MINISTRY OF EDUCATION AND TRAINING
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TEACHING SOME SELECTED UNITS IN THE CHAPTER « ELECTROMAGNETIC INDUCTION » IN 11TH-GRADE PHYSICS BY THE BLENDED TEACHING OF OFFLINE AND ONLINE CLASSES

Major: Theory and Methods of Teaching Physics

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SUMMARY OF DOCTORAL DISSERTATION OF EDUCATION STUDIES

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INTRODUCTION

1. Rationale

It can be seen that the knowledge presented in the module "Electromagnetic Induction" (EI) in 11th-grade Physics coursebook gives a room for the application of blended learning (online and offline) to teach some selected units so that students can be provided with new knowledge, self-study, practice and then apply the learnt knowledge into the real life successfully. For these reasons, the researcher decided to conduct a study on "*"Teaching some selected units in the chapter "Electronicmagnetic Induction" in 11th-grade Physics by the blended teaching of offline and online classes"*.

2. Aims of the study

To propose the contents and the procedure of the teaching of some selected units in the chapter "Electronicmagnetic Induction" in 11th-grade Physics by the blended teaching of offline and online clasess (So-called B-learning) in order to develop students' creative and problem solving competency.

3. Subjects and scope of the study

- Subjects of the study:

+ Contents, methods and procedure of the teaching of Physics to high-schôl students with the use of B-learning.

+ Students' creative and problem-solving competency in the teaching of Physiscs.

+ Contents of the chapter "Electronicmagnetic Induction" in 11th-grade Physics

- Scope of the study: Contents, methods and procedure of the teaching of the chapter "Electronicmagnetic Induction" in 11th-grade Physics in some schools of Hiep Hoa District – Bac Giang

4. Hypothesis of the study

If learning contents and procedure for teaching the chapter "Electronicmagnetic Induction" in 11th-grade Physics with the use of B-learning and problem - solving learning can be appropriately applied into reality, it can help improve students' creative and problem solving competency.

5. Research tasks of the study

- Present a theoretical overview on competency-based learning in which focusing on the creative and problem solving competency.

- Study the roles of blended learning to the development of students' learning competencies.

- Study blended learning: its theoretical background and its implementation for different levels and situations.

- Provide a practical basis and suggest the implementation of blended learning in Vietnamese situation.

- Suggest and first apply blended learning to the teaching of module of EI in 11th-grade Physics.

6. Research methods

6.1. Theoretical research

6.2. Practical research

6.3. Expert referencing

6.4. Pedagogical experiment

7. New contributions of the study

7.1. Scientific contributions

Suggest and conduct the first implementation of blended learning into Vietnamese teaching and learning situation.

7.2. Practical contributions

Propose contents, methods and forms of blended learning to teach the module of EI in 11th-grade Physics.

CHAPTER 1. A THEORETICAL OVERVIEW OF THE STUDY

1.1. A theoretical overview of face-to-face learning environment

Offline classes use face-to-face teaching and learning activities. Face-to-face activities are organized with a particular time and in a particular place.

As for the roles and methods of establishing a face-to-face learning environment, Jean-Marc Denommé and Madeleine Roy (2000) presented internal and external factors of the learning environment, and the interplay of Student – Teacher –

Learning environment. They argued that face-to-face learning environment can decide teaching and learning methods: Face-to-face learning consists of facilities, teaching aids and its arrangement, teaching and learning time, etc. These factors have big influence on students' knowledge perception and learning interests. Therefore, it is essential to arrange tables and chairs in an appropriate way that allows more students' discussion, and to arrange an appropriate learning time length that allows students finish their learning tasks.

1.2. A theoretical overview of IT-based learning environment

In an IT-based teaching environment, students and teachers communicate and interact through the Internet. This is so-called Online-learning or E-learning. E-learning is an IT-mediated learning method through the interaction with learning contents and teaching methods.

In a study on roles and methods of IT-based learning, Tamara van Gog, Dominique M.A.Sluijsmans, Desire´e Joosten-ten, Brinke Frans J.Prins (2010) indicated important roles of this kind of instruction: Allow students to improve their learning performance; Allow students to acquire self-assessment skill; Support students to seek personalized feedback from peers or teachers on their task performance or assessment skill; Be flexible, by offering logically built-up sequences of tasks, but allowing full choice; and Be accessible, by allowing learners to work on the tasks whenever they wish, wherever they have Internet access.

1.3. A theoretical overview on B-learning

According to Michael B. Horn (2014) blended learning is a formal education program in which a student learns at least in part through online learning with some element of student control over time, place, path and/or pace and at least in part at a supervised brick-and-mortar location way from home. The modalities along students' learning path within a course or subject are connected to provide an integrated learning experience.

Michael Horn (2014) suggested 4 models of blended learning: (1) Rotation Model (*including: Station Rotation, Lab Rotation, Flipped Classroom, Individual Rotation*); (2) Flex Model; (3) A La Carte Model; and (4) Enriched Virtual Model. Philipp Bitzer, Matthias Söllner, JanMarco Leimeister (2015) proposed a procedure of

blended learning: starting from Introducing Lesson Objectives (Teacher's) => Working with learning contents (face-to-face) => Understanding learning objectives (online) => Practicing and discussing (face-to-face with Teacher) => Teacher (and Students) evaluate the learning performance.

