic change factors	Use systematic change factors in familiar fields	Use systematic change factors in both familiar and unfamiliar fields
Data analysis	Data is not related to hypothesis	Data analysis is not logical	Data analysis is almost logical	Data analysis is logical

In present study, the experimental competence of high school students is defined as the ability to apply knowledge, skills and attitudes to formulate empirical hypotheses; design experimental plans; conduct experiments and collect results or analyze experimental data.

Based on the expermental competence structure of Hammann, 2004 and Schreiber, N., Theyssen, H. and Schecker., 2009, in this research, the structure of an experimental capacity is presented including four components, shown in Figure 1.

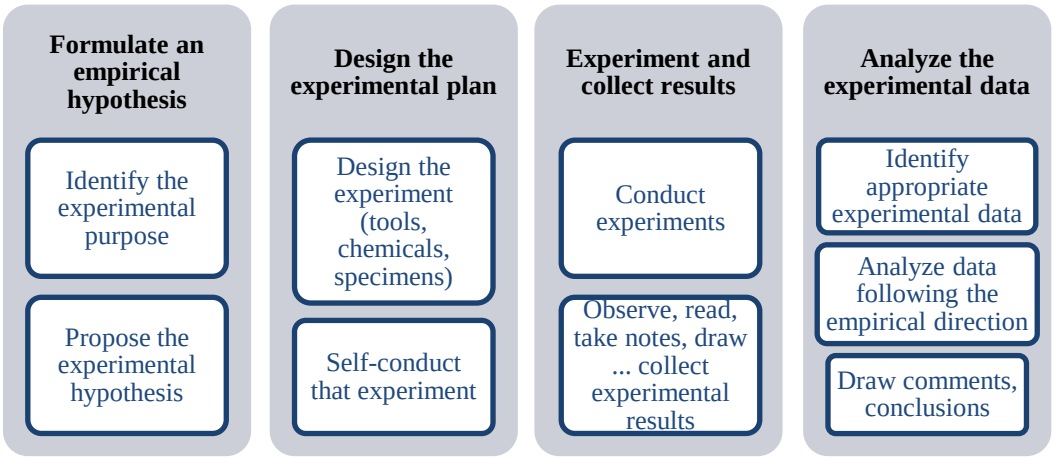


Figure 1: *Experimental competence structure*

So far, experiments have been commonly used in natural sciences to investigate the nature of things and phenomena. The trend of modern teaching considers knowledge of activity method as a basic, important type of knowledge, which is tool knowledge. The best way to study empirical sciences is to use the same scientific cognitive method to organize activities for learners to explore, research and self-gain knowledge. Therefore, in teaching experimental sciences such as biology, using experiments is a crucial visual means to effectively visualize, illustrate and consolidate knowledge.

Students' experimental competence is formed through subjects in the general education curriculum. There are various ways to improve the students' experimental capacity. In this study, the corresponding empirical exercise system has been applied to improve the experimental competence for 43 high school tenth graders in teaching biology.

2. Research methodology

In this study, the following methods have been used:

- Theoretical analysis of research subjects and issues by studying of official documents, pedagogical works and methods of domestic and foreign authors;
- Compare and analyze comparatively, synthesize, systematize and classify documents on the research issues;
- Experimental method: supervise, organize and conduct pedagogical experiments on 85 students, regardless of gender and qualification, which are divided into 2 groups: (1) The experimental group, consisting of 43 students in class 10A1, has been learning a specific content in a strict procedure during the school year through a system of experimental exercises; (2) The control group, consisting of 42 students in class 10A2, was taught the same content as the experimental group but according to the traditional method.
- Pedagogical experimental data were analyzed and processed using SPSS 20 software.

2.1. The basis of experimental research

85 Grade 10 students were selected, consisting of 45 female and 40 male from a high school in a North Central Province of Vietnam, which has a tradition of studiousness but has difficult economic conditions and the harshest climate in Vietnam.

