UDC 33

DEVELOPING CREATIVITY COMPETENCE OF PUPILS IN PHYSICS TEACHING IN VIETNAM HIGH SCHOOLS WITH AID OF COMPUTERIZED EXPERIMENT KITS

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Abstract. The focus of this article is a solution in organizing pupil's physics learning activities in Vietnam high schools, within an orientation of competence approach in order to enhance creativity competence of the pupils. The proposed solution is to enhance the use of computerized experiment kits in Physics learning. This article analyzes advantages of Physics in general and those of computerized experiment kits in physics teaching and learning in particular to the development of pupil's creativity competence. The article also illustrates a plan of learning the subject "Spring pendulum" of Physics in Vietnam high schools, with the use of the ViLabs computerized experiment kit, which contributes to developing Vietnam pupil's creativity competence. The experiment results show that creativeness indicators in the classes participating in the experiment are higher than those in traditional classes.

Keyword: Competence, Creativity competence, Physics teaching, Computerized experiment, ViLabs.

1. Introduction:

It is said in the article Assessing Key Competences across the Curriculum - and Europe by David Pepper in the European Journal of Education, Volume 46, Issue 3, September 2011, pages 335–353, that "The development of key competences for lifelong learning has been an important policy imperative". Besides, in the article "Translating Key Competences into the School Curriculum: lessons from the Polish experience" in the European Journal of Education, Volume 46, Issue 3, September 2011, pages 323–334, the authors Mirosław Dąbrowski and Jerzy Wiśniewski partly expressed the experience in organizing teaching and learning activities in the orientation of competence approach which had been implemented by Poland through 20 years. The article also discussed macro-changes, such as changes to the structure of the system (e.g. the length of compulsory education), school governance, the roles of principals and teachers, teacher training programs, etc. Among the discussed competences, creativity is the important one. In his studies, Torrance showed the importance of pupil's creativity competence and discussed how to develop pupil's creativity competence, and how to evaluate pupil's creativity competence. In those studies, Torrance proposed many methods of developing pupil's competences, such as creating chances of discussing, proposing problems, etc. In this article, we shall present our study, being enhancing the use of modern teaching aids (herein computerized experiment kits) in teaching Physics in Vietnam high schools in order to develop pupil's creativity competence.

2. Content:

2.1. Creativity competence and developing pupil's creativity competence in teaching physics in high schools

The definition of competence has been studied by many scientists in Vietnam and in the world, such as:

- Competence is the ability of an individual to meet with complex demands and fulfill the duties in a particular context. (OECD, 2002).
- Competence is abilities and skills which are inherited or can be learned to solve

problems in the life. Competence is also involved in motivational, volitional and social preparedness and skills to apply solutions successfully and responsibly in variable situations (Weinert, 2001).

- Competence is the ability to apply knowledge, experience, skills, attitude and activeness in behaving appropriately and effectively in various life situation. (Quebec-Ministere de I'Education, 2004).

Though they may be different, the above definitions of competence all emphasize the ability to apply knowledge, skills, and techniques successfully in solving a particular problem. Therefore, we choose the definition of competence as: "Competence is the ability to apply individual's knowledge, skills, and techniques in solving situations to gain high-quality result".

There are many competences which the learners need to develop during learning; it is not easy to name the competences clearly and separately. Classification of competences depends on various opinions and criteria. Studying the plan designed in an orientation of competence approaching of different countries, we can see that there are 2 main types: general competence and specialized competence. General competence (also called key competence by EU Education & Training) includes basic, critical competence for the people to live and work in the society. This competence is developed from different aspects and, in education, from different subjects. Specialized competence is the competence in specific subject/field. (Do Thanh Hung, 2012)

There are also different opinions in which competences belong to general competence. Despite that, creativity competence always is an integral part of general competence.

Creativity competence is the competence group which represents individual's creativity, the ability to give a solution to a problem or situation. In educating in general and in Physics teaching, in particular, pupil's creativity competence is presented in the following abilities:

+ To raise different questions about an event, phenomena. To determine and clarify new information or idea. To analyze and summarize relevant information from various sources.