1.4. Propose the implementation of blended leaning to the problem-solving process

Based on theoretical and practical basis collected, the researcher determines the next research tasks to be fulfilled as follows:

1. Propose a model of blended learning for the teaching of Physics in Vietnam, which is based on a combination of face-to-face and online learning environment that is appropriate to Vietnamese teaching and learning situation.

2. Implement the proposed blended learning model into the teaching of module of EI to develop creative and problem solving competencies.

CHAPTER 2. A THEORETICAL AND PRACTICAL STUDY ON THE USE OF BLENDED LEARNING IN THE TEACHING OF PHYSICS IN HIGH SCHOOLS

2.1. Developing students' creative and problem solving competencies through the teaching of Physics in high schools

2.1.1. Creative and problem – solving competency

2.1.1.1. Definition

In creative problem-solving process, it requires creativity (expressed in components of creative and problem – solving) helping develop the learner's creative and problem-solving competency. Creative and problem-solving competency is the ability to detect problems, to find new, unique and non-fixed solutions and then to apply them effectively to deal with the problems.

2.1.1.2. Components and indicators of creative and problem-solving competency.

Table 2.2. *Components and Behavioral Indicators of students' creative and problem-solving competency*

Stages	Behavioral indicators
IDENTIFY AND STATE THE PROBLEM	

1. Identify and state the new problem of physics	ST1. Anlyze real-life situations to find out the problem of physics. ST2. State the problem to be solved.
SOLVE PROBLEMS AND CONCLUSIONS	
2. Find, select, implement and suggest solutions to deal with the problems of physics	ST3. Find and select the solution based on theoretical and experimental research. ST4A. Solve the problem by theoretical research: State the problem, suggest and present the write down the theretical solution to the problem. ST4B. Propose the hypothesis and its theoretical basis. ST5. Modify the problem and its theoretical solution or the hypothesis and its theoretical basis.
3. Propose and conduct the experiments	ST6. Propose experiments: Based on theoretical conclusions or hypotheses, making inferences to find out the resutls to be checked. Propose the experiment to check: what type of equipment is used, the equipment is arranged, how the experiment is conducted and what expected results are. ST7. Conduct experiments: Arrange the equipment, carry out the measurements, collect resutls, analyze the results and draw conclusions.
4. Find, select and improve the old experiment equipment or create new equipment.	ST8. Analyze (the collected results) to find out the simplest experiment with the lowest error. ST9. Select and improve the existing equipment for better use ST10. Design and create new equipment.
PRACTICE, CONSOLIDATION AND EXTENSION	
5. Applying new knowledge	ST13. Apply learnt knowledge to solve physics problems with new information in the workbook, methods of apply knowledge to solve the physics problems. ST14. Apply the learnt physics knowledge to explain and deal with new phenomena found in real life. ST15. Apply the learnt physics knowledge to explain the structure and working principle of a technical application.

	ST16. Propose the production of a technical application based of physics knowledge.

2.1.2. Methods for developing students' creative and problem-solving competency

Method 1: Create a favorable learning environment for students

Method 2: Organize creative activates associated with providing new knowledge

Method 3: Practice giving predictions and proposing hypothesis

Method 4: Practice proposing methods for testing the hypothesis

Method 5: Solve creative physics problems

Method 6: Apply the learnt knowledge to deal with real-life situations

2.1.3. Teaching Physics in high schools to develop students' creative and problem-solving competency

2.1.3.1. Identify the teaching objectives, contents, methods, teaching aids and assessment tools

2.1.3.2. Use the problem-solving processes to develop students' creative and problem-solving competency

Table 2.4. Activities for stages of discovery learning and problem-based learning

Stages	Procedure (including 4 activites)
1. Identify the problem to be solved from the existing situations: from existing knowledge, experiences, experiments, exercises and historical stories, etc. ⬇ 2. Stae the problem to be solved (or the question to be answered)	Activity 1. Analyze existing situations
⬇	⬇

3. Solve the problem - Speculate the possible solutions to solve the problem: via theoretical reserach and/ or experimental research - Adopt the speculated solutions		Activity 2. Discover new knowledge
⬇		
4. Draw conclusions (new knowledge)		
⬇		⬇
5. Applied the new knowledge to deal with the next tasks/ problems		Activity 3. Practice and do experiment
		Activity 4. Make implication and extension

Activity 1. Study real-life situations

1. Aims: To collect and analyze the data to figure out real-life problems

2. Contents and procedure:

- Procedure:

+ Teacher assigns the learning tasks (clarify the contents, methods, procedure and criteria to evaluate the final product)

+ Students work individually or in groups to perform the task (through real-life situations, material referencing, and video referencing). Report and discuss (time, place and method). Find out/ state the problem/ demand arisen in the real life (with the Teacher's help).

- Contents: Study physics phenomena through experiments, learn in nature, do exercises, history stories or technological items or any products that apply physics knowledge (by collecting the data, analyzing the collected data, questioning). Assess the physics phenomena and technological products (giving comments or predictions)

3. Expected results: Degrees of task completion (recording data on the physics phenomena, and technological items or products; assessing and making questions on phenomenon and technological items or products).

