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Stimulate Students' Thinking and Creativity by Active Teaching Methods in the Content Section "Electromagnetic Induction" - General Physics

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Abstract: *This article introduces one of the teaching methods that is very meaningful in enhancing the activeness of learners: applying a combination of some active teaching methods to teach the chapter "Electromagnetic Induction" of the General Physics subject at the Vietnam - Korea University of Information and Communication Technology. With this method, students are almost completely proactive, self-reliant in searching and receiving knowledge. Through the article, the author presents that the class is divided into groups of students, each group takes on a certain amount of knowledge in the chapter. The lecturer guides and requires the groups to manufacture, assemble, and operate experiments related to the knowledge that needs to be built. Those experiments and knowledge are written by students using Powerpoint software and presented in reports on the fabrication and operation of the experiments to clarify knowledge for the whole class. After each group's report, students and the lecturer comment, evaluate, supplement, standardize knowledge, and together build and receive knowledge in line with the objectives of the chapter. Teaching results show that: In terms of knowledge, students acquire knowledge more deeply, apply theory to exercises better. In terms of skills, students form problem-solving ability, practical action ability, etc. That shows that the proactive teaching method contributes to innovating teaching methods in universities and colleges today. Therefore, the author wants to emphasize the ability to use proactive teaching methods in the process of teaching physics to stimulate thinking and exploration to enhance students' creativity at school.*
Keywords*: Active teaching method; Electromagnetic induction, Creative.*

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I. Introduction

The purpose of innovation in university teaching methods is to improve the quality of teaching and learning to suit the trend of globalization and international integration in education. Currently, most of the teaching methods of general physics in universities and colleges are still passive, the most common is still using chalkboards, or using computers to display slides full of text for students to take notes. These methods are no longer effective, too dependent on lecturers' presentations and rarely use active learning skills, with little interaction between students and lecturers inside and outside the classroom. Students learn passively, mainly listening to lectures by teachers, taking notes, recalling information learned, memorizing and reproducing it when taking exams or using it at work. Passive learning means that graduates will rarely participate in scientific research and will not be creative in their work.

On the other hand, general physics is a subject with many applications in science and technology, practice and life. Meanwhile, some training requirements for students of all majors after completing general physics in terms of knowledge and skills are: students must clearly understand the concepts, laws, physical phenomena, learn the structure and operating principles of technical equipment to serve as a basis for studying the major later and after graduation. Therefore, if the lecturer teaches passively, he will not be able to meet those requirements. To overcome the above limitations, with his ability and teaching experience, the author has boldly applied the active teaching method to organize the teaching of the chapter "Electromagnetic Induction" - a general physics subject, taught to classes in the Information Technology major to initially form the ability to think creatively for first-year students at the Vietnam - Korea University of Information Technology and Communications.

II. Active Teaching Method

2.1. Concept of active teaching method: is an educational method, teaching in the direction of promoting the positivity, initiative, creativity of learners. Active teaching method aims to activate, proactively activate the cognitive activities of learners, that is, focus on promoting the initiative of learners rather than focusing on promoting the initiative of teachers.

2.2. Introducing some active teaching methods

There are many active teaching methods, in this article the author only briefly introduces some teaching methods commonly used in advanced universities. The author temporarily divides active teaching methods into 2 groups depending on the level of connection with reality: Group of methods for students to learn actively and group of methods to help students learn through experience. The following is a summary table of teaching methods

