

Developing Problem-Solving Competency for Students in Teaching Biology at High School in Vietnam

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Abstract Accessing to the general trend of the world, Vietnam is in the process of setting up a new General education curriculum oriented to learner competency development. In that curriculum, problem-solving is one of the common competencies that need to be formed and developed for students. Thus, developing and evaluating problem solving competency is one of the tasks that teachers in disciplines at all levels of learning and need to do. However, in in Vietnam nowadays, teaching of competency approach is still difficult for teachers. In this article, on the basis of research on competency, we have given a problem-solving competency development process in teaching biology at high school as an illustrative example.

Keywords: *competency, problem-solving, problem-solving competency, problematic situation, biology*

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1. Introduction

In the current trend of education reform, many countries around the world have built general education curriculums oriented to competency development. Competency approach curriculum answers the question: *We want to know what do students know and what they can do?* The leading countries in this field are Australia, Singapore, Korea, China, Japan and many European countries such as Germany, England, Finland, etc.

Since 2000, the OECD (Organization for Economic Co-operation and Development) has started to study a common competency framework with the following criteria: (1) The learning is maximally personalized; (2) Learners can deal with and respond to the rapid transformation of modern society; (3) The school has the opportunity to promote the democracy; (4) It is effective and feasible for many socio-economic contexts. By October 2001, the OECD published the competency framework for high school students in three competency groups that are recognized in a holistic and integrated approach [1,2].

Vietnam is also in the process of reforming its general education curriculum which is built from transfer of content approach to competency approach with a system of common competencies. In order to implement this curriculum, teachers will need to undergo training sessions in order to transform teaching methods, teaching forms and assessment oriented to competency development. This is a difficult period for high school teachers.

Thus, in Vietnam today, it is necessary to have researches on processes, measures for developing competency as well

as the ways to assess students oriented to competency development. One of the core competencies that need to be built and developed for students is problem-solving competency.

Researching on problem-solving competency, many authors argued that this competency is built through the problem-solving process and when it is able to solve problems, the efficiency of problem-solving will be increased in diverse situations occurring in human life. There have been many research theories and frameworks on problem-solving, including five theories that have attracted many scientists such as Polya [3,4], (PISA Program for International Student Assessment) [5], ACARA (Australian Curriculum, assessment and reporting Authority) [6], O'Neil [7], ATC21S (Assessment and Teaching of 21st century skills) [8].

In Vietnam, there were many authors who studied on problem-solving teaching and problem-solving competency. However, there is still a need for specific research applying those views in teaching the subjects as reference materials to help teachers respond to the teaching of the new general education curriculum.

2. Content

2.1. Competency

- *Definition of competency*

In the world, in the researches on competencies, many authors defined competency in different aspects. However, it is possible to define the competency in three trends: The first is that the authors defined competency as a quality of

personality. This group includes perspectives of Binet and T. Simon; P.A. Rudich [9]; Covaliov A. G. etc. In which Covaliov A. G. considered competency as individual psychological traits to be associated with the good result of accomplishing a certain activity [10]. From these perspectives, competency is the inner ability (psychological and physiological quality) of every human being to achieve a certain activity.

The second group is based on the structural component of the competency to define the competency. All definitions under this group confirm that competency is composed of skills. For example: "*Competency is the ordering set of skills that affect the contents of a given situation to solve the problem posed by such situation*" (Rogiers X. [11]). T. Lobanova and Yu Shunin [12], etc. T. Lobanova and Yu Shunin emphasized that "*competency*" and "*skill*" should not be considered synonyms. Skill presents ability to do cognitive or behavioral actions in a proficient, accurate and adaptive manner to changeable conditions, while competency means a system of complex actions, including competencies and non-cognitive components (attitudes, emotions, motives, values, and ethics).

The third group defines the competency basing on the origin of competency. The All definitions of this group confirm that competency is formed from activities and through activity the competency can be formed and developed. There are authors having the same opinion with this group such as John Erpenbeck [13]; Weitnert [14]; New Zealand education curriculum; Draft general education curriculum of the Ministry of Education and Training of Vietnam [15], etc. Typical definitions from the group's point of view are: "Competency is the ability to manipulate knowledge, experiences, skills, attitudes and excitement to act appropriately and effectively in diverse situations of life "(Thomas Armstrong, 2011) [16].

In the Deseco project (2002), the authors' team identified "Competency is as an internal mental structure system, the ability to mobilize knowledge, cognitive skills, practical skills and attitudes, emotions, values, morality, motivation of a person to successfully perform activities in a specific context" [17].

