

**HUE UNIVERSITY
UNIVERSITY OF EDUCATION**



LE MINH DUC

**DEVELOP THE RESOLVE SITUATION SKILL IN
TEACHING BIOLOGY EXPERIMENTAL
PRATICAL LESSONS IN HIGH SCHOOL FOR
PEDAGOGICAL STUDENTS**

Major: Theory and methodology of teaching biology

Code: 9140111

**SUMMARY OF THE DOCTORAL DISSERTATION ON
EDUCATIONAL STUDIES**

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Advisor (s):

- 1. Assoc. Prof. Dr. Phan Duc Duy**
- 2. Dr. Vu Dinh Luan**

Review 1:

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HEADING

1. Reason for choosing this topic:

❖ *From the mission to innovate biology teaching methods at high school.*

Time to practice experiment for student is increased more than the current program and is more noticed in the Biology of the general education program in 2018.

❖ *From the mission to innovate the program, methods of training for high school teachers*

The innovation of training programs and contents for teacher at pedagogical schools in order to create a team of teachers with full quality, capacity and professional qualifications to fulfill the innovation requirements is extremely important. However, the training for pedagogical students in problem-solving ability in teaching PE has not yet been given due attention.

❖ *From actual situation of Biology practical experiments teaching at High school*

The current high school teachers still have many difficulties and confusions in creating, organizing their PE classes, especially when solving problems arising in their Biology PE classes, which affects their teaching quality.

2. Research target

The research aims to identify situations in teaching biology practice experiment at high school; identify structure of problem-solving ability to build process of training student skill to resolve situations in teaching biology practice experiment at high school; aim to improve the training quality of Biology teachers at pedagogical universities nowadays.

3. Scientific theory

If we can identify situations in teaching biology practice experiment as well as structure of problem-solving ability and process, methods to train student problem-solving ability in teaching biology practice experiment at high school, we can build up problem-solving ability during process of teaching biology practice experiment and improve the teaching quality in biology.

4. Research subject and object

4.1. Research subject

Problem-solving ability in teaching biology practice experiment; the process of training student problem-solving ability in teaching biology practice experiment at high school; criteria and tools to evaluate problem-solving ability in teaching biology practice experiment.

4.2. Research object

The process of training teaching skill for students in pedagogical universities.

5. Research task

- Research theoretical basement to train student problem-solving ability in teaching practice experiment in pedagogical universities.

- Research difficulties in teaching biology practice experiment at high school and actual situation of training student problem-solving ability in teaching biology practice experiment in pedagogical universities and make it practical basis of developing process of training student these skills.

- Research situations which high school teachers and students in pedagogical universities regularly face to during process of teaching biology practice experiment.

- Design structure of problem-solving skill in teaching biology practice experiment in order to make it basis to identify target, content, training tools and evaluate student's training result.

- Create pedagogically situations which are regularly faced to in teaching biology PE into exercise to make it a tool in order to train student problem-solving ability in teaching biology practice experiment at high school.

- Research and propose procedures to train student problem-solving ability in teaching biology practice experiment at high school.

- Research and propose criteria, assessment ruler, assessment levels of the achievement of students' problem-solving ability in Biology PE teaching at high school.

- Implementing pedagogical experiments in order to confirm the possibility of the proposed scientific hypothesis.

6. Research methods

Theoretical research method; Investigation method; Professional method; pedagogical experiment; Methods of data processing by mathematical statistics; Using SPSS 18.0 software to process survey data and pedagogical experiments.

7. Research scope

Research on the current situation of training problem-solving ability in Biology PE teaching at high school of pedagogical students and conduct experiments at 2 universities: Ho Chi Minh City university of education and Sai Gon university.

8. Latest contributions of this subject

8.1. Identify actual situation of training problem-solving ability in Biology PE teaching at high school of pedagogical universities nowadays.

8.2. Identify situation which teachers face to in teaching biology PE at high school.

8.3. Design structure problem-solving ability in biology PE teaching.

8.4. Propose the procedure and tools to train problem-solving ability in biology PE teaching at high school.

8.5. Create pedagogically situations which are regularly faced to in teaching biology PE into exercise to make it a tool in order to train student problem-solving ability in teaching biology practice experiment at high school.

8.6. Create criteria to evaluate problem-solving ability in teaching biology practice experiment at high school.

9. Thesis structure

Beside the heading, conclusion, comments and research result, this thesis is divided into 3 chapters:

Chapter 1: Theoretical and practical basis of the topic

Chapter 2: Develop the problem-solving ability for students in biology practical experiments teaching at high school

Chapter 3: Pedagogical experiments.

RESEARCH CONTENTS AND RESULT

CHAPTER 1: THEORETICAL AND PRACTICAL BASIS

1.1. RESEARCH OVERALL

1.1.1. Overview of research and problem-solving ability in teaching

1.1.1.1. In the world

There are cases studied by many psychologists, such as K. Dunker, X.L. Rubinstein, A.M. Machiuskin, I. Ia. Lecne under the perspective of critical thinking. In the other hand, some authors, such as R.J. Sternberg, J.R. Hayes, J.D. Bransford, B.S. Stein, J.E. Pretz, A.J. Naples, R. Taconis (2000)... studied and analyzed them under the perspective of practical activities; or using such cases as positive methods of training. The case studies nowadays mainly refer to actual situations and problem-solving ability in life; in communication; in training; in education in general. After studying, we found that, the research and formation for pedagogical students of problem-solving ability in Biology PE teaching is still very little and has not been properly concerned.