4. Evaluation and Conclusion

- Teacher interviews, gives feedback and draws conclusion

- Students agree on the conclusion

Activity 2. Investigate and build knowledge

1. Aims: Introduce new knowledge

2. Contents and procedure

- Procedure:

+ Teacher assigns learning tasks (clarify tasks of reading/ listening/ seeing/ doing and recording data, explaining and creating new knowledge)

+ - Students study how to solve problems at home or in class, then present and discuss new knowledge in class.

- Contents:

+ Study the physics knowledge presented in the course book, learning handouts and online lessons, doing experiments to build knowledge and forming new knowledge.

+ Students apply the new knowledge to answer questions and deal with problems found in real life as presented in Activity 1.

3. Expected results: Degrees of task completion (identifying and recording data, explaining and introducing new knowledge).

4. Evaluation and Conclusion

- Teacher facilitates and draws conclusion on the new knowledge. Giving feedback, editing the answers/ results of solving real-life situations.

- Students agree on the conclusion.

Activity 3. Practice and conduct experiments

1. Aims: Develop skills of applying new physics knowledge, skills of practicing and doing physics experiments.

2. Contents and procedure

- Procedure:

+ Teacher assigns the learning tasks (giving a set of questions/ exercises with a limited number, asking students to practice doing the exercises and doing experiments).

+ Students answer the questions, do the exercises, practice and do experiments. Report and discuss (selecting groups of students with different results to clarify the learning outcomes and methods)

- Contents: Answer questions about physics phenomena, and physics theories; do qualitative and quantitative exercises. Practice and do physics experiments.

3. Expected results: Different degrees of task completion (completing questions/ exercises/ practice/ experiments)

4. Evaluation and conclusion

- Teacher give comments, makes evaluation and draws conclusion on students' performance, methods of doing exercises, results of doing practice and doing experiments.

- Students agree on the conclusion.

Activity 4. Apply and develop the knowledge into the reality

1. Aims: Apply and develop the new knowledge into the reality

2. Contents and procedure

- Contents: Identify solve problems and situations arisen in the lesson and in the real life.

- Procedure:

+ Teacher assigns the learning tasks (clarify the criteria and final results).

+ Students work individually or in groups to perform the learning tasks outside the classroom or at home; Report the results and discuss (by articles, PowerPoint or videos) with appropriate presentation (exhibition, workshops,).

3. Expected results: Articles, PowerPoint, videos, collections of pictures and models for the completion of the assigned tasks.

4. Evaluation and conclusion

- Teacher gives feedback and draws conclusion

- Students agree on the conclusion

2.2. Applying blended learning in problem-solving in the teaching of Physics in high schools to develop students' creative and problem-solving competency

2.2.1. Blended learning

2.2.1.1. Levels and models of blended learning

Flipped Classroom (Figure 2.3): This learning model centers on individual work and collaboration. Each student is assigned a learning task to self-study and interacts with others on the Internet. Students perform the task with the teacher's online instructions. Afterwards, students report the results to the teacher via the Internet. In the classroom, students discuss the task results and apply the gained knowledge into practice.

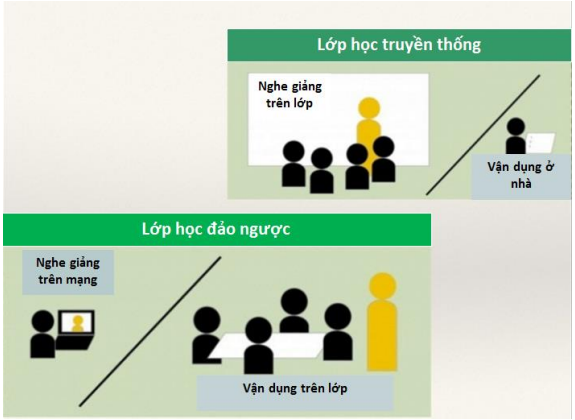

Figure 2.3. Compare Flipped Classroom and traditional classroom

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2.2.3. Criteria on blended learning

Criterion 1. Assure to meet the learning objectives

Criterion 2. Assure to provide appropriate learning materials and lab equipment to meet the learning objectives.

Criterion 3. Assure to match with students' conditions.

Criterion 4. Assure to match with learning individuals.

Criterion 5. Assure to match with learning methods.

2.2.4. Procedure of designing a blended learning lesson

2.2.5. Testing and assessment in blended learning

Methods of testing and assessment in blended learning are illustrated in Figure 2.7.