According to the draft general education curriculum of the Ministry of Education and Training of Vietnam (2017): "Competency is an individual attribute which is formed, developed by available quality and learning and training process, allows people to synthesize knowledge, skills, and other personal attributes such as excitement, belief, will, etc. to successfully perform a certain type of activity, achieving desired results in specific conditions " [[15]; p. 6].

Types of competency in general education curriculum in Vietnam

The general education curriculum forms and develops the following core competencies for students:

- Common competencies are formed and developed by all subjects and educational activities such as self-control and self-learning competency, communication and co-operation competency, problem-solving competency and creativity;

- Professional competency: Professional competencies are formed and developed primarily through a number of subjects and certain educational activities such as language competency, computational competency, natural and social exploration competency, technological competency, informatics competency, aesthetic competency, physical competency.

2.2. Developing Problem - Solving Competency for Students in Teaching Biology at High School in Vietnam

In the general education curriculum, it is generally identified three common competencies and 7 professional competencies. Among them, problem-solving competency plays a particularly important role because of the integration in which all the competencies are left. Also, in some general education curriculums that only this competency is focused on developing.

We have developed a problem-solving competency for students in teaching biology in the following steps:

2.2.1. Definition and Identification of Problem-Solving Competency Structure

Once the competency to be developed has been identified, the teacher should clearly identify which competency needs to be developed? Including which criteria in its structure and describe the competency as behaviors that can be performed, thereby training students through each behavior and synthesizing behaviors.

- *Definition of problem-solving competency*

As defined in the Program for International Student Assessment, problem-solving competency is "*the ability of an individual to understand and solve problem situations when the solution is not clear. It includes participation in solving that problem - demonstrating the potential as an active and contributing citizenship*" [5].

According to Tu Duc Thao, when dealing with any problem, students must rely on accumulated knowledge and experience, conduct reasoning to find the answer, and also by reasoning, students can generate new ideas. Thus, solving problems allows students to learn and practice thinking. Thinking and problem-solving are closely related; Thinking to solve problems, through problem-solving to develop thinking [18].

According to author Nguyen Canh Toan, problem-solving is "intellectual activity, considered as complex level and the highest level of perception, as it requires the mobilization of all intellectual competency of the individual. In order to solve the problem, the subject needs to mobilize memory, perception, reasoning, conceptualization, and language using simultaneously with emotions, motives, belief in itself competency and competency of controlling situation" [19].

Thus, problem-solving competency can be understood as *the ability of the individual to mobilize knowledge, skills and personal experience in detecting problems, finding solutions and implementing problem-solving effectively.*

- *Identification of problem-solving competency structure*

In teaching Biology, many authors conducted researches on problem-solving teaching, such as Tran Ba Hoanh - Trinh Nguyen Giao [20], Ngo Van Hung, Nguyen Hai Chau [21], Tran Van Kien [[22]; 65], the process of problem-solving approach consists of three steps as follows:

- **Step 1** - Introduction: In this step, the teacher creates the problematic situation, students detect, identify the problem occurring and present the problem to be addressed.

- **Step 2** – Problem-solving: students propose hypotheses, make plans and implement problem-solving plans.

- **Step 3** – Conclusion: students draw conclusions about new knowledge.

Table 1. Expression of component skills in problem-solving competency

Problem exploration and detection	Hypotheses formation	Problem-solving planning and implementation	Problem-solving solutions assessment and conclusion drawing
<ul style="list-style-type: none"> - Analyze the situation, establish relationships between things, phenomena. - Realize the contradiction between new problem occurring and learned knowledge. - Express in a form of a question 	<ul style="list-style-type: none"> - Collect, select, arrange problem-related contents and knowledge. - Set up the relationship between the contents of the problem with the contents of learned knowledge. - Propose hypotheses about the relationship between impact factors / causes and results. 	<ul style="list-style-type: none"> - Propose methods for hypotheses testing + By scientific critical reasoning method + Or by conducting scientific experiments. - Explain, clarify the cause of the problem, draw conclusions about the cause of the problem. 	<ul style="list-style-type: none"> - Assess the effectiveness of problem solving. - Synthesize, generalize knowledge, form new knowledge. - Confirm the knowledge and experiences gained after completing the problem-solving.