NO.	METHOD NAME	BRIEF DESCRIPTION	BENEFITS FOR LEARNERS
Help students learn proactively			
01	Brainstorming	- The teacher states the problem to be solved, specifies the time and method of working. - Students work individually, quickly list ideas.	- Creative thinking -Solutions and recommendations
02	Share in pairs	- The teacher raises the issue to be discussed, sets the time and method of sharing. - Students work in pairs, listen and present opinions, defend and refute.	- Communication structure - Critical thinking
03	Organize group learning	- Teachers organize the class into groups and prepare study groups. - Each group receives a learning task and works together to complete it.	- Teamwork skills - Communication skills
04	Problem-based learning	- Teachers create “problems” related to the teaching content. - Students are assigned to solve “problems” on an individual or group basis.	- Identify and formulate problems. - Propose solutions. - Discuss, judge, and balance solutions.
05	Role playing method	- The teacher prepares a “script” with content related to the subject. - Some students are assigned roles to perform the “script”. The remaining students act as audience and evaluators.	- Critical thinking. - Awareness of personal knowledge, skills and attitudes.
Help students learn through experience			
06	Teaching through project work	- Teachers prepare the content of the subject projects. - Students are assigned to carry out the projects on an individual or group basis.	- Hypothesis - Design and implementation skills - Written communication skills - Presentation skills
07	Case study	- Teachers create situations related to the teaching content. - Students are assigned to solve situations on an individual or group basis.	- Propose solutions - Estimate and qualitative analysis.
08	Simulation	- Teachers build simulation models (hardware, software), explain rules, situations, and monitor the model as it operates. - Students perform simulations and reflect on their experiences through reports or exercises.	- Modeling skills - Survey testing skills - Graphic communication
09	Service learning	- Teachers connect with the community and link community issues with subject theories. - Students voluntarily participate, solve community problems, and apply the knowledge they have learned.	- Roles and responsibilities to society - Recognizing the context of social organizations - Eager to learn and learn throughout life

III. Organizing The Teaching Of The Content "Electromagnetic Induction" In The Direction Of Active Teaching

The General Physics course of the Department of Natural Sciences contains the content of general knowledge in the training program of university and college. This is one of the contents considered to be heavy on basic knowledge, academic in nature, causing teachers and students to spend a lot of effort to be able to complete their tasks. Applying new methods in teaching and learning is one of the solutions to help improve the learning efficiency of students, reduce psychological pressure on students, create interest and promote creativity and self-study ability of students. So, to do this, on the basis of studying the program and textbook, the author has effectively applied active teaching methods to different stages of the teaching process in some lessons and contents of "electromagnetic induction". From the proposed measures, the author designed some content sections towards fostering students’ self-study ability and used them for teaching at the Vietnam-Korea University of Information and Communication Technology. The results are as follows:

+ Systematize the content of the lessons in the Electromagnetic Induction section. Within the framework of this article, the author introduces 04 lessons: "Electromagnetic induction phenomenon"; "Fuel current"; "Self-induction phenomenon"; "Some applications of electromagnetic induction phenomenon".
+ Exploit active teaching methods to achieve knowledge and skills goals: group learning organization method, simulation method, role-playing method
Group learning organization method: The lecturer divides the class into groups of students, assigns each group a certain task, guides the implementation process and requires completion time. With the chapter "Electromagnetic induction", the author divides into 4 groups corresponding to the following contents:
- Group 1: Learn and present the concept of "Electromagnetic induction phenomenon".
- Group 2: Learn and present "Electromagnetic current".
- Group 3: Learn and present "Self-induction phenomenon".
- Group 4: Learn and present "Some applications of electromagnetic induction phenomenon".

Simulation method helps students experience. Lecturers ask students to prepare experimental equipment related to the task their group undertakes in advance. For this preparation, lecturers must give students directions in advance about the names of experiments related to the research content, names of equipment, how to find or make equipment. Lecturers can spend more time interacting with students outside of the instruction time until students complete the experiment. Through the process of preparing and doing experiments, students will have problems, ask themselves questions such as "why?", "why?". After completing the experiment, student groups write reports to prepare for presentation using Powerpoint software. Because they are first-year students, teachers need to support and guide students to find and read related knowledge of the group in textbooks to present theoretically and support how to use Powerpoint presentation software.
Role-playing method, let groups of students present prepared content. Student groups choose a reporter to act as the information transmitter. The remaining students act as the audience and evaluate the reports of other groups. The teacher is the one who supports, adjusts the knowledge content that students have errors, and supplements the missing knowledge in the report.