2.2.6. Using blended learning in problem solving process

2.2.6.1. Reasons for developing students' creative and problem-solving competency through blended learning

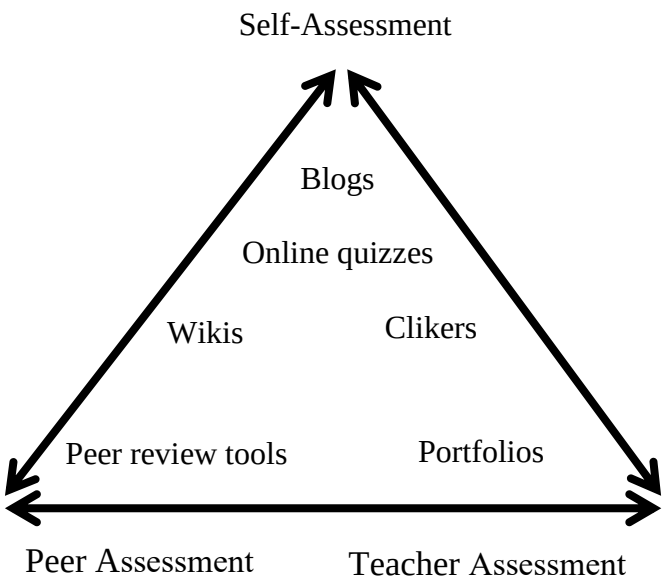

Figure 2.7. Testing and assessment in blended learning

Using blended learning brings many opportunities for students to:

- Conduct offline and online *learning activities* flexibly and have more time to think and discover.

- Access different *learning material sources* in images, videos, ullustrations, etc. to study physics phenomena and apply solutions to deal with problems.

- Collect Feedback on their learning process, and then based on the feedback to adjust the learning process to increase the learning effectiveness.

- Have *Interactions* with partners, teachers and learning materials to conduct learning activities more easily.

- Self-assess their learning process more easily combined with their teachers' assessment to have some changes in their learning to increase the learning effectiveness.

This also creates opportunities for students to develop their creativity during their learning process to find out the solutions to deal with the problems. The teacher can take advantage of this to apply teaching methods which help develop students' creative and problem-solving competency.

2.2.6.2. Using blended learning in problem solving

Table 2.8. Using B-learning in problem-solving learning

Steps of problem – solving learning process	In-class activities	Online activities
1. Generate problem to be solved	- Analysis physics phenomena/ real-life situations via videos, pictures, simulation; Study experiment equipment, conduct experiments, solve exercises, historical story… - Raise questions and suggest answers to those questions, from which to generate the problem to be solved	Analysis physics phenomena/ real-life situations via videos, pictures, simulation; solve exercises; historical story…
2. State the problem to be	Discuss and state the problem to be solved (questions to be answered)	

solved (questions to be answered)		
3. Solve the problem - Propose solutions to the problem based on the theoretical background and practical surveys. - Apply the proposed solutions to solve the problem	Discuss to find out and then adjust solutions to deal with the problem	Study E learning lessons to build new knowledge
4. Draw conclusions (new knowledge)	- Draw conclusions on answers to the questions and new knowledge - Answer questions and complete all the assigned learning tasks.	
5. Apply the new gained knowledge to deal with the next learning tasks	- Conduct experiments - Present and report results of learning tasks and experiments	- Study the theoretical background and conduct experiments - Do exercises
	Conduct experiments, present and report the results	Study physics phenomena and technological products

2.2.6.3. Use blended learning for practice and extension of the learnt knowledge

2.3. Study the real situation and teaching conditions of the module "Electromagnetic Induction"

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2.3.3.4. Some conclusions

Based on the analysis of data collected from the surveys on teachers, students and teaching experiments 1 and 2, some conclusions in blended learning can be drawn as follows:

- It is essential to teach units of EI as one module.

- It is essential to teach the module through problem-solving process, in which learning process is divided into smaller learning tasks so that students can self study and discuss in the classroom.

- It is essential to combine face-to-face learning and online learning in order for students to take on the learning task, study the learning materials, self-study, discuss in groups and submit the final results for the learning task.

- Guide students to perform the learning tasks and then report, discuss the learning results for teachers to evaluate, give feedback and draw conclusion. Give much time for students to report results, do experiments and discuss the results to draw conclusions.

CHAPTER 3. CONTENT DESIGN AND USING BLENDED LEARNING TO TEACH THE MODULE "ELECTROMAGNETIC INDUCTION"

3.1. Identify the learning objectives and learning contents of the module of EI

3.1.1. Identify the problems to be solved in the teaching of the module of EI

- Lesson's name: Electromagnetic Induction

- The problems that need to be solved in this lesson are "On which physics quantities does the number of flux lines through S area depend on which factors and how it depends on those factors? When there is an induced current in the coil, based on what principle is the direction of the current in the coil determined? How does the magnitude of the electromotive force in the coil depend on which factors and how it depends on those factors?".

3.1.2. Select learning contents to design the lesson

The teacher asks students to conduct some experiments on EI (the motion of magnet in the coil) and raise some questions about the procedure and results. This leads to the problems to be solved in the lesson. After observing the changes of the

direction and strength of the electric current, students will have more motivation to learn new knowledge in the lesson such as: Flux, Lenz's Law, and Faraday's Law to solve the problems arisen in the experiments.

Organize learning activities for students to practice and develop the gained knowledge about: Electromotive force in a segment of a moving wire in the magnetic field; Foucault current; Electromagnetic self-induction; self-induced electromotive force. Study the structure and working principle of some applications used in the real life.

3.1.3. Determine the standards of knowledge and skills and objectives for students' competency development

Based on learning contents presented above, learning process focuses on developing students' creative and problem-solving competency: Proposing and selecting appropriate lab equipment and experiment methods when conducting experiments on EI, Foucault current, and self-induction. Apply the learnt knowledge to learn about the Foucault electric current, and self-induction. Do exercises and experiments. Explain the structure and working principle of some technical applications.