1.1.1.2. In Vietnam

Current case studies in Vietnam mainly focus on situations in communication and in casual life. In Education, cases and problem-solving ability refer to cases arising in class management; in teaching; developing problem-solving ability for students proposed by some authors, such as: Nguyen Quang Uan, Tran Huu Luyen, Tran Quoc Thanh, Bui Van Hue, Tran Trong Thuy; La Van Men, Phan The Sung, Luu Xuan Moi, Luc Thi Nga, Nguyen Trai, Bui Thi Mui, Nguyen Thi Thuy Dung.

1.1.2. Overall of research on practical experiments teaching

1.1.2.1. In the world

Since the early 1920s, many case studies were made in order to find the optimal method in experimental teaching by educators such as: Cunningham (1924), Anibal (1926), Barnard (1942), Mason (1952), Soar (1966), Campbell (1968), Reuss (1970). The fact shows that, despite a lot of attention and research, the organization of experimental activities in schools always faces subjective and objective difficulties.

1.1.2.2. In Vietnam

The current research directions often focus on developing the content and practice process of Biology at high schools; improving experiments. Some works on improving experiment at high schools were also conducted by other authors such as: Mai Thi Thanh (2005); Nguyen Thi Thang (2006); Cao Thi Minh Tu (2007); Nguyen Thi Cuc (2009); Hoang Viet Cuong (2009); Do Thanh Trung (2012); Dang Thi Ngoc Thanh, Le Minh Duc (2013), ...; [32]. PE teaching at some schools nowadays shows that the goal of "teaching students how to do experiments" is more common than "teaching students how to teach how to do experiments".

1.2. THEORETICAL BASIS

1.2.1. Practical experiments

1.2.1.1. Practice

Practice means a teaching method which helps students to apply the knowledge they have learnt to implement experiments; identify samples or perform technical procedures.

1.2.1.2. Experiments

Experiment means creating a phenomenon, a change in certain conditions in order to find out, study, test or prove.

1.2.1.3. Practical experiment

Practical experiment means the arrangement of teacher for students to implement experiment in order to help learners to study on the nature of phenomena, processes and orders of Biology.

1.2.2. Practical experiment teaching

1.2.2.1 Occupational competency framework for undergraduate of Pedagogical University

The current professional competency standards of pedagogical students have been designed very fully, specifically, clearly. Although there are some differences in some criteria, they have approached the standards according to the general standards of the world as well as in line with the actual situation of professional standards for high school teachers in Vietnam [45]. This is the basis for pedagogical universities to develop corresponding output standards for pedagogical training disciplines, orienting the design of training program frameworks of majors in the training process. The

above competency framework is also the basis in developing capacity for pedagogical teachers, orienting to develop competency standards for pedagogical teachers and creating training activities for teachers under such competency standard.

1.2.2.2 The importance of PE teaching in Occupational competency framework for undergraduate of Pedagogical University

PE teaching is an important feature for Biology teacher, a part of developing lessons plans; organizing classes for students. In order to organize effectively and vividly the practical experiments, Biology teachers need to meet the necessary teaching competencies, such as: developing lesson plans; organizing learning activities; ability to apply methods and means.

1.2.2.3 Process of organizing PE teaching

The process of organizing PE teaching in practice is currently divided into the following steps:

- Step 1: Determine the target and content of the PE
- Step 2: Prepare necessary conditions for PE teaching
- Step 3: Develop lessons contents of PE teaching
- Step 4: Conclude the knowledge needed to be formed for students and draw experience (if any).
- Step 5: Guide students in cleaning and tidying up the laboratory.

1.2.3. Ability of teaching biology practice

Ability of teaching biology practice is the ability to instruct, organize learners to affect “alive” object (observation actions, doing experiment) following a certain process in order to complete study task well.

1.2.4. Situation and situation in Biology practical experiments teaching

1.2.4.1 Definition of situation

Situation in teaching is a situation with some problems which creates psychological contradictions for learners that makes them concern, research in order to rationally solve such problems in order to achieve optimal learning results.

1.2.4.2 Classification of situation in teaching

Based on implementation process, teaching mission, it can be classified as follows: situation in teaching knowledge; situation in teaching skills; situation in teaching consciousness, attitude, habit; situation attached with training skills to apply knowledge in practice.

1.2.5. Problem-solving skill in teaching

1.2.5.1. Definition of skill and teaching skill

Teaching skill is ability to implement teaching activities with high quality. A teacher's teaching skill is created during training process and is stimulated and developed during pedagogical process. To biology teachers, there's close attachment between teaching theory and practical content.

1.2.5.2. Problem-solving skill in teaching

Problem-solving skill in biology PE teaching is ability to apply available knowledge, experience to solve effectively obstacle which occur during process of preparation, teaching experiment at high school.