3.1. Teaching order of the chapter "Electromagnetic induction"

3.1.1. Organize student groups to prepare experimental equipment related to the task the group is undertaking.

Based on the existing knowledge, the lecturer guides the student groups to prepare equipment related to the task that the group undertakes. The content of the instructions must state: the name of the experiment, the purpose of the experiment, the names of the experimental equipment and how to buy or utilize, manufacture. This task is very important, can be considered the most important and the most difficult, because doing the experiment at first is not easy to succeed, so the teacher needs to support so that the students are sure to complete it before being able to do the next steps.

3.1.2. Guide and require students to complete the report

- Independent groups assemble the experiment and conduct the experiment at home, or in the classrooms for self-study students until successful.
- After assembling and conducting, the groups present the content to be reported according to the teacher's instructions. The report content needs to clarify: The purpose of the group's research, the experimental equipment and how to make or get it from where, assemble, conduct and state the phenomenon of the experiment, explain the phenomenon, process the experimental results, from the experimental results generalize related physics knowledge. All content is presented on Powerpoint presentation software.

3.1.3. Present the report to the class

- Groups select a representative student or several students (if necessary to assist during the experiment) to report to the class. For a successful and effective report, the teacher requires groups to practice before reporting to the class.
- The remaining groups follow the report to understand the content, evaluate the report, and ask questions, exchange and discuss.

3.1.4. Students and teachers standardize knowledge

The knowledge that student groups report may not be stated accurately, so students and lecturers need to standardize the knowledge. Student groups pose questions for the reporting group to answer. If the reporting group cannot answer, or answers incorrectly, the lecturer needs to take notes. After the groups report and question, the lecturer needs to standardize the knowledge so that it is consistent with the objectives of the lesson.

3.2. Implementation results

3.2.1. About preparing equipment, assembling experiments and conducting experiments in each group

a. Experiment for the concept of "Electromagnetic induction" (group 1)

- Experimental equipment Two magnetic plates (1) consist of many ceramic magnets placed close together. They are mounted vertically on a horizontal plastic stand and rotate easily because the plastic stand is mounted on ball bearings. Ceramic magnets (2) are used to mount the two magnetic plates. A closed wire frame (3) is wound from copper wires with a diameter of 0.07 mm, coated with insulating paint. On the wire frame, there are two pairs of wire ends with 200 turns and 400 turns. The wire frame is deformed by a thin stainless steel bar (4), easily movable, mounted below the frame. Two LEDs (5) are used to detect whether there is an induced current in the wire frame (if the light flashes, it means there is an electric current). A 12 V DC power source is available at universities.

Figure 1: Experiment on electromagnetic induction phenomenon

- With the experimental equipment in group 1, the following experiments can be performed:

+ Experiment on the appearance of induced current on the wire frame when the magnitude of magnetic induction B at the cross-section of the wire frame changes.

+ Experiment on the appearance of induced current on the wire frame when the area S of the cross-section of the wire frame changes.

+ Experiment on the appearance of induced current on the wire frame when the angle α between the normal vector of the cross-section $\vec{n}$ of the wire frame and the magnetic induction $\vec{B}$ changes.

b. Experiment on “Fuel Current” (Group 2)

- Experimental equipment for testing 300 mm long aluminum bars, with thin, solid aluminum plates (1) and 300 mm long aluminum bars, with thin, grooved aluminum plates (2). These two aluminum plates have the same size of 70 mm x 50 mm x 2 mm. The shaft has two ball bearings (3) to mount the aluminum bars and the shaft is mounted on the experimental stand (4). Two magnetic plates consisting of many ceramic magnets are closely mounted on the support with ball bearings in the experimental equipment for electromagnetic induction. 2000-turn copper wire tube, cylindrical in shape, inner diameter 40 mm, height 60 mm (5), with outputs connected to an electric plug. U-shaped steel core (6) with cross-section 10 mm x 10 mm, height 60 mm, is assembled from many insulated steel sheets together. Solid I-shaped steel block (7) and I-shaped steel block are assembled from many insulated steel sheets together (8). The steel blocks all measure 10 mm x 10 mm x 40 mm; thermometer (9), 12 V DC power source available at the University