3.2. Methods of teaching and assessing the module "Electromagnetic Induction:

3.2.1. Diagram of students' learning activities

Table 3.2. Procedure of the teaching of the unit "Magnetic flux"

Steps	In-class activities	Online activities
1. Generate problem to be solved	Carry out the experiment in which the permanent magnet bar moves when the lead coil is connected to the galvanometer. The result shows that the electromechanical needle deviates from the equilibrium position. This produces an induced current called *Electronicmagnetic Induction*.To have the induction, there should have changes in the number of magnetic flux lines through the coil.	

2. State the problem to be solved (questions to be answered)	On which physics quantities does the number of flux lines through S area depend on which factors and how it depends on those factors?	
3. Solve the problem	(After online at-home learning) - Point out the characteristics of magnetic flux lines of a straight magnet: The density decreases when they move far from the magnet. - Hypothesis: The number of magnetic flux lines through coils depends on the magnetic field B of the magnet, the area in the direction perpendicular to the magnetic flux line (area S and angle α made by the normal vector of S and $\vec{B}$). - Corollary: If B changes, S, the number of magnetic flux lines through the coil changes. At that time, induced current appears in the coil. - Proposed experiments to check the corollary: Change the magnetic field B by changing the electric current of the electromagnet by variable resistors, change the area S by pulling-compressing the coil on magnet plate, changing the angle α by rotating the magnet or coil on U shape magnets. - Conduct experiments and draw a conclusion: In all the experiments, there exists an induced current.	(At-home learning) Study E-learning lectures on experiments done in class, and study the characteristics of magnetic lines of straight magnets to: - Indicates the number of magnetic flux lines through the coil depending on the factors - Introduce the experimental plan to test the prediction on how to change the magnetic field lines. Explain why there are these experimental options.

4. Draw conclusions (new knowledge)	- Conclusion: The number of magnetic field lines through the coil depends on B, S and α. To characterize this property, construct the concept of magnetic flux Φ: = BScosα. The meaning of Φ: is to describe the number of magnetic lines through the area S.	Study ELearning lesson: Conclusions on the meaning of magnetic field.
5. Apply the new gained knowledge to deal with the next learning tasks	Propose more ways to make changes on Φ: Wire segment sliding on open wire frame in magnetic field.	Explain the results of the experiment: The coil is placed near the electromagnet and it stops the current through the coil.

3.2.2. Methods of testing and assessment in the teaching of the module "Electromagnetic Induction"

* Summative assessment: After some learning tasks and the final test, assess students' memorization and application of the learnt knowledge to do multiple choice questions.

* Formative assessment: To evaluate degrees of task fulfillment as presented above (focusing on the italic aims in formative assessment) and indicators of student's creative and problem solving competency. Teacher uses a set of criteria to evaluate combined with students'self assessment. The criteria of evaluation are described as follows.

Activity 3.1. Determine induced electric current in some cases

Ord	4 pts	3 pts	2 pts	1 pt	Final score
1	Propose 05 ways to change the magnetic flux: change B or S or α.	Propose 02 ways to change the magnetic flux.	Propose 01 ways to change the magnetic flux.	Propose no ways to change the magnetic flux.	

2	Propose ways of assessing e depending on 03 quantities B, l, v.	Propose ways of assessing e depending on 02 quantities.	Propose ways of assessing e depending on 01 quantity.	Propose no ways of assessing e depending on quantities.	
3	Be able to conduct the correct arrangement of experiment equipment, make measurements, collect the results, analyze the collected results and draw conclusions.	Be able to conduct the correct arrangement of experiment equipment, make measurements, collect the results, analyze the collected results	Be able to conduct the correct arrangement of experiment equipment, make measurements and collect the results.	Be able to conduct the correct arrangement of experiment equipment, make measurements.	

3.2.3. Organize learning activities using a blended learning process

Activity 1. Study EI

1. Aims

- Observe if there is an electric current when a magnet moves in and out the current coil.

- Find out the correlation between the direction of the electric current and the moving direction of the magnet, and between the strength of the current with the moving speed of the magnet.

- Present a new problem

2. Contents and procedure

In class, students observe an experiment on EI (magnet moving in a current coil) conducted by the teacher and then do the following tasks:

- Describe the procedure of the experiment and the report the results collected.

- Give comments on the results collected: Where does the electric current come from? What factors do the direction and the strength of the current depend on?

- Propose some hypotheses on:

+ Causes to the presence of the electric current

+ Factors affecting the direction and the strength of the current.