1.3. PRACTICAL BASIS

1.3.1. Actual situation of situation in teaching Biology practical experiments at high school

We have conducted a survey of difficult situations which teachers have encountered in teaching Biology PE with 174 Biology teachers who are teaching at high schools in localities such as: Hanoi; City. Ho Chi Minh City; Nghe An; Hue; Danang; Ninh Thuan; Binh Thuan; Dong Nai; Tay Ninh; Ben Tre; Dong Thap; Can Tho.

The survey results showed that, the unsuccessful experiments include the following groups of situations: 1. The implementation duration is not enough for the requirements of the experiment; 2. Lack of chemicals, equipment, tools or such tools are damaged; 3. The teacher successfully performed the experiment; 4. Teachers have difficulty in guiding students to analyze and evaluate experimental results. Situations related to laboratory safety and equipment to ensure safety in PE teaching have not been suggested and given due attention by teachers, with 25.2% of teachers said that, they were not trained to solve incidents when spilling chemicals; 30% of them have no experience in preserving chemicals to ensure safety in laboratory.

Also, according to the statistics, up to 14.9% of the teacher consider themselves lack of confident to successfully perform all of the experiments in thigh school biology program.

1.3.2. Actual situation of the problem-solving ability in biology practical experiments teaching of the undergraduates of pedagogical universities

1.3.2.1. Actual situation of the problem-solving ability in Biology practical experiments teaching of the undergraduates of pedagogical universities

We conducted surveys with 126 students studying the 3rd and 4th year at Hue University of Education; Da Nang University of Education; HCMC University of Education; Saigon University. The survey results show that in general, almost students who are questioned are still bad at problem-solving skill in biology practice experiment, especially in component skills such as: identify target, propose project and explain chosen project to solve situation; especially re-examine chosen project. Therefore, during training graduate student of pedagogical biology major, increasing to train student problem-solving skill in biology practice experiment is very necessary, devote to raise teaching quality in biology practice experiment teaching as well as teaching quality in biology in general.

1.3.2.2. Actual situation of students' PE teaching practice in Biology in the course Theory and teaching methods at pedagogical universities

The study conducted to find out the current duration and content for developing PE teaching skills for students in Biology at 5 schools including: Hanoi National University of Education; HCM city University of Education; Hue University of Education; Da Nang University of Education; Saigon University. We found that the training duration for students in PE teaching skills starts from the 3rd and the 4th year in university, focus on biology teaching theory module (the overview part); biology teaching method and practice pedagogical professional competence within very limited duration. Therefore, we found that it's difficult to train student teaching biology PE skill sufficiently as well as problem-solving skill in teaching biology PE the most sufficient.

CHAPTER 2: DEVELOPING THE PROBLEM-SOLVING ABILITY IN BIOLOGY PE TEACHING AT HIGH SCHOOL

2.1. Analysis of the practical experiments structure in Biology program at High school

2.1.1. Analysis of the practical experiments structure in the current Biology program at high school

In the current Biology program at the high school, there are 16 PE lessons, accounting for 12.4% of the total 129 lessons, including 14 experiments, and the remaining lessons as sample, films, pictures and specimen observation exercises. Thus, the practice duration specified in the program and the textbook is relatively limited, and on the other hand, most of such exercises arranged at the end of the chapter are only for reinforcing and illustrating the theoretical knowledge they have learned.

2.1.2. Analysis of the Biology practical experiments program at pedagogical universities

The topic analyzed in detail the outlines of practical subjects (internships) in the bachelor's program in Biology Pedagogy at 04 schools: Hanoi National University of Education, Hue University of Education, and HCM City University of Education, Saigon University. After studying and analyzing the practical program of basic subjects, the PE courses in basic subjects have fully equipped students with specialized knowledge of Biology.

2.2 Situation in biology practical experiments teaching at high school

Based on the order of organizing Biology PE lesson at high school, we have classified and systematized the situations that can appear during the PE teaching. During PE teaching, there are many kind of situation that may happen, more or less depending on each specific experiment. After research, we have identified 45 situations that might happen and separate into the following groups: laboratory safety situation; situation when creating, conducting experiments; situations when teaching experiments; situation when conducting experiment improvement.

❖ **Situation 1:**

The DNA extraction progress according to the current official textbook does not specify the stage of identifying whether the white precipitate obtained after this process is DNA or not. How can we confirm it is indeed DNA but not other matter of the cell? This problem makes it difficult for both teachers and students to analysis and prove their experimental results.

Solution: Using the method of Diphenylamine reaction with DNA to identify DNA. The reagent is a solution of 0.5% diphenylamine in Concentrated sulfuric acid. Using a needle or bamboo stick to gently pick up the white precipitate and put it in a test tube containing 10ml diphenylamine, then put in a water bath in 10 minutes, if the result appears as a blue color, it means such precipitate is DNA. DNA reacts with diphenylamine based on the conversion of deoxyribosec6 in DNA.