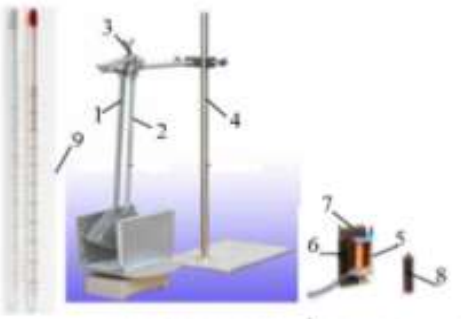

Figure 2: Experiment on Fuco current

- With the experimental equipment, students can conduct the following experiments:
+ Experiments on the oscillation of a solid aluminum plate in air and in a magnetic field.
+ Experiments on the oscillation of a solid aluminum plate and a grooved aluminum plate in air and in a magnetic field.
+ Experiments on the heating of a solid steel block and a steel block made from many insulated steel sheets when placed in a magnetic field that changes over time.

c. Experiment on “Self-induction phenomenon” (group 3)

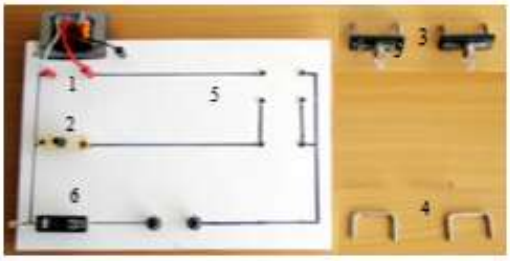

Figure 3: Experiment on self-induction phenomenon

- Experimental equipment: The wire frame (1) has an iron core with 1000 turns. The 30Ω potentiometer (2) is mounted on a base with a jack. Two 1.5V-3W incandescent lamps (3) are mounted on a base with a jack. The circuit breaker (6), the electrical connector (4) and the printed circuit board (5) have pairs of holes for connecting electrical components. To conduct experiments with the experimental equipment, it is also necessary to use a 12V DC power source available at Universities and Colleges.

- The experimental equipment allows to conduct the following experiments:
+ Experiment on self-induction phenomenon when closing the circuit.
+ Experiment on self-induction phenomenon when breaking the circuit.
+ Experiment on self-induction phenomenon when breaking the circuit.

d. Experimental equipment on "Some applications of electromagnetic induction phenomenon" (group 4)

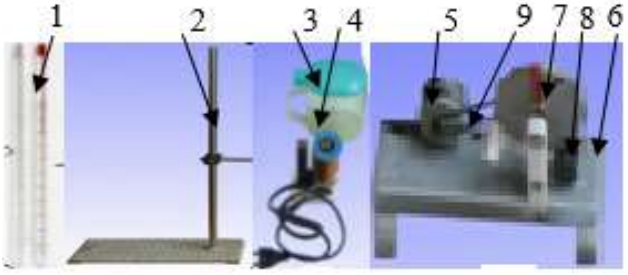

Figure 4: Experiment on the application of electromagnetic induction phenomenon

- Experimental equipment

The thermometer (1) is used to detect the heating of water in the cup (3). The stand (2) is used to install the experimental model of the induction cooker. The copper tube with 2000 turns, cylindrical shape with an inner diameter of 40 mm, height of 60 mm (4), has outputs connected to the power plug. The U-shaped steel core has a cross-section of 10 mm x 10 mm, height of 60 mm, is assembled from many insulated steel sheets together, a solid I-shaped steel block. The DC motor (5), the wooden stand (6), the aluminum block (7) is placed on the stand and can rotate around its axis, the U-shaped magnet is made from a ceramic magnet (8), the drive belt (9). In addition, to conduct experiments with the experimental equipment, the thermometer, the 12 V DC power source available at the University

- The experimental equipment allows to conduct the following experiments:
+Experiment on the functional model of the induction cooker.
+Experiment illustrating the principle of structure and operation of the electromagnetic brake.