3. Expected results

3.1. Describe the procedure of the experiment and the results collected

*** Lab equipment:** Copper wire, magnet, electrometer

*** Procedure and results of the experiment:**

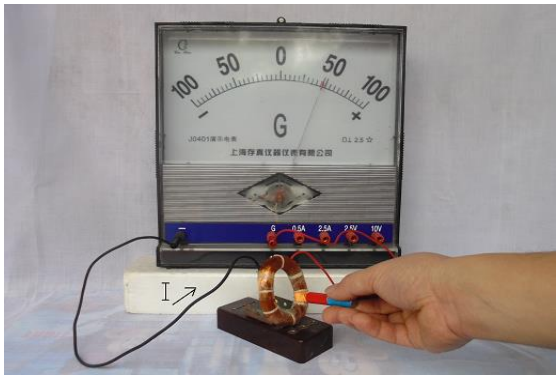


Figure 3.3. Experiment on the movement of the magnet

- Connect the two ends of the coil to the galvanometer to make a closed circuit (Figure 3.3);

- Place the N pole of the magnet into the coil, the needle deviates to the right;

- When the magnet stands still in the coil, the needle does not deviate;

- Take the N pole of the magnet out of the coil, the needle deviates to the left;

- The faster the magnet is put forward or taken out of the coil, the more the needle deviates. In contrast, the more slowly the magnet is put forward or taken out of the coil, the less the needle deviates.

3.2. Evaluate the results of the experiment

- Only when the magnet moves into or out of the coil does the needle deviate. This indicates that only when there is a change in the magnetic field is there an electric current.

- The direction of the electric current depends on the increase and decrease of the magnetic field in the coil and its direction.

- The intensity of the electric current increases when the moving speed of the magnet increases and vice verse.

3.3. Propose some hypotheses

- When the magnet moves into or out of the coil, there is an electric current in the coil.

- When there is a change of magnetic filed in the coil, there is an electric current in the coil.

- The direction of the current depends on the direction of the magnet and the direction of the magnetic flux in the coil.

- The more the speed of the magnetic filed varies, the stronger the electric current is.

4. Evaluation and Conclusion

Teacher gives feedback on some hypotheses and then points out some problems to be solved: On which physics quantities does the number of flux lines through S area depend on which factors and how it depends on those factors? When there is an induced current in the coil, based on what principle is the direction of the current in the coil determined? How does the magnitude of the electromotive force in the coil depend on which factors and how it depends on those factors?.

Activity 2. Law of Electromagnetic induction, Lenz's Law and Faraday's Law

1. Aims

- Build the knowledge about EI, Lenz's Law, and Faraday's Law.

- Explain where the electric current comes from and identify the direction and its strength in some particular cases (when the magnet moves into or out of the coil).

2. Contents and the procedure

*** Online:** Students are asked to self-study with the help of ELearning lessons Figure 3.4 to answer questions as follows:

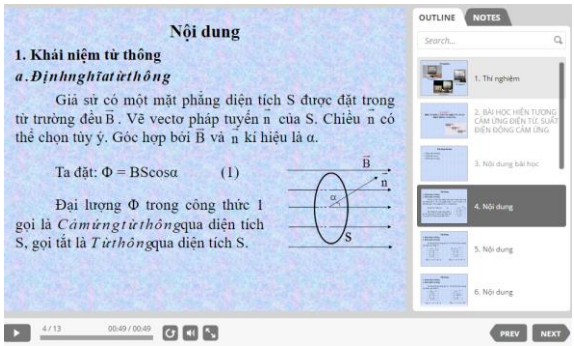


Figure 3.4. Snapshot of a lesson on EI

- How to change the number of flux lines:

Question 1. The number of flux lines through the coil depends on which element and how it depends on that factor?

Question 2. Are there any experiments to test hypotheses in Question 1? Why should this experiment be conducted?

- Find the rule to determine the current flow:

Question 1. The direction of the magnetic field generated by the current in the coil relative to the magnetic field of the magnet?

Question 2. Are there any experiments to test hypotheses in Question 1?

- How to determine the magnitude of current:

Question 1. How does the current in the coil depend on the Magnetic flux variation?

Question 2. Are there any experiments to test hypotheses in Question 1?

*** In class:**

- The student group presents the answers of the questions

Teacher gives instructions on Question 2, Part (1), (2), (3) for students to draw on paper at home.

- Teacher ask students to read textbooks to learn and present information about magnetic flux and the law of electromagnetic induction

- Teacher choose 02 groups of students to explain results of their experiments at class.

3. Expected results

3.1. How to change the number of flux lines through S area

The number of flux lines through the area S depends on the magnitude of the magnetic field $\vec{B}$ of the magnet, the area S is limited by the coil, the angle is equal to $\vec{B}$ and the $\vec{n}$ normal of S.

3.2. How to determine the current direction

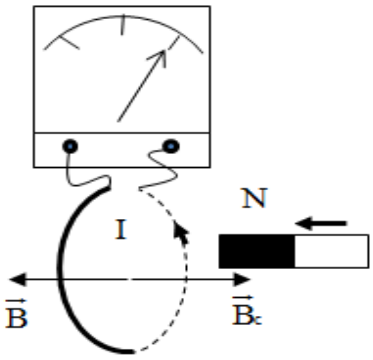
- Rule: When the flux lines through the coil increases, the magnetic field $\vec{B}_c$ is opposite to the magnetic field $\vec{B}$ and vice versa.

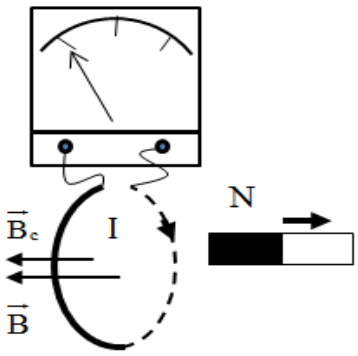
- General: Induced current has dimensions so that the magnetic field it produces is effective against the cause of its birth (Lenz's law).