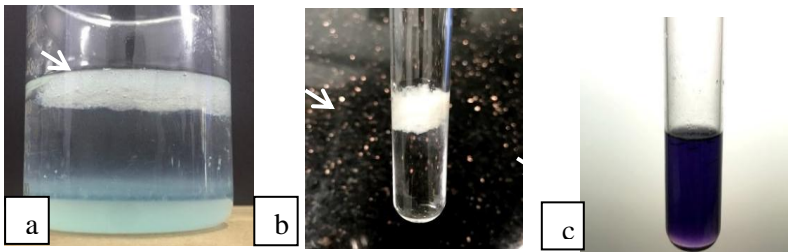


Image 2.11: Typical color reaction of DNA

a) DNA is precipitated in alcohol;

b) ADN is cleared in the test tube;

c) Typical blue color creation of DNA with diphenylamine

❖ **Situation 2:**

The dye chemical proposed in the textbook includes 4-5% orcein acetic or 4-5% carmine acetic. Such dye chemicals are expensive, difficult to prepare and less popular. However, there are not many researchs in finding a more suitable alternative dye chemical. Therefore, teachers are often difficult in this stage, which affect the entire result.

- Solution:

Instead of the original suggested in the textbook, a new research has proposed to use methylene blue – a dye which is very popular, low-cost, easy to use and preserve. The preparation process for methylene blue is very simple: mixing 1% methylene blue in 10% acetic acid solution; Filter it through filter paper and store in a jar at cool temperature.

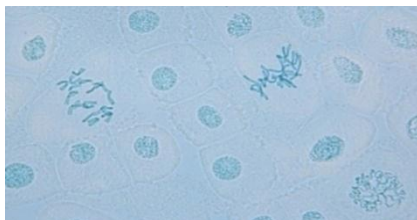


Image 2.2: Chromosomal specimen of Onion ($2n=16$) colored by 1% methylene blue (X400)

2.3. Training process for students to develop the problem-solving ability in Biology practical experiments teaching at high school

Problem-solving skill in biology PE teaching is ability to apply available knowledge, experience to solve effectively obstacle which occur during process of preparation, teaching experiment at high school. Structure of problem-solving ability in Biology practical experiments

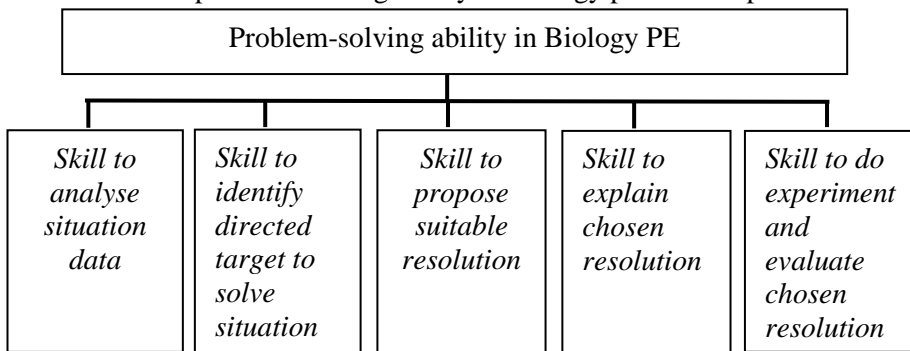


Image 2.3. Structure of problem-solving ability in Biology practical experiments - Skill to analyse situation data

When a situation appears, firstly learner must identify problem of situation. Aim to solve situation effectively, learner must analyse relationship between these factors, identify which factor is the basic

reason which make contraction of situation. The process of analysis will help learner to explore quickly basic problem to solve.

- *Skill to identify directed target to solve situation*

In each of situation there will be one or more problem which must be resolved, must be identified in order to make it basement to identify target of process problem-solving. Beside that, learners must identify which target learner can achieve after having resolved situation.

- *Skill to propose suitable resolution*

Based on target of problem-solving skill and result of analyzing situation factors in order to make prediction and propose resolution based on private knowledge and experience. These proposal must be predicted strong point and weak point in different practical conditions in order to make it basic to decide the best solution.

- *Skill to explain chosen resolution*

After having chosen resolution, learner implement to analyse scientific basic, the suitability of chosen resolution in specific situation in order to make it basic to solve problem effectively.

- *Skill to do experiment and evaluate chosen resolution*

Do experiment the chosen resolution, consider the progress and result of resolution process whether it is suitable or not in order to have suitable adjustment and have lesson for learner during process to solve situation.

2.4. Training process for students to develop the problem-solving ability in Biology practical experiments teaching at high school

It can be seen that the formation and development of skills is knowledge combining thinking and op practice. Therefore, in order to effectively develop problem-solving ability for undergraduates, this training process needs to approach the stages of the formation and development of skills in learners and is also developed on the basis of cognitive theory. The training process for undergraduates must be developed to ensure systematicity, inheritance, suitability with the content when teaching Biology PE in accordance with the practical conditions at pedagogical Universities; to ensure that undergraduates can practice this skill regularly in basic modules as well as in the Teaching Methods module during the training process.