3.2.2. About knowledge and skills

The above teaching method shows that students are almost proactive in learning activities from designing, manufacturing experimental equipment, presenting reports, to commenting, evaluating, and standardizing knowledge acquisition. Students are proactive in preparing experimental equipment. The initiative is demonstrated through the fact that they have to make their own implementation plans, search for equipment, assemble, and test run until the experiment is successful under the initial guidance of the lecturer. On the other hand, students are proactive in presenting reports in front of the class, this activity is "teaching others", then evaluating and standardizing knowledge. To do well in these activities, students must prepare at home both knowledge, presentation skills and presentation skills very carefully, so that the acquired knowledge is more deeply engraved. In addition, the lecturer has designed many activities for students, so that students will form many skills. From group activities, assigning topics to help form problem-posing skills, problem-solving skills, teamwork skills, and experimental preparation requirements to role-playing activities to present reports, students will become familiar with some technical equipment, develop practical skills, explain the operating principles of technical equipment, and public speaking skills. Active teaching methods enhance the initiative of learners, but do not mean underestimating the role of teachers. On the contrary, they require teachers to spend a lot of time interacting outside of class and helping students in activities. Teachers must act as organizers, orienters, and guides to achieve teaching goals. But in return for that hard work, students not only acquire knowledge deeply but also develop the ability to self-study and lifelong learning.

IV. Results Achieved, Conclusions

After determining the objectives and selecting appropriate experiments for each content, the author designed teaching processes for the above content and applied them to teaching in the 23rd course at the school, then gave periodic tests and assessments; collected statistics from the periodic test scores of the classes and made comments.

The results of students' periodic test scores after learning with virtual experiments and the statistical table of students' periodic scores in classes not taught with the active teaching method

Class	Total students	Excellent Student (%)	Good Student (%)	Average Student (%)	Weak Student (%)	Poor Student (%)
Physics 01	70	15 (21)	47 (67)	5 (7)	3 (5)	0
Physics 03	68	22 (32)	29 (43)	12 (18)	5 (7)	0
Physics 05	42	9 (21)	25(60)	4(10)	3(7)	1(2)

Table 1. Results of students' periodic test scores after learning using the active teaching method

Class	Total students	Excellent Student (%)	Good Student (%)	Average Student (%)	Weak Student (%)	Poor Student (%)
Physics 02	69	3(4)	26(38)	25(36)	10(14)	5(8)
Physics 04	58	0(0)	37(64)	11(19)	0(0)	10(17)
Physics 06	70	0(0)	20(29)	32 (46)	11(15)	7(10)

Table 2. Periodic test scores of students who do not study using the active teaching method

Comments: Through the statistical analysis of the score table, the author found that students were satisfied and interested in the lessons using active teaching methods, and from there the results of the mid-term test also increased: the percentage of good and good students increased significantly, the percentage of average and weak students decreased compared to the remaining classes. In addition, this percentage also increased compared to previous school years.

Here the author would like to reaffirm once again that the use of active teaching methods in teaching will bring many good and encouraging results in the learning of students in the school, creating conditions to promote the ability to self-explore, self-think, and creativity of students, thereby developing their self-learning ability in the most optimal way. At the same time, the use of experiments is also a step to improve the effectiveness of teaching.

V. Conclusions

The article introduces a teaching method that uses active teaching methods to help students think logically and, more importantly, to maximize their creativity, thereby enhancing their ability to self-study and research. After several years of implementing teaching using this method, the author has found that the lesson is

much more effective than traditional teaching methods or a lesson that only uses electronic lectures for students to copy.

Through this, the author hopes to clearly introduce the benefits of active teaching to develop students' self-study ability. Not only stopping at teaching, the author also hopes that students will continue to exploit this tool to practice logical thinking in cognition, thereby grasping knowledge in the subject more easily.

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