Table 2. Tasks of teachers and students when practicing 4 skills of problem-solving competency

Skill to be practiced	Teacher's activities	Students' activities
Problem exploration and detection	Raise a question: With this situation, it requires which that you have to do? - Suggestion 1: Please underline the key phrase - Suggestion 2: Please express the problem in a form of a question.	<ul style="list-style-type: none"> - Underline key word(s), phrase(s) - Realize the contradiction between new problem occurring and learned knowledge. - Express in a form of a question
Hypotheses formation	Ask groups of students to discuss the following learning tasks: - Please analyze the problem, point out the knowledge involved in the problem. - Please set up the relationship between the problem with the contents of learned knowledge. - Please propose hypotheses to explain the problem.	<ul style="list-style-type: none"> - Analyze and clarify the relationship between the contents of the problem. - Give the idea of cause and effect relationship. - Propose hypotheses to explain the problem.
Planning and problem-solving	Ask groups of students to discuss a hypothesis testing plan. - How can hypotheses be tested? - Which hypothesis is true? Please explain - Please draw conclusion about the cause of the result.	<ul style="list-style-type: none"> - Propose measures for hypotheses testing. - Conduct scientific critical reasoning to support or reject hypotheses. - Conduct scientific experiments for hypotheses testing.
Problem-solving solutions assessment and conclusion drawing	Ask groups of students to discuss the following learning tasks: - Assess hypothesis testing methods. - Draw new knowledge - Point out gained experiences.	<ul style="list-style-type: none"> - Check the effectiveness of hypothesis testing - Synthesize, generalize knowledge, form new knowledge. - Draw lessons learned

In the aforementioned three steps, step 1 will train students with problem exploration and detection skills; Step 2 will train students with hypotheses proposal skills, planning skills and problem solving skills; Step 3 will train students with skills of synthesizing and generalizing knowledge, building knowledge, and drawing lessons learned after solving problem.

Based on the problem-solving steps, we believe that in order to develop the problem-solving competency, students need to be built and developed four elementary skills, namely **Skill 1** "Problem exploration and detection"; **Skill 2** "Hypotheses formation"; **Skill 3** "Planning and problem-solving"; **Skill 4** "Problem-solving solutions assessment and conclusion drawing".

When training for the problem-solving competency, it is necessary to practice each problem-solving skill; we give specific activities of teachers and students in the exercise as presented in Table 2.

2.2.2. Determination of Competency Development Measures and Design of Proper Tools

Competencies are developed through activities. In order to form and develop problem-solving competency, it is possible to use organizational measures such as using problematic situations, using situational exercises, using practical exercises, using project exercises,...

For each measure, teachers will design a tool that is appropriate for students. Specific examples are given in the following section.

2.2.3. Measure Choice and Teaching Organization to Develop Problem-solving Competency for Students

In this article, we choose the measure for developing problem-solving competency: use of problematic situations.

According to the Vietnamese Dictionary, a situation is the happening of an event with which you must cope [[23]; p. 1551].

According to Dinh Quang Bao and Nguyen Duc Thanh, a problematic situation is a psychological state of the subject of perception when the subject meets with perceptual contradiction or difficulty. The contradiction or difficulty is beyond the existing knowledge of the subject, implying a something unknown and involving a positive and creative inquiry [[24]; p. 3].

In addition, many other authors defined a problematic situation, including I. Lecne [25], M. I. Macmutop [26], A. V. Petrovski [27], Nguyen Ngoc Quang [28]. In spite of their different expressions, the authors affirmed that a problematic situation is filled with a content that needs to be determined and a task that needs to be implemented.

Example of a problematic situation used to practice problem-solving competency in teaching the Genetics section – Biology for 12th graders:

Problematic situation: In 1957, Franken and Conrat carried out an experiment of separating the ARN core from the protein coverings of two viral strains A and B. Both the strains were pathogenic to tobacco, but harms on the leaves were different. The ARN core of strain A was mixed with the protein of strain B, and a hybrid virus was created. Infected by the hybrid virus, the tobacco would contract a disease. The isolation of the leaf of the infected tobacco would create viral strain A [[22]; p116].

Think to answer the following suggested questions:

Question 1:What types of knowledge is the content of this experiment related to?

(This question aims to form the problem detection skill.)

For the question above, students will think and determine the related types of knowledge: Knowledge of genetics, Knowledge of botany and Knowledge of microbiology.

Question 2:Change the content of the situation into a problem question.

(This question aims to form the problem detection skill.)

Question 3:Mention possible causes to explain why the isolation of the leaf of the infected tobacco created viral strain A, not viral strain B.

(This question aims to form the scientific hypotheses formation skill.)