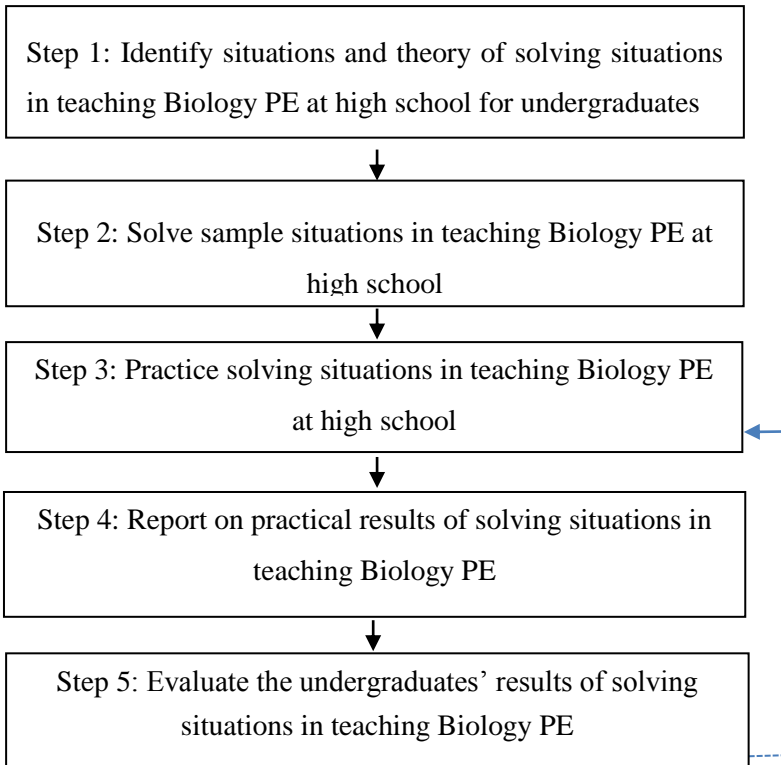


Image 2.4: The process to develop problem-solving ability for undergraduates in teaching Biology PE at high school.

- *Step 1:* For undergraduates to study theoretical knowledge about the role and meaning of experiments in teaching Biology at high schools; objectives of teach PE, principles and process of solving situations when conducting experiments and teaching PE. This step helps undergraduates to have the necessary theoretical background knowledge for the formation of problem-solving ability in teaching Biology PE at high school.

- *Step 2:* Organize for undergraduates to practice solving sample situations, this is their practice stage. This stage includes the following steps: Students observe some sample situations that have been solved by others in the correct sequence of steps; repeat such

steps to solve the same situation under the guidance and suggestions of the teacher. Students are asked to discuss and evaluate the treatment options for the teacher's sample situations. The assessment process will help students express their views on the solutions, assessments, arguments, and proofs through their understanding of the above situations.

- *Step 3:* Teacher assigns tasks to students through exercises and case studies. In this stage, students will practice dealing with common situations in teaching Biology PE at high school. Students can work in groups or individually, submit products as reports and class presentations. The groups discuss and evaluate the results in class. The teacher monitors, observes and evaluates the level of achievement in each component skill of the students; monitor the progress and change in attitude of students in the problem-solving process.

- *Step 4:* Students discuss in groups, conduct experiment; evaluate the options to handle the situation; conduct experimental improvements (if any). In this step, students discuss in groups to analyze the situation and propose an appropriate solution. For relatively simple experiments with short implementation time, students verify proposed solutions; evaluate and continue to adjust such options to be most appropriate; Make appropriate improvements to the experiment if necessary.

Students practice in groups, evaluate the proposed options; complete solutions to solve situations when teaching PE.

- *Step 5:* The teacher assesses the students' students' skill acquisition by tests; lesson plan; observation; taking notes; peer assessment of students. The assessment of the formation and development of problem-solving skills for students is conducted through tests spread throughout a semester. Besides the test results; the teacher monitors, observes, records and evaluates the learning attitude, the change in attitude of the students. Combined with the peer assessment results of the students, the teacher conducts the assessment of the students' skills training results according to the pre-designed criteria. In addition to the teacher's assessment, students also self-assess their own level of formation of problem-solving ability in teaching biology PE at high school. The teacher guides

students to self-assess the development of the problem-solving ability when teaching their own PE, thereby taking appropriate corrective measures. If the self-assessment of students' skills is still low, they need to go back to step 3 of this process to practice more. Through self-assessment, students will see that the self-assessment process is also their own learning process.

2.5. List of exercises of developing for undergraduates the problem-solving ability in Biology practical experiments teaching at high school.

Based on the collected situations, we developed 19 exercises, 17 situation exercises for student to develop the problem-solving ability in Biology PE teaching at high school under the procedure.

2.5.1. Training exercise for student to analyse situation data (7 exercises)

For example: when implement specimen to observe process of meiosis in chives cell. Student can't observe clearly all periods of meiosis process on specimen, basically student only observe the 1st and the 2nd period. The above situation is showing out which problem? Why can you only observe the cell on the 1st and the 2nd period?

2.5.2. Training exercise for student to identify target to direct when solve situation (7 exercises)

For example: during process of observation specimen mitosis on onion roots cell (image 2.5), teacher usually ask student the below question: Which the period of cell division are the cell in the image 2.5 on? After having observed cell in the image 2.5, Ms. An said that there was unusual situation on the process of mitosis onion root cell. What is the target of above situation? Do you agree with Ms. An? Why?