2.2. Research stages

The research took place in 24 months, divided into 4 phases as follows:

a. Phase 1 (October 2017 - March 2018): Theoretical researched and analyzed, identified research objectives and missions, developed a research framework, conducted field surveys, prepared materials, selected experimental subjects.

b. Phase 2 (March 2018 - August 2018): During this phase, the experimental plan is determined, the experimental procedure was developed, the system of exercises used in teaching to improve experimental capacity was designed together with a set of tools to evaluate pedagogical experimental results. Four types of empirical exercises had been proposed that ensured the principles: Experimental assignments are designed as learning activities for students; integrate students' knowledge, skills, and attitudes during the experiment; ensure sustainability and development; ensure systematic and practical relevance (Truong Xuan Canh, 2015).

c. Phase 3 (September 2018 - May 2019): This is the stage of pedagogical experimentation, in which the teacher conducted experimental teaching for 43 students of class 10A1. The results obtained after the experiment are presented by the teacher, at the same time clarifying the results, analyzing the causes leading to those results. This phase takes place over a period of 9 months, equivalent to a school year of high school students in Vietnam. In a course of 9 months, students experience a wide range of subjects, many

of which focus on improving students' experimental capacity, especially natural sciences such as Physics, Chemistry, Biology. It should also be noted that students' experimental competence can be formed at primary and secondary school levels but to a lesser extent, because the educational goal of Vietnam is to improve practical and experimental capacity right at the primary level (Vietnam Ministry of Education and Training, General Education Program, 2018 , pp. 3-7). Therefore, the students' experimental ability may have appeared before the experiment. Students' experimental capacity is determined to include 4 component competencies: (1) Forming empirical hypotheses; (2) designing experimental plans; (3) experimenting and collecting results; (4) experimental data analysis. Each of the above-mentioned component competencies is determined by the criteria and is evaluated for corresponding points. There are 3 rating levels with corresponding scores: low (level 1: 1 point); average (level 2: 3 points) and high (level 3: 5 points), which are detailed in Table 2.

Table 2: *Criteria for evaluating students' experimental competence*

	Level 3 (5 points)	**Level 2 (3 points)**	**Level 1 (1 point)**
Develop an empirical hypothesis	Identify the empirical hypothesis from a given scientific problem	Identify the empirical hypothesis from the given experimental plan	No hypothesis is identified, or hypothesis is not related to the experiment
Design the experimental plan	Design experimental plans on the basis of given materials necessary to conduct or self-propose materials and design experimental plans on the basis of experimental hypothesis	Analyze experimental plan to identify the objects, materials ...	No experimental design or design unrelated to the experiment
Experiment and collect results	Conduct experimental steps with skillful and complex manipulations; identify reasonable contents and methods to observe, record and collect results	Conduct experiments according to given procedure; observe, record, collect results according to given request	Not conducting the experiments properly / conducting the experiments but do not know how to collect results
Analyze experimental data	Process, present, analyze results in complex form to draw scientific conclusions (Experimental results are the impact of two or more factors)	Process, present and examine results in simple form to draw scientific conclusions (experimental results are the impact of one factor)	No analysis or inaccurate analysis of the results

d. Phase 4 (June 2019 - October 2019): Conduct the experimental process, analyze, interprete, systematize and generalize findings, presented and clarified the obtained results.

3. Results and discussion

After a 9-month course, students' level of empirical competence demonstrated significant improvement, reflected in the results before and after the experiment. Before conducting the experiment, the experimental capacity of the students in the control and experimental classes was preliminarily assessed, serving as a basis for comparison with the experimental results. The results show that the experimental ability of students in both classes is at the average level (level 2) predominates, in which experimental class from 61.9% (%) to 69.05%, control class from 34.88% to 65.12%, shown in Figure 2. The rate of achieving high level (level 3) in both classes was very low, below 5%, specifically the control class was from 4.65% to 6.98%, the experimental class was 4.76.