For this question, students will argue to discover that the hybrid virus has the core of strain A and the covering of strain B, but the next generation is viral strain A, which proves that the core of the virus bears information about the whole structure of the virus. Therefore, the hypothesis is formed as follows: For a tobacco mosaic virus, the ARN core is a matter that bears genetic information.

Question 4:Why have you raised such hypothesis?

For this question, students must use critical thinking skills to prove their points of view. Other students can criticize your point of view.

Question 5: (The teacher raises an assumption): If the isolation of the leaf of the infected tobacco creates viral strain B, not viral strain A, what hypothesis will be raised?

Question 6: What conclusion can be drawn from the result of this experiment?

(Questions 5 and 6 aims to form the skill of assessing a solution to a problem and drawing a conclusion.)

Finding an answer to each of the questions above is the use of skills to solve problems in the situation.

In the initial stage, students get instructions from the teacher. When students are familiar with how to solve problems, each student will solve problems on their own or through team discussion.

- Using a problematic situation to develop problem-solving competency for students

When a problematic situation is used to develop problem-solving competency for students, tasks of the teacher and students are shown in Table 3.

Specific steps are as follows:

In the stage of practicing problem-solving competency, students are continuously in contexts that generate problematic situations, solve problems, and evaluate problem-solving efficiency through the four steps of process on problem-solving competency practice.

Step 1: Problem arising / problem approach

The teacher tells a story to create a perceptual context in which students can identify problematic situations.

Example of the story entitled "*Pathogen and antibody*". When a pathogen penetrates the human or animal body (the inner body environment), the body will create a corresponding antibody to kill the pathogen. In nature, there are billions of types of pathogens, and theoretically there will be billions of corresponding antibodies. An antibody is a type of protein in blood. For the human body, there are only over 100 genes defining antibody protein.

The teacher asks students to study the story to raise situations in terms of various aspects of the story and to choose the situation related to the main content of the lesson. In the context above, it is possible to predict the following ways of inference and corresponding situations:

Way 1: Think about the structure of the antibody. In this way of thinking, students will raise the situation: How is the antibody structured to perform the function of antigen condensation?

Way 2: Think about the pathogenic mechanism of the antigen. In this way of thinking, students will raise the situation: Why can the antigen be pathogenic to the animal body?

Way 3: Think about the expression mechanism of the gene defining antibody protein. In this way of thinking, students will raise the situation: In human cells, there are only over 100 genes defining antibody, but why can a countless number of various types of antibody be created?

Table 3. Tasks of the teachers and students when using a problematic situation to practice problem-solving competency

Skill to be practiced	Teacher's activity	Students' activity
Problem exploration and detection	- Raise a problematic situation. Instruct students how to find a problem.	- Approach and analyze the problematic situation; identify a contradiction; and raise a question.
Hypotheses formation	- Give students a suggestion about how to relate the situation to the learned knowledge. - Instruct students how to raise a hypothesis to explain the problem.	-Relate the situation to the taught knowledge. - Raise hypotheses to explain the problem and choose the most proper hypothesis.
Problem-solving planning and implementation	- Give students a suggestion and cooperate with students in raising measures for testing the hypothesis. - Give instructions to and supervise students testing and assessing each hypothesis.	- Propose measures for testing the hypothesis. - Test and assess the hypothesis.
Problem-solving solutions assessment and conclusion drawing	- Instruct students how to assess the efficiency of the hypothesis testing. - Instruct students how to generalize knowledge. - Help student affirm the obtained knowledge and experience.	- Assess the efficiency of the hypothesis testing. - Affirm the obtained knowledge and experience.

In the above-mentioned different ways of arguments, the teacher asks students to think and choose only situations that are related to the main content of the lesson. As a result, students will come to agree on the most relevant situations to the lesson: In human cells, there are only over 100 genes defining antibody, but why can a countless number of types of various antibodies be created?

Step 2: Practice 4 skills of problem-solving competency

** Problem exploration and detection*

- Students analyze and clarify the content of the situation.

If each gene defines a type of antibody, about 100 genes can only create about 100 types of antibody. Thus, the contradiction is in the relationship between gene and antibody protein.

- Students identify the contradiction between the arising situation and the taught knowledge.

Because Biology for 9th graders was taught, students know that each gene defines and synthesizes 1 type of protein. In this situation, the number of types of protein is thousands of times the number of types of gene.

- Students express the situation in 1 question:

The question raised by students is expected as follows:

In what way can a gene synthesize various types of protein?