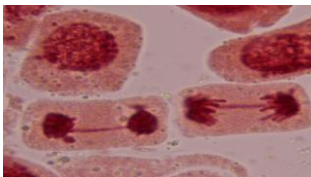


Image 2.5: Mitosis of onion root cell (X600)

2.5.3. Training exercise for student to train skill to propose suitable resolution(11 exercises)

For example: When teaching the experimental content about the phototropism of plants (Biology 11, there is a hypothesis that "The cotyledon is the place to receive light in the phototropism in plants", I will organize for How do students design an experiment to test the above hypothesis?

Anticipate situations when students conduct the above experiment and propose appropriate handling measures.

2.5.4. Training exercise for student skill to explain chosen resolution (4 exercises)

In the practical content of studying the size of the population according to the catch-release method. When doing the above experiment, a friend suggested the idea of counting the number of rice weevils in the jar.

In your opinion, is this proposal feasible? Why?

Please elaborate a detailed implementation plan for the above experiment.

2.5.5. Training exercise for student skill to do experiment and evaluate chosen resolution (6 exercises)

With practical content observing chromosome number mutations on temporary microscopy. Some teachers have difficulty in preparing 4-5% orcein acetic dyes or 4-5% carmine acetic dyes. These dyes are expensive and difficult to prepare.

Please study relevant documents to find alternative dyes to help teachers overcome these difficulties.

Design an improved process to perform mitotic slides with the following goals: simple implementation process, saving cost, time and giving the best efficiency.

2.6. Criteria for assessing situational skills in teaching and experimenting with Biology in high school students at Pedagogical University

2.6.1. Purpose and overall quality level rating scale

Assessment of skills is a very necessary stage in order to determine the status and progress of learners in the process of learning and training. The assessment of skills does not stop at each individual skill, but also evaluates the sum of the component skills in order to comprehensively assess the learner's capacity. In this topic,

we choose to use the Dreyfus scale to evaluate the skills of handling situations in teaching experimental experiments for students.

2.6.2. Criteria and rating scale

Through the analysis of the system of skills to handle situations that need to be trained for students, based on the requirements to be achieved about situation handling skills in teaching experimental experiments. We proceed to build the criteria tables to evaluate the component skills. To assess the proficiency of the 5 component skills, we design each skill to correspond to 4 levels (Level 1. Initial; Level 2. Initially at a higher level of toxicity; Level 3. Have skill; Level 4. . Proficiency) will be recorded and adjusted accordingly after conducting the survey.

2.6.3. Scale to evaluate the synthesis of situational skills in teaching and experimenting Biology in high school

Table 2.1: Scale to evaluate the synthesis of situational skills in teaching and experimenting biology in high school

Level	Performance of component skills
Level 1: Initial	Student achieves level 1 in all 5 component skills.
Level 2: Initially at a higher level	Students need to achieve level 2 in the component skills (A, B, C, D); Component skills (E) may be at level 1 due to objective conditions of time and facilities, students cannot re-experiment the chosen option.
Level 3: skillfull	Students need to achieve level 3 in the component skills (A, B, C); individual skill (D) can reach level 2; Component skill (E) can be at level 1.
Level 4: Competent	Students need to reach level 3 in the component skills (A, B, C, D); Component skills (E) may be at level 2 due to objective conditions of time and facilities, students cannot re-experience the chosen option to the fullest extent.

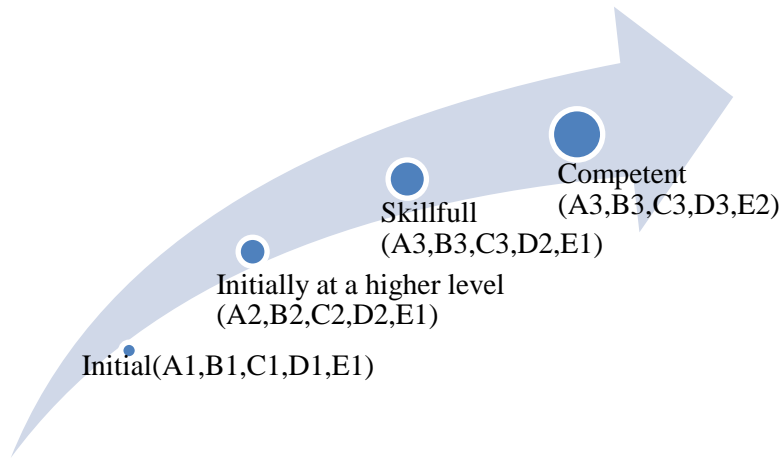


Image 2.6: Diagram of developing situation handling skills for students in teaching at high school.

2.6.4. Assessment methods

Students perform examinations through exercises and situation exercises; Evaluation through the practical lesson plans of students; Through the observation sheet, taking notes during the students' lessons.

2.6.5. Assessment tools

Based on the assessment criteria of skills, we develop the assessment sheet of problem-solving ability in PE teaching.

CHAPTER 3: PEDAGOGICAL EXPERIMENT

3.1. Purpose

Evaluate the correctness and effectiveness of the scientific hypothesis set out in this topic.

3.2. Experimental objects and methods

3.2.1. Experimental objects

Perform experiments for students in the 3rd and 4th years studying Biology Pedagogy at Saigon University and Ho Chi Minh City University of Education, including 58 students and 177 students for official experiments in total. Duration of experimental survey: 1st semester of school year 2018 - 2019; 1st semester of school year 2019-2020.