+ To form the idea based on given information. To propose solutions to improve or replace those which are no longer appropriate. To compare and make comments on solutions proposed by himself or others.

+ To think and generalize solutions into processes. To respect different opinions. To apply the knowledge into similar events with appropriate revision.

+ To have the interest and freedom in thinking, proactive and do not feel shy in expressing their opinions; to find out new and positive factors in other opinions.

To develop creativity competence during teaching is not really easy. However, teaching physics has many advantages in developing pupil's creativity competence, because physics is a natural science which studies various rules of material world, which is presented in such activities as:

+ Observing physics phenomena: pupils can observe and create methods of naming and describing the phenomena according to their knowledge.

+ Proposing study methods (or proposing experiment method): Pupils study the knowledge of physics which is all verified by experiments; thus, physics knowledge is valuable for pupils to develop their creativity competence, showing in proposing study/experiment methods.

+ Experiment: is the activity in which the pupils directly perform experiments to find out physics rules or to verify physics rules. This activity requires a lot of skills and brings many opportunities for creativity and innovation to get results fastest and most accurately.

+ Activity of naming physics rules: following the study and verification experiment. Here the pupils must think to discover a general and ruled relationship and name the rules. It also brings about chances for pupils to create methods of finding out physics rules in a fast and accurate manner.

+ Activity of knowledge reviewing and strengthening: here the pupils will systemize their knowledge and synchronize it with their available knowledge map, and apply the

knowledge that they found out in above activities to explaining new phenomena or solving requirements in physics problems. The creativity is presented in the fact that pupils can be flexible in knowledge systemizing, finding out a relationship with old knowledge, and discover the aspects which do not match with the old knowledge.

2.2. Computerized experiment

The experiment is a process in which people impact intentionally and systematically onto a subject in a particular condition to observe, study, research, check or prove a hypothesis.

There are many types of experiment, depending on classification criteria. In teaching, based on teaching purposes we can classify experiments by pupils into performance experiment and practice experiment. Based on working environments, we can classify experiments into the real experiment and virtual experiment. Virtual experiments are those built in computers, including the experiment devices and study subjects. The pupils interact through the monitor, keyboard, and mouse devices. Real experiments are those performed directly by the pupils and the experiment devices and study subjects are interacted directly. With the invention and strong development of the computer, there are more and more real experiment stages being performed or supported by the computer and sensors. Based on these criteria, we can classify real experiment into:

+ Traditional experiments in which pupils perform the experiment without computer's support.

+ Computerized experiments are those performed as traditional experiments but computers are used as a supporting tool in collecting and processing statistics by connecting to sensors or other statistic gathering devices.

Thus, we can define Computerized experiment as physics experiments which are performed directly with a connection to computers to collect and process data.

Nowadays, there has been some computerized experiment kits, one of which is the ViLabs that we developed. In the ViLabs kit, we use sensors to collect data from the experiments (for example, ultrasonic sensor SRF 05 to collect data of distance, coordinate; temperature sensor LM35; electric current sensor Hall ACS712; …); data is processed on Raspberry Pi, and monitors (laptop, smartphone, …) are connected to display the data.

With our technology capability, the computerized experiment kits in general and the ViLabs in particular have many advantages over traditional experiment equipment, such as:

+ Higher visualization in displaying data and results;

+ Saving time due to fully automatic data collection and processing;

+ Enable to collect large amount of different types of data in very short time;

+ Highly accurate data collected;

+ Saving time of experiment set-up;

+ Although the system is a computerized experiment, it does not require users to have special knowledge in computers or programming languages because user's behaviors have been studied thoroughly by us.

Furthermore, computerized experiment kits still assure the roles and functions of an experiment in physics teaching, and are a modern teaching aid which strongly supports the development of pupil's creativity competence.