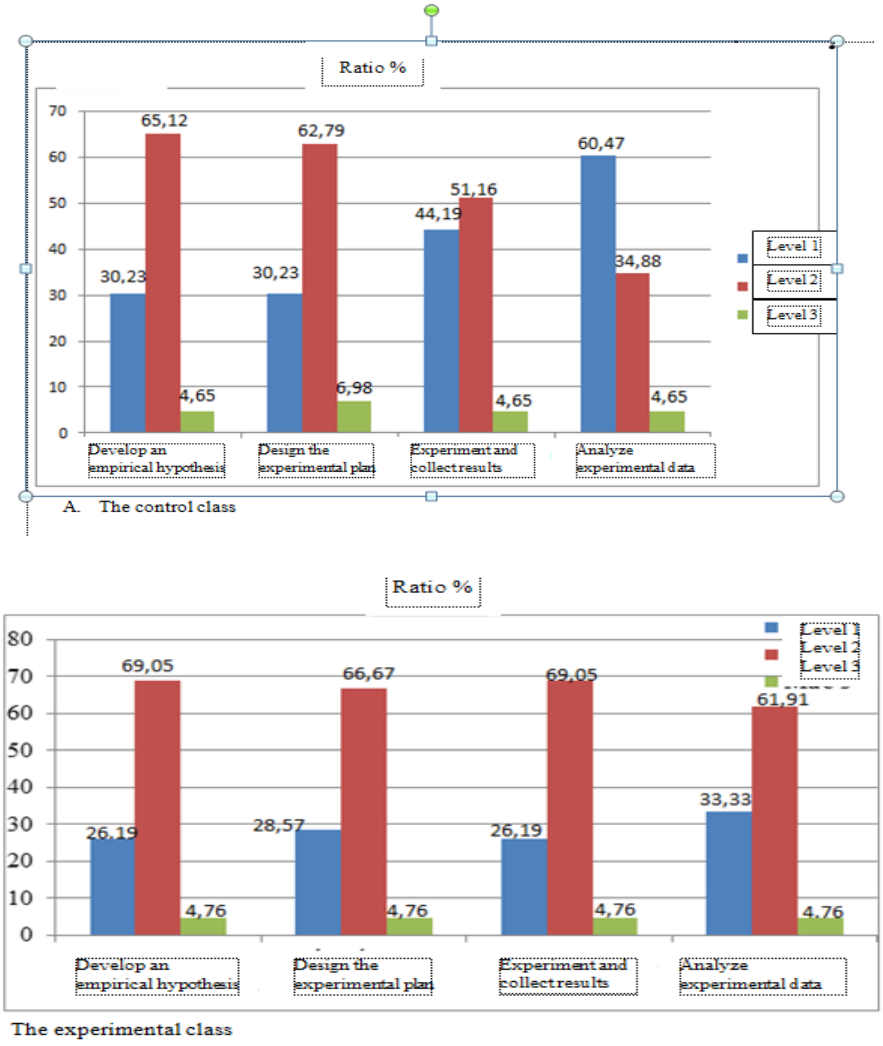
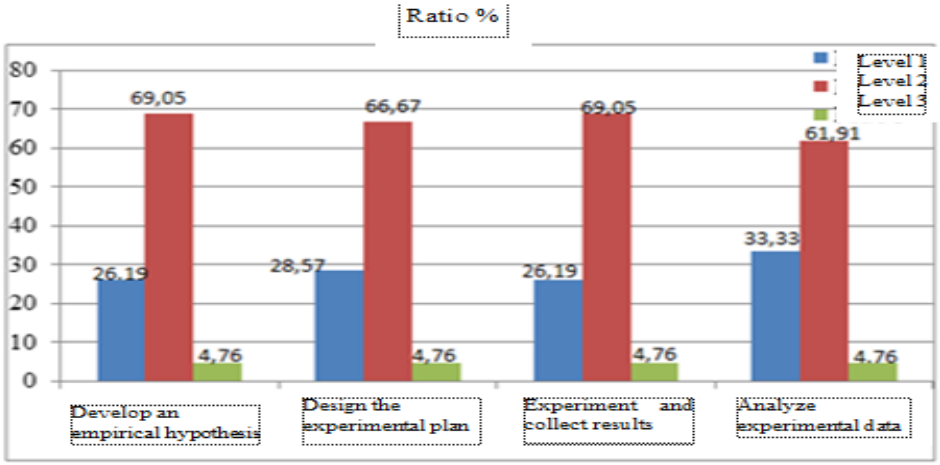