3.3. How to determine the magnitude of current

$$e_c = -\frac{\Delta\Phi}{\Delta t}$$

3.4. Explain the results of the experiment





4. Evaluation and Conclusion

Teacher interviews students about the knowledge and asks them for explanation on the results of the experiment. After that, teacher asks students to propose some methods of testing the hypotheses on the direction, and the strength of the induced electric current.

Activity 3.1. Determine the induced electric current in some cases

1. Aims

- Develop the skills of applying Law of EI, Lenz's Law to identify whether there is an induced electric current in some cases.

- Conduct experiments to test the causes to the presence of the electric current and methods to identify the direction of the induced electric current.

2. Contents and procedure

*** Online:**

Students are asked to read the materials and watch the recorded videos on the procedure of doing the previous experiment, and then propose some new experiments to create induced electric current and identify its direction (Answer questions 2-items (1), (2), (3) in Activity 2; draw the diagram on the paper, take photos, and then submit to the teacher):

+ Move the magnet to forward the tube.

+ Let the wire frame rotate in the magnetic field.

+ Place the coil near the tube with a changed magnetic field.

+ Drag and compress the wire frame in the magnetic field.

+ Move the steel core in or out of the tube placed in the magnetic field.

+ The current carrying wire moves in the magnetic field, slipping on the U-shaped wire frame.

*** In class:**

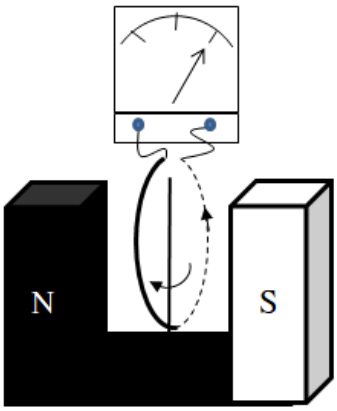
- Teacher selects 2 groups with different results to present about the hypotheses. Teacher asks students to do the experiment and then give comments on the strength of the induced electric current in the experiment.

- Students conduct the experiments to test the proposed hypotheses

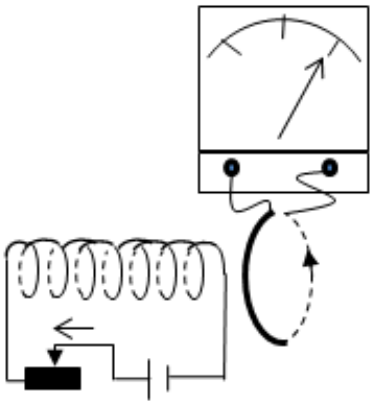
3. Expected results

3.1. Methods of creating induced electric current

- Figures below show 4 experiments and their results:



+ Let the wire frame rotate in the magnetic field



+ Put the coil near the wire tube with the magnetic field changing.

3.2 Results on the direction and the strength of the electric current in the moving wire.

4. Evaluation and Conclusion

Teacher gives feedback and draws conclusion on the results of the ways to create induced electric current and its direction, the formula to calculate the strength of the induced electric current in the moving wire and methods of testing the hypothesis. Give feedback on the strengths of the current in different experiments.

Activity 3.2. Practice and consolidation

Activity 4. Application and extension

Activity 5. Practice

3.3. Management online learning activities

On the Web http://truonghocketnoi.edu.vn (How to access the lecture: choose Tỉnh/Thành is Bắc Giang, name: HS.00311.02185, password: 12345678, click

"Không gian trường học"→choose tearcher: Nguyễn Thị Thanh, grade: 11→choose link for lecture).

CHAPTER 4. TEACHING EXPERIMENTS

4.1. Reasons, subjects and methods of teaching experiments

4.1.1. Reasons for conducting teaching experiments

- To check the reliability and feasibility of data on the Internet, and of the lab equipment to have some changes to meet the criteria of the teaching and learning process.

- Have first evaluation on the teaching process to the aims of developing students' creative and problem-solving competency.

4.1.2. Subjects and methods of teaching experiments

4.2. Procedure of teaching experiments

4.2.1. Time and place of teaching experiments

- Teaching experiments are conducted with 3 rounds: Round 1 – school year 2014 -2015, Round 2 – school year 2015 -2016, Round 3 – school year 2016 -2017

Table 4.1. Details of experimental groups

School year	High school	Class	Number of students	Name of the teacher
2014-2015	Hiep Hoa No.1 High School	11A3	16	Pham Kim Chi
2015-2016	Hiep Hoa No.1 High School	11A3	36	Ha Manh Dac
2016-2017	Hiep Hoa No.1 High School	11A1	43	Nguyen Thi Thanh

4.2.2. Procedure of the teaching experiments

4.3. Analysis and evaluation of the results collected from teaching experiments

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4.3.4. Analysis on the teaching process and evaluation on the students' learning process