2.3. Computerized experiment supports the development of pupil's creativity competence during physics teaching in high schools

As analyzed above, with its advantages, physics subject has a very good role in developing pupil's creativity competence, represented clearly through each teaching stages of the subject. These advantages are presented even more clearly with the support of computerized experiments, in particular:

Computerized experiment facilitates studying the problem quickly and showing the phenomena easily. With high-speed and accurate measuring ability and especially immediate visualized displaying (by charts, tables), computerized experiments facilitate in displaying natures of physics phenomena clearly. This speeds up and support the accurate naming of physics phenomena and describing the observation, which will be the basis for pupils to perform afterward creativi-

ty activities such as proposing a hypothesis, choosing methods of verifying the hypothesis, etc.

Computerized experiment facilitates studying difficult physics problems. Many physics phenomena happen quickly and non-visually such as oscillation, wave, alternating current, etc. and therefore they are very difficult for pupils to perform creativity activities during the study without equipment to support imagining about the phenomena. Computerized experiment creates clear chances of visualizing such phenomena, which supports pupils in studying the phenomena and their rules more actively and creatively.

Computerized experiment facilitates studying physics phenomena – rules more deeply. With strong processing capability of computers, computerized experiments have the capability of processing data quickly and strongly, which overwhelms human's manual and mental calculation capability. For example, pupils can easily survey the velocity, acceleration, dynamic energy, potential energy of an oscillating object in minute's time for collecting data. This is really important to the development of pupil's creativity competence. With their sharp capabilities, many pupils may have further and more creative questions or studies than the subject of the lesson. That is also a high aspect of creativity in learning.

Computerized experiment enables different methods of studying physics phenomena and rules. For each physics phenomena or rules, there always are different methods of studying, checking, and verifying; however, due to the limits of capabilities and equipment, people normally cannot satisfy the methods they want to perform. Once a new method is performed, the physics natures are showed more clearly, even new natures show up. Thus, computerized experiment enables teachers and pupils to propose and perform more experiment methods, which shall make the problem more interesting and pupils more active, and pupil's creativity competence are developed further.

Computerized experiment creates interest in studying mission. Due to the modernity of the equipment and closeness to advanced applications in the life, computerized experiment bring about new feelings, activeness and spirit of learning to the pupils, which, in the first step, will make pupils more active in learning knowledge, exploring phenomena, enhance teaching effectiveness and then create basis for creativity competence development.

2.4. Example: Developing creativity competence in teaching "Harmonic oscillation of spring pendulum" with aid of Vi-Labs computerized experiment kit

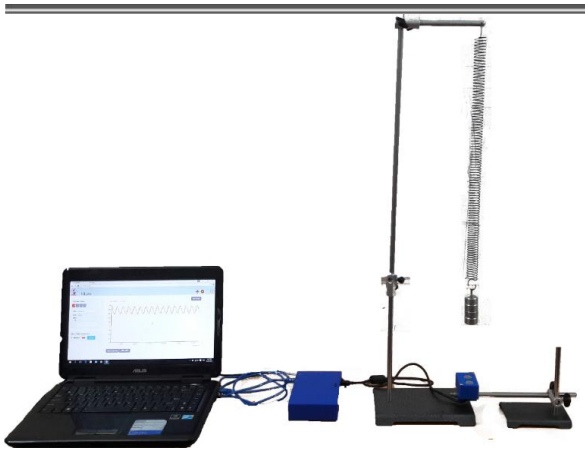

Figure 1: Diagram of experiment to survey

In Vietnam knowledge of harmonic oscillation of spring pendulum belongs to Chapter 1, Physics 12 of High School. Here, the pupils study and prove the oscillation of a spring pendulum is harmonic. However, harmonic oscillation's elongation varies according to a cosine function and the determination of elongation of the massive bob in oscillation of the spring pendulum is not easy, proving that oscillation of the spring pendulum is harmonic becomes very difficult for both pupils and teachers. Thus, the pupils almost cannot develop their creativity competence when studying this subject in the class. This can be improved a lot of due to the ViLabs computerized experiment kit.

To create chances for pupils to develop creativity competence during studying knowledge of "spring pendulum", we designed 4-stage activities for the pupils as follows:

+ Stage 1: Raising the demand of studying if the oscillation of a spring pendulum is harmonic. In this stage, the teacher will introduce the spring pendulum and bring the pupils to the questions "Is the oscillation of a spring pendulum is harmonic?" Computerized experiment kit does not show its role in this stage.