** Hypotheses formation*

- Students collect, choose and arrange knowledge contents related to the situation. In this situation, the related knowledge contents are:

- + Structural characteristics of antibody protein
- + Characteristics of a fragmented gene
- + Genetic expression mechanism of a lymphocyte
- Relate the situation to the taught knowledge

Relationship: Gen → mARN → Polypeptide chain → Protein

- Raise a hypothesis to explain the problem

It is possible to raise the following hypotheses:

Hypothesis 1: A gene defines and synthesizes many types of mARN; each type of mARN only defines and synthesizes a type of polypeptide chain defining a type of protein.

Hypothesis 2: A gene defines and synthesizes many types of mARN; each type of mARN defines and synthesizes many types of polypeptide chain; each type of polypeptide chain defines a type of protein.

Hypothesis 3: A gene defines and synthesizes many types of mARN; each type of mARN only defines and synthesizes a type of polypeptide chain; many types of polypeptide chain define a type of protein.

Hypothesis 4: A gene defines and synthesizes a type of mARN; each type of mARN only defines and synthesizes a type of polypeptide chain; many types of polypeptide chain defines a type of protein.

Hypothesis 5: A gene defines and synthesizes many types of mARN; each type of mARN defines and synthesizes many types of polypeptide chain; many types of polypeptide chain defines a type of protein.

- Agreement on hypotheses

Students in each team make a discussion with one another and come to an agreement on the raised hypothesis. Depending on awareness of students in each team, they can raise different hypotheses. Excellent students can come to an agreement on hypotheses 3 and 4.

** Problem-solving planning and implementation*

- Propose measures for hypotheses testing

For this situation, hypothesis testing are based on applying knowledge of the structure of antibodies (learned in grade 11), on transcription, decode. After that, to make inference to affirm or reject the above hypothesis, and to come to the right conclusion.

- Conducting scientific critical reasoning to support or reject the hypothesis of other groups

Depending on the teaching practice, the teacher may give some questions to orient students' thinking, to help them with scientific argumentation, to find the correct hypothesis. The questions should be as follows:

Question 1: How is the antibody structured? (Review Biology 11)

Question 2: Can a polypeptide produce many types of protein? (Answer: It can. Because each protein can be produced by the interaction among one or many polypeptide).

Question 3: Can a gene synthesize many types of mRNA molecules? (Answer: It can. By cutting introns and linking exons in different ways in segment gene, it is possible to synthesize a variety of mature mRNAs, each of which is decoded into a polypeptide.

Question 4: Can one type of mARN synthesize multiple polypeptide ? (Answer: It cannot, because the genetic code is specific)

** Problem-solving solutions assessment and conclusion drawing*

- Students evaluate the effectiveness of hypothesis testing.

In step 3, students verify the correctness of each hypothesis, then evaluate the science of those methods. Because, in many cases, the inference process is logical (or the practical process gives correct results) but the methodology is not suitable, the results are unreliable. Therefore, evaluating the hypothesis testing not only helps students with critical thinking skills but also helps them take the initiative in assessing and conducting researches.

- Students synthesize, generalize knowledge to form new knowledge.

After finding the right hypothesis, students draw conclusions about the relationship among: Gene → mARN → polypeptide → Protein.

+ Each gene is capable of synthesizing many types of mature mARN. Each mRNA only synthesizes one type of polypeptide, each of which can produce different types of protein, since each protein can be made up of multiple polypeptide chains interacting with each other by valence bonds or weak bonds (hydrogen bonds, ionic bonds, water resistance bonds, ...).

+ Only about 100 genes regulate the antibodies but they can produce billions of antibodies, because each antibody is made up of four polypeptide chains (two heavy chains and two light chains); Genes regulating antibodies are segment genes, each of which is capable of producing hundreds of different types of mRNA molecules, producing hundreds of different types of polypeptide chains. So, with hundreds of genes, each of which contains hundreds of polypeptide chains which are arranged in different ways, a variety of different antibodies will be created.

- The student confirms the learned knowledge and experience.

+ After solving the problem, students understand the following concepts: What is a segment gene? What is the role of gene segmentation?

+ Students learn that when solving a problem, they need to discover the intrinsic nature of the contradiction followed by the content of knowledge that is relevant to the conflict of the situation, to propose scientific hypothesis and to find ways to verify, evaluate each hypothesis, draw conclusions about the cause of the problem, then form new knowledge.

2.2.4. Assessment and Experience Drawing

The purpose of this step is to review the results of the training process, to determine the level of competency development, to draw experience and to continue improving.