3.2.2. Experimental arrangement

Organize experiments under the criteria based on the impact experimental method in order to monitor the formation and development of problem-solving ability in PE teaching. The assessment before and after the experiment will be indicated in the same assessment sheet with specific measure.

3.3. Official experimental results

The problem-solving ability in PE teaching of 177 students were observed, recorded and evaluated. In addition, the researching method were used to verify the results by randomly selecting 9 students from 3 groups of academic ability levels as excellent, good, average.

Table 3.1. Results of the examination on problem-solving ability in Biology PE teaching at high school

Exam No.	Number of students	Topic No. 1		Topic No.2		Topic No. 3		Topic No.4	
		Quantity	%	Quantity	%	Quantity	%	Quantity	%
1	177	152	85.9	24	13.6	1	0.6	0	0.0
2	177	97	54.8	50	28.2	24	13.6	6	3.4
3	177	38	21.5	74	41.8	55	31.1	10	5.6
4	177	19	10.7	25	14.1	115	65.0	18	10.2
5	177	0	0.0	26	14.7	127	71.8	24	13.6

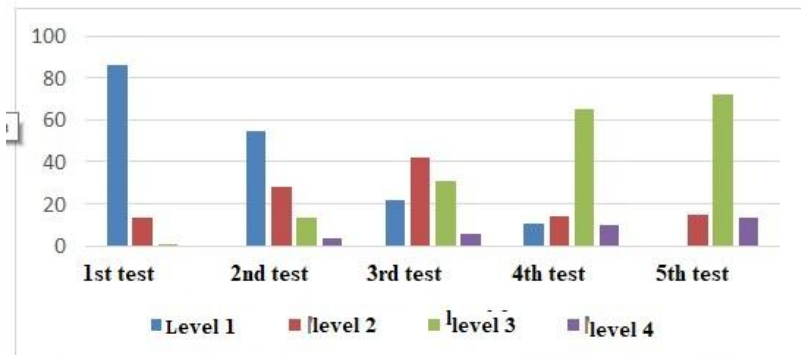


Table 3.2: Results of the examination on problem-solving ability in Biology PE teaching at high school

The results of the 5 tests are indicated in table 3.6 and image 3.2, showing that, in the first test before the experiment, the number of students who achieved level 1 was 85.9%, many students did not pass at level 2 and 3. Most students have not yet analyzed the contradictions of the situation; still confused in proposing solutions; have not fully explained scientific basis of such solutions. After training in teaching methods, students' skills have improved with increasing results in examination No. 2, 3, 4 and 5. The results in the final examination showed that there were no student at level 1; 14.7% at level 2; 71.8% at level 3 and 13.6% at level 4.

Table 3.2. Achievement results of the problem-solving ability in PE teaching

Statistical parameters	Test No.1	Test No.2	Test No.3	Test No.4	Test No.5
Number of sample	177	177	177	177	177
Arithmetic Mean	1,15	1,66	2,21	2,75	2,99
Median	1	1	2	3	3
Mode	1	1	2	3	3
Standard deviation	0,371	0,839	0,844	0,782	0,533
Variance	0,137	0,704	0,712	0,611	0,284
Variation range	2	3	3	3	2
Minimum	1	1	1	1	1
Maximum	3	4	4	4	4
Total	203	293	391	486	529

According to the analysis of experimental results in Table 3.2, it can be seen that, the Arithmetic mean of the achievement results are gradually increasing after each specific test as follows: 1.15, 1.66, 2.21, 2.75, 2.99. The initial results show the development of problem-solving ability in PE teaching of students.

The standard deviation and variation range are within the confidence range after the examinations. In order to compare the difference of the examinations' results whether they are statistically or not, the compare mean/ Paired Sample T-test were used in SPSS software to

determine the difference between the mean values over the 5 examinations. Hypothesis H0: there is no difference between the examination of the problem-solving ability in PE teaching; Theory H1: there is a difference between the examination of the problem-solving ability in PE teaching. The test results are indicated in Table 3.3.

Table 3.3. Result of the different of the average value of the examinations

					t	df	Sig.(2-tailed)
	Arithmetic Mean	Standard deviation	Confidence range 95%				
			Lower	Higher			
KT1 – KT2	0,508	0,604	0,598	0,419	11,179	176	0,000
KT2 – KT3	0,554	0,499	0,628	0,480	14,776	176	0,000
KT3 – KT4	0,537	0,500	0,611	0,463	14,279	176	0,000
KT4 – KT5	0,243	0,430	0,307	0,179	7,515	176	0,000

Result of the T-test in Table 3.8 show that the difference of the Arithmetic Mean of the skill achievement of students after the examinations is statistically significant. The arithmetic means gradually are 0,508; 0,554; 0,537; 0,243 with p values (Sig.(2-tailed)) which are all less than 0.05. Thus, it is possible to reject the hypothesis H0, and accept H1, ie the difference in arithmetic mean of the level of skills achieved by students after the examinations, which is statistically significant with 95% confidence range. The examination results show that the development of problem-solving ability in PE teaching is due to the impact of experimental factors, not by chance. Experimental results show the effectiveness of the measures; training process for students the problem-solving ability in Biology PE teaching at high school.