+ Stage 2: Creating methods of verifying spring pendulum's oscillation to be harmonic. This stage requires high creativity of pupils because they have to propose methods of proving harmonic oscillation of the spring pendulum from the definition of harmonic oscillation. In this stage, the teacher should be a guide to instruct pupils in finding out methods. In case pupils have difficulties in finding out the methods, teacher can support by mind-oriented questions such as:

- What is harmonic oscillation?
- How to know if elongation of an oscillation follows cosine function or not?
- How to measure the elongation of a massive bob when it is in very quick oscillation?

Then, pupils can propose at least 2 methods of verifying if the oscillation of the spring pendulum is harmonic, which are:

Method 1: "To prove elongation x follow the equation $x'' - \omega^2 x = 0$"

Method 2: "To measure elongation x by time, drawing the diagram and prove the diagram follow a sine or cosine function"

In this stage, due to the fact that Vietnam high schools do not have equipment with fast speed enough to measure elongation x of the oscillation, most of the teachers skip this stage and bring pupils to the situation that there is only one choice which is Method 1. This takes away a great chance for pupils to develop their creativity competence.

+ Stage 3: To prove the oscillation of a spring pendulum is harmonic. With the proposed methods, pupils are free to choose the method to verify the harmony of the spring pendulum's oscillation. Without limitation in measuring equipment, pupils can easily

choose method 2. After being successful with method 2, pupils will feel interesting and somehow confident because their creativity brings out good results. In technical aspects, ViLabs computerized experiment kit enable to measure elongation of the massive bob with velocity of 30 to 100 samples per seconds, store the data and draw the diagram as follows:

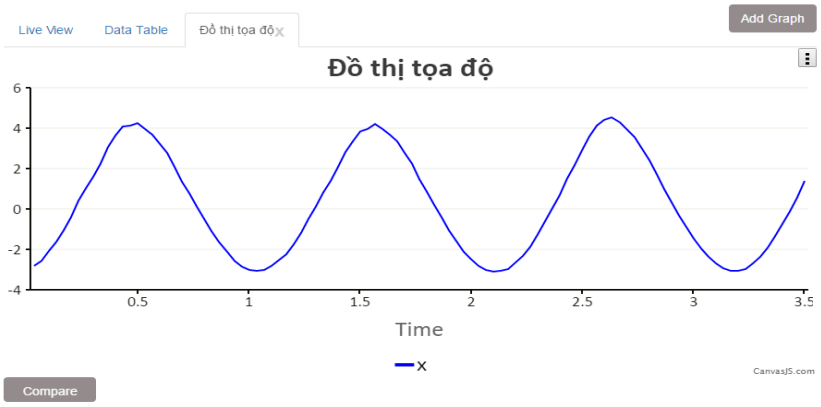

Figure 2. **Diagram of elongation of spring pendulum**

Then, to confirm this rule is a sine/cosine function by time, we can use the standard function for comparing. In specific, we use the "Compare" function to create a standard sine function by time in the form of A.sin(B.t + C) + D, to be drawn on the same diagram of the elongation, with A, B, C, D being variables. Next, we change the A, B, C, D parameters until the standard diagram and the elongation diagram almost superpose, we can confirm the elongation varies by times under a sine/cosine function rule (i.e. harmonic rule). One specific example (with elongation diagram in Figure 1) performed by us, after adding standard function and changing parameter, showed the results as in the following figure:

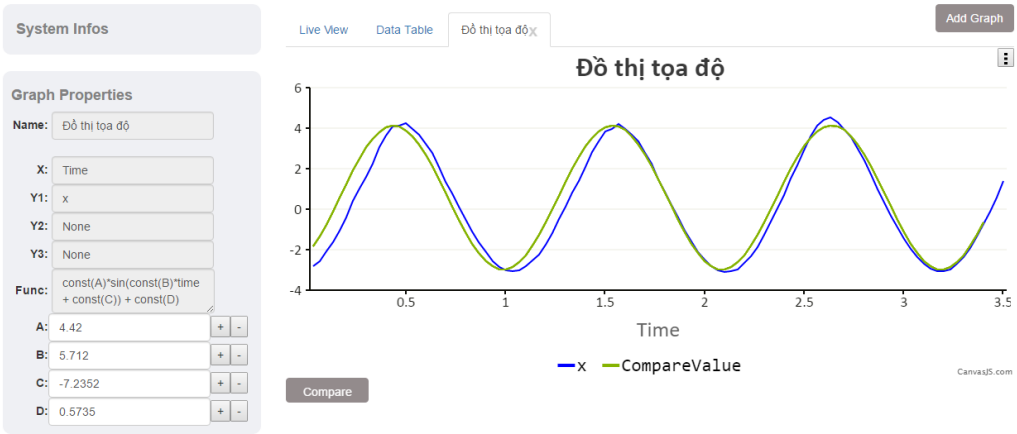

Figure 3. **Diagram of elongation and standard function for comparing**

From that comparing results, we conclude that elongation diagram is harmonic oscillation diagram with amplitude A = 4.42cm, angular frequency ω = 5.71 rad/s, initial phase φ = - 7.24 rad, and corresponding oscillation equation: x = 4.42sin(5.71t – 7.24) + 0.57 (cm, s). Then, we can calculate period of oscillation of the massive bob as:

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{5,71} \approx 1,1 \text{ (s)}$$

Comparing against the parameters measured from the experiment:

Elongation of the spring at the equilibrium position: $\Delta\ell$ = 26 cm.

Mass of the bob: m = 250 g

Gravity acceleration in Ho Chi Minh City: g = 9.78 (m/s^2).

→Period of oscillation:

$$T = 2\pi\sqrt{\frac{\Delta\ell}{g}} = 2\pi\sqrt{\frac{0,26}{9,78}} \approx 1,03 \text{ (s)}$$

We confirm that the experiment results gained by ViLabs are reliable.

+ Stage 4: To make conclusion and comments on the results. This is the last stage in the pupil's studying activities chain. Through the oriented work results, pupils will easily conclude if the oscillation of the spring pendulum is harmonic or not.

Pupil's activities organization as described above has been experimented by us in Vietnam high schools with more than 100 pupils. In such experiments, pupil's confidence is strengthened; the pupils frequently discuss, raise problems and are more creative in solving studying problems compared to those in classes without the support of computerized experiments.

3. Conclusion

Thus, creativity competence of the pupils has been developed through physics teaching and learning with the support of computerized experiment. Our experimental studies need to be performed again with measurement of creativity indicators according to popular tools such as Torrance Test of Creative Thinking, Remote Associates Test, and Khatena-Torrance Creative Perception Inventory.

Because the operation principles of computerized experiment devices are often more modern than the knowledge of the pupils, teachers should use the devices in physics phenomena which cannot be performed by basic experiment devices.

Bibliography

1. David Istance (2011), Education at OECD: recent themes and recommendations, European Journal of Education, Volume 46, Issue 1. 2011. – P. 87–100.
2. David Pepper. Assessing Key Competences across the Curriculum - and Europe, European Journal of Education, Volume 46, Issue 3, 2011. – P. 335–353.
3. Dang Thanh Hung. "Competency and education with competence approach", Vietnam Education Management Journal, Volume 43. – P. 43–49
4. OECD. Definition and Selection of Competencies: Theoretical and Conceptual Foundation, 2011.
5. Mirosław Dąbrowski, Jerzy Wiśniewski. Translating Key Competences into the School Curriculum: lessons from the Polish experience, European Journal of Education, Volume 46, Issue 3. – P. 323–334.
6. Torrance E. P. 1990. The Torrance test of creative thinking: Norms. Bensenville, IL: Scholastic testing service.
7. Tremblay Denyse. The Competency-Based Approach: Helping learners become autonomous. In Adult Education - A Lifelong Journey. 2002.
8. Weinert F. E. Vergleichende Leistungsmessung in Schulen - eineumstrittene Selbstverstondlichkeit, In F. E. Weinert (eds), Leistungsmessung in Schulen, Weinheim und Basejl: Beltz Verlag. 2001.