Fig. 2: *Experimental competence levels of students (%)*

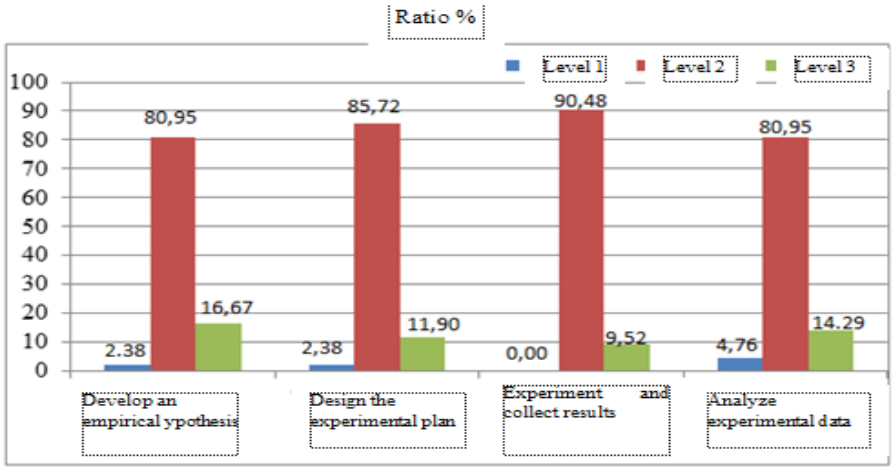
After the experiment, through exercises and experimental evaluation sheets, the components of experimental capacity are evaluated. Collected data were evaluated using SPSS20 software, the results indicate that the average score of the experimental class is much higher than that of the control class, specifically, the average score is 12.9 for the experimental class, compared to 9.7 for the control class. On the other hand, when comparing the results of the experimental class before and after the experiment, there is a difference in the experimental ability of students, specifically:

- Before the pedagogical experiment, the average score was 10.0952.
- After the pedagogical experiment, the average score is 12.9048.

The comparison chart of achieving the criteria of the experimental class before and after the pedagogical experiment is shown in Figure 3.



A. Before the experiment



B. After the experiment

Fig. 3: *Experimental competence of students in the experimental class before and after pedagogical experiment*

As shown in Figure 3, the percentage of students reaching level 2 and level 3 increased markedly after the experiment, the majority of students achieved level 2 or higher. The rate of students reaching level 1 decreased significantly, from 4.6% to 2.38%. The rate of students reaching level 2 increased from 61.91% - 69.05% to 80.95% - 90.48%. This is a very positive sign.

In addition to evaluating students' experimental capacity in the experimental and control classes as above, at the end of the course (after finishing the pedagogical experiment), a test of biological knowledge has been carried out, which consisted of 25 multiple-choice questions in 45 minutes. A comparison between two classes is shown in Figure 4.

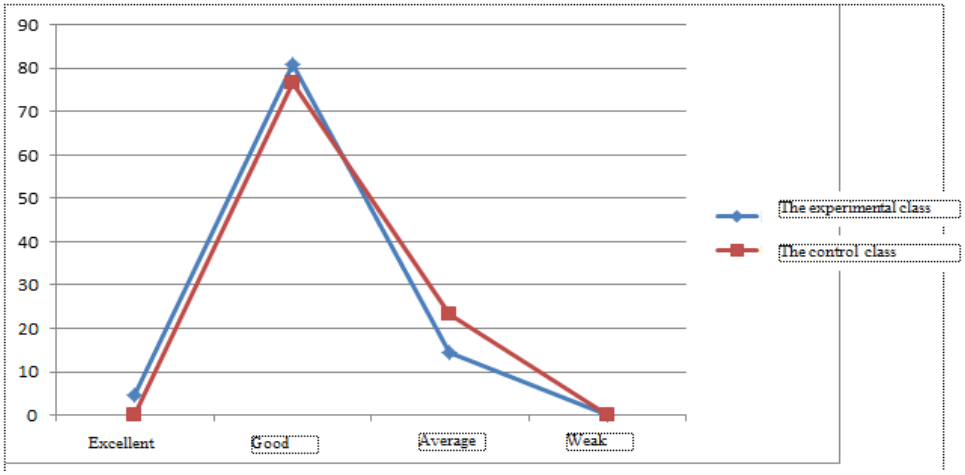


Fig. 4: *Comparison of students in the control and experimental classes after finishing the pedagogical experiment*

Figure 4 shows that the learning outcomes of students are different. Specifically, the experimental class had 2 students with excellent scores (accounting for 4.76%), while the control class had no excellent students. For students with average results, the control class had 10 students (reaching the rate of 23.26%), while the experimental class achieved lower, 8.97%. Thus, the level of knowledge sustainability in the experimental class is much higher than that in the control class.

Through the evaluation of pedagogical experimental results for the purpose of improving students' experimental capacity, the final learning results demonstrate that students have made remarkable progress in learning results and experimental capacity. It proves that students acquire good knowledge, gradually form and develop experimental capacity, represented in higher results in the experimental class compared with the control class.