To evaluate problem-solving competency, teachers need to design a way of problem-solving competency development and assessment tools.

We identify the problem-solving competency development in five levels as follows:

Level 1: Students begin to know how to detect problems but do not know how to form hypothesis, how to solve problems; how to generalize knowledge and draw experience after solving problems.

Level 2: Students find out problems exactly, know how to form hypothesis, are still confused with finding solutions to problems and have not solved the problems; do not know how to generalize knowledge and draw experience after solving problems.

Level 3: Students promptly find out right problems, form right hypothesis, are still confused with solving problems, do not know how to generalize knowledge and draw experience after solving problems.

Level 4: Students promptly find out right problems, promptly form right hypothesis, solve right problems, are still confused with how to generalize knowledge and draw experience after solving problems, need supports from their teachers and other students.

Level 5: Students promptly find out right problems, promptly form right hypothesis, promptly solve right problems, promptly generalize new knowledge and draw experience after solving problems

For the assessment tool of problem-solving capability, we use problematic situations.

Example 1: After completing the lesson "Duplication of DNA and Mutagenesis", the teacher may examine the skills of problem-solving competency in the following situations:

Situation: A rare hereditary disease that is expressed to be immunodeficient, slow to grow, slow to mature, and has a small head [4]. Suppose that DNA was extracted from a patient with the above symptoms and DNAs have equal length and other DNA segments were very short but with an equivalent total mass. Scientists have identified that it is caused by mutagenesis that corrupted an enzyme involved in DNA duplication.

Questions for evaluating each skill of problem-solving competency:

Question 1: Raise a question to clarify the content of this situation.

Answer: Of enzymes involved in DNA duplication, which enzymes involve the function of joining DNA segments?

Question 2: Make an assumption to explain the cause of this problem.

Answer: Gene mutation regulates the synthesis of enzyme DNA ligase causing this enzyme to lose its biological function.

Question 3: Explain the given hypothesis.

Answer:

- During DNA duplication, shaped circuit with the direction of $3' \rightarrow 5'$, the new circuit is synthesized continuously; shaped circuit with the direction of $5' \rightarrow 3'$, the new circuit is synthesized in Okazaki segments with the equivalent length.

- Of enzymes involved in DNA duplication, only enzyme DNA ligase has the function of linking Okazaki segments to form continuous polynucleotide chains. If this enzyme is damaged its function by mutation, the Okazaki segments will not be connected, thus DNA segments are very short but have the equivalent total mass.

Question 4: Make a conclusion of the role of enzyme DNA ligase .

Answer: Enzyme DNA ligase has the function of connecting the Okazaki segments to form a continuous polynucleotide chain. If this enzyme is inactivated, it will cause abnormalities in the structure of the genetic materials leading to diseases.

Example 2: After completing the lesson "Chromosome and Genetic Mechanisms at the cellular level," teachers can examine the skills of problem-solving competency in the following situations:

Situation: In the wild, there are some plants that reproduce by flowering, seeding, and then seeds germinate into seedlings and continue the new cycle (called sexual reproduction); Some other plants reproduce from the roots or from the branches, from the leaves to the seedlings, then the seedlings are separated from the original plant to develop and mature (called asexual reproduction). It is found that with sexual reproduction, flowers have various colors, while with asexual reproduction, flowers have only a few certain colors in the same species.

Questions for evaluating each skill of problem-solving competency:

Question 1: Raise a question to clarify the content of this situation

Question 2: Make an assumption to explain the cause of this problem

Question 3: Explain and clarify the given hypothesis

Question 4: Specify the cause of the diversity of the biological world.

The above examples illustrate the assessment of each skill of problem-solving competency through exercises of evaluating problem-solving competency. Assessing each skill of problem-solving competency helps teachers identify skills of which students are weak so that they can take measures to support and train students to strengthen each skill. The most important feature of problem-solving competency is the accuracy and the speed of problem solving. Therefore, besides evaluating each skill, it is necessary to evaluate the result and the speed of problem solving. Exercises should ask students for the final answer without requiring intermediate steps to address the situation.

3. Conclusion

Problem-solving is one of the common competencies in the general education curriculum in Vietnam towards the formation and development of students. There are many researches on this competency in the world such as PISA, ACARA, Polya, etc. In the article, we proposed a four-step problem-solving competency development process, and illustrated those 4 steps by using the problematic situations in teaching Biology in Vietnam with specific actions to help teachers to study and practice in teaching Biology in particular and other subjects in general in order to meet the new general education curriculum.

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