During the observation, recording and evaluation of the skill proficiency of 9 students in 3 groups of different academic abilities, the result obtained in Table 3.17 and Chart 3.12 show that Student 1, Student 2, Student 3 all have the proficiency of problem-solving ability in PE teaching at the highest level as level 4. However, student 3 is the best among these 3 students, because from the beginning, this student was at level 1, but after the training, it has developed to the highest level as level 4 at the 3rd examination and maintained such score in the following examinations. Student 1 and 2 have the same skill development, despite of the difference in the skill achievement before the time of this experiment. The 3 students in the average range of ability are student 7, 8 and 9 have starting points at level 1, but their developments are different. Student 9 has a relatively slow development. After 3 examinations, all 3 students are at level 1; in the 4th examination, they reach level 2; and level 3 in the 5th examination. Students with good and excellent ability have made remarkable progress in developing the problem-solving ability in Biology PE teaching.

Table 3.4. Created result and development of problem-solving skill of 9 students

No.	Experimental analysed student's symbol	The 1st test	The 2nd test	The 3rd test	The 4th test	The 5th test
1	Student 1	2	2	3	4	4
2	Student 2	1	2	3	3	4
3	Student 3	1	2	4	3	4
4	Student 4	1	2	2	3	3
5	Student 5	1	2	3	3	4
6	Student 6	2	1	2	3	3
7	Student 7	1	1	2	2	3
8	Student 8	1	1	2	2	3
9	Student 9	1	1	1	2	3

CONCLUSION AND RECOMMENDATIONS

1. CONCLUSION

During the implementation of this research, we have achieved the following theoretical and practical results:

1.1. Systemize theoretical basic on practice, practice experiment, practice experiment teaching, ability of biology practice experiment as well as situation, teaching situation and problem-solving skill in teaching.

1.2. Develop 45 common situations in PE teaching for 15 practical topics in Biology program at high school. These situations have been systematized into groups, including: Laboratory safety situation; Situation when creating, conducting experiments; Situations when teaching experiments; Situation when conducting experiment improvement.

1.3. Problem-solving ability in Biology PE teaching at high school is an important component for teachers' expertise. We determine the logical structure of component skills in order to train students, including: Analyzing skill the data of situation; Skill to identify aiming target when handling problem; Skill to propose suitable solutions; Skill to explain the selected solution; Skill to practice, evaluate the selected solution. The smooth coordination of the above component skills will help teachers actively and creatively handle situations arising in Biology PE teaching at high school.

1.4. Establishing a problem-solving skill training process in teaching and experimenting consists of five steps: Step 1. Determine situations and theory of handling situations in high school biology teaching and experimentation for the undergraduates; Step 2. Handle sample situations in high school biology teaching and experimentation; Step 3. Practice handling situations in high school biology teaching and experimentation; Step 4. Report on practical results of handling situations in high school biology teaching and experimentation; Step 5. Evaluate the undergraduate's results of handling situations in high school biology teaching and experimentation to perfect their skills.

1.5. Establish 35 exercises to train student problem-solving skill in teaching biology practice experiment at high school and they are

classified based on component skills which are identified in structure of skill.

1.6. We have researched and developed the criteria; assessment measure; development progress of the problem-solving ability in Biology PE teaching at high school.

1.7. Successfully and effectively improved some experiments in Biology program at high school to train not only component skill but also total problem-solving skill in teaching biology PE. Proposing solutions to handle problems to ensure the safety of Biology laboratory at high schools.

2. RECOMMENDATIONS

2.1. Cần Need to focus on developing the problem-solving ability in PE teaching to approach the general education program of 2018.

2.2. The developing of the problem-solving ability for students need to be done in both basic subject as well as the Teaching theory and methods.

2.3. Need to regularly train laboratory safety knowledge, problem-solving ability in PE teaching as skills to improve experiments for teachers according to actual conditions of schools and localities.

2.4. Strengthen the maintenance of laboratory equipment. Improve the efficiency of laboratories in teaching Biology nowadays.

LIST OF PUBLISHED WORKS RELATED TO THE THESIS

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6. Le Minh Duc, Phan Duc Duy, Lu Thi Thanh Nga (2020), *Problem solving ability during the DNA extraction at High school Biology program*, Journal of Science of Hue University: University of Social Sciences and Humanities, part 129, issue 6A, 2020, pp. 67-75, DOI: 10.26459/hueuni-jssh.v129i6A.5658.
7. Phan Duc Duy, Le Minh Duc (2020), *Developing problem-solving ability in Biology teaching practical experiments at High school*, journal of Education, issue 484, (2nd term – August 2020), pp. 44-48.
8. Phan Duc Duy, Pham Thi Phuong Anh, Dang Thi Da Thuy, Nguyen Thi Dieu Phuong, Le Minh Duc (2021), *Enhancing the teaching competence in Biology experimental practical lessons in high school for pedagogical students*, Proceedings of the 2nd International Conference on Innovation in Learning Instruction and Teacher Education – ILITE 2, University of Education Publisher, p.201-214.