4. Conclusion

Using experimental exercises in teaching not only supports students to improve their experimental capacity, which is specified in Circular 32 issued in 2018 on the quality and ability of high school students, but also the competencies required for students to enter university or work in different occupations after high school. Experimental exercises also

promote the ability to receive scientific knowledge, stimulate students to interact more with teachers and group members when performing assigned tasks, contributing to innovating teaching methods towards active student's activity. There are many measures to improve students' experimental capacity. Among them, pedagogical experimentation in teaching is an effective approach, which is proven through research results.

Contribution/Originality: The main objective of the article is to understand students' experimental capacity, the usage of experimental exercises to improve the experimental competence for high school students. Thereby encouraging and suggesting for teachers how to use empirical exercises to improve this competence for students.

REFERENCES

Dresner, M., De Rivera, C., Fuccillo, K. K., and Chang, H. (2014). Improving higher-order thinking and knowledge retention in environmental science teaching. *BioScience*, 64(1), pp. 40-48.

Bakytzhan A. Kurbanbekova, Torebai A. Turmambekova, Usen A. Baizaka , Pulat A. Saidakhmetova, Rakhymzhan T. Abdraimova, Aigerim E. Bekayevaa, and Kuldarkhan O. Orazbayevab (2016). Students' Experimental Research Competences in the Study of Physics. *International journal of environmental and science education*, vol. 11, no. 18, 13069-13078.

Hammann, M. (2004). *Kompetenzentwicklungsmodelle: Merkmale und ihre Bedeutung dargestellt anhand von Kompetenzen beim Experimentieren*. MNU 57/4, 196-203.

Bethanie Carney Almrot (2015). *The importance of laboratory exercises in biology teaching; case study in an ecotoxicology course*. Institution for Biological and Environmental Sciences, Box 463, University of Gothenburg.

Vietnam Ministry of Education and Training (2018). *General Education Program, Overall Program.* Circular No. 32, Promulgation of general education program, pp. 3-7.

Truong Xuan Canh (2015). *Designing and using exercises to develop experimental competence for students in teaching Plant Biology - Biology grade 11 High school*. Doctoral Dissertation for Education Sciences, Hanoi National University of Education.

TÓM TẮT

NÂNG CAO NĂNG LỰC THỰC NGHIỆM CHO HỌC SINH TRUNG HỌC PHỔ THÔNG Ở VIỆT NAM

Phạm Thị Hương[1], Phạm Như Quỳnh[2]
[1] Trung tâm Quản lý và Phát triển học liệu số, Viện Nghiên cứu và Đào tạo trực tuyến, Trường Đại học Vinh, Việt Nam
[2] Khoa Sinh, Trường Sư phạm, Trường Đại học Vinh, Việt Nam
Ngày nhận bài 28/10/2022, ngày nhận đăng 06/12/2022

Nâng cao năng lực thực nghiệm cho học sinh là nhiệm vụ cần thiết trong giáo dục phổ thông hiện nay, giúp học sinh bước đầu hình thành năng lực nghiên cứu khoa học và là một bộ phận của năng lực nhận thức khoa học, nhất là trong học tập các môn khoa học tự nhiên như sinh học, vật lý, hóa học. Trong bài báo này, các phương pháp nghiên cứu lý luận và thực tiễn đã được sử dụng kết hợp với thực nghiệm sư phạm trên 85 học sinh lớp 10, trong đó có 43 học sinh lớp thực nghiệm và 42 học sinh lớp đối chứng tại một trường trung học phổ thông ở Việt Nam. Kết quả cho thấy việc sử dụng bài tập thực nghiệm trong dạy học đã nâng cao rõ rệt năng lực thực nghiệm của học sinh. Mức độ năng lực thực nghiệm của học sinh ở lớp thực nghiệm tăng lên so với lớp đối chứng, kết quả trước và sau thực nghiệm sư phạm của lớp thực nghiệm cũng chuyển biến tích cực. Kết quả nghiên cứu bước đầu chỉ ra vai trò của bài tập thực nghiệm và đề xuất xuất quy trình sử dụng bài tập thực nghiệm trong dạy học nhằm nâng cao năng lực thực nghiệm của học sinh.

Từ khóa: Năng lực thực nghiệm; bài tập thực nghiệm; học sinh trung học phổ thông; Việt Nam.