4.3.4.1. Analysis on the teaching process and evaluation on students' performance

Figure 4.1. Students conduct the experiments

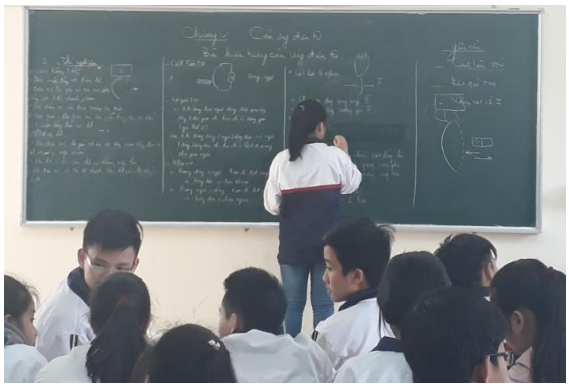
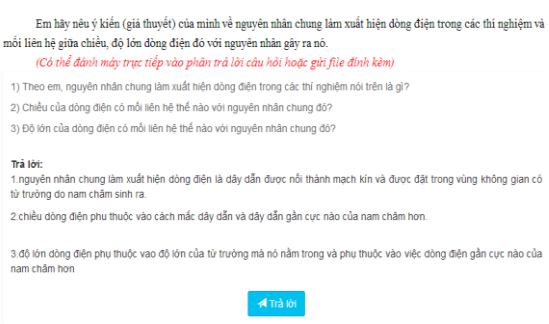


Figure 4.2. Students present the results of the experiments

* Activity 1: For the first face-to-face class, Teacher asks students to conduct 3 experiments on EI and then present: the procedure of the experiments, results of the experiments, and the strength of the induced electric current. Students work in groups to conduct the experiment as required (Figure 4.1). Teacher asks a group member to record the procedure and results of the experiments and then give comments on the direction and the strength of the induced electric current. Afterwards, 03 group representatives go to the board and write down the results of the 3 experiments. (Figure 4.2). Teacher elicits feedback on the procedure and results of the experiments, and asks students to give comments on the direction and the strength of the induced electric current. The results of these experiments show that there is an induced electric current created in the coil and the strength of the current varies. Here, teacher asks students to answer the questions as: Where does the induced electric current come from? How do these causes affect the direction and the strength of the induced electric current? What is the common cause of creating induced electric current in these experiments? And how does it affect the direction and the strength of the induced electric current?

Figure 4.3. Students self study on the Internet



Em hãy nêu ý kiến (giả thuyết) của mình về nguyên nhân chung làm xuất hiện dòng điện trong các thí nghiệm và mối liên hệ giữa chiều, độ lớn dòng điện đó với nguyên nhân gây ra nó.

(Có thể đánh máy trực tiếp vào phần trả lời câu hỏi hoặc gửi file đính kèm)

1) Theo em, nguyên nhân chung làm xuất hiện dòng điện trong các thí nghiệm nói trên là gì?

2) Chiều của dòng điện có mối liên hệ thế nào với nguyên nhân chung đó?

3) Độ lớn của dòng điện có mối liên hệ thế nào với nguyên nhân chung đó?

Trả lời:

1.nguyên nhân chung làm xuất hiện dòng điện là dây dẫn được nối thành mạch kín và được đặt trong vùng không gian có từ trường do nam châm sinh ra.

2.chiều dòng điện phụ thuộc vào cách mắc dây dẫn và dây dẫn gần cực nào của nam châm hơn.

3.độ lớn dòng điện phụ thuộc vao độ lớn của từ trường mà nó nằm trong và phụ thuộc vào việc dòng điện gần cực nào của nam châm hơn

Trả lời

Figure 4.4. Students' answer online questions

To have more time for answering questions raised in the class, teacher asks students to watch recorded videos on the experiments and answers the questions by registering an online lesson. (Figure 4.3). Each student watches 03 videos on the 03 experiments, study learning materials (course book, handouts, and models) and answers the questions at the class. (Figure 4.4).

4.3.4.2. Evaluation on students' creative and problem-solving competency

When learning the module of EI, students are provided activities and learning tasks to show their creative and problem-solving competency: Students do experiments, giving comments and explanations on the results of the experiments. They have to self-study to get the knowledge to explain the EI, self-induction, Foucault current. Students have to observe and present how the flux changes and propose the method of testing that change. Students have to explain their choices of lab equipment to do experiments on self-induced circuit. Students can answer some open-ended questions that require creativity (predicting the movement of the induced current predict and explain physics phenomena arisen in new situations). Propose methods of testing electromotive force in the wire moving in the magnetic field. Students can apply the learnt knowledge to explain the structure and working principle of some technical applications.

Below is the table that shows students' results on the activities they take part in. The scores are measured by the criteria to evaluate students' creative and problem-solving competency.

Table 4.15. Rank students' performance according to criteria of evaluating creative and problem-solving competency (by activities)

TT	**Level** (measured by indicators)	**Level 1** 3,25<Đ≤4	**Level 2** 2,5<Đ≤3,25	**Level 3** 1,75<Đ≤2,5	**Level 4** 1<Đ≤1,75
1	Activity 1 (Doing experiments) Indicator: ST1	22/43 (51,2%)	17/43 (39.5%)	4/43 (9.3%)	0 (0%)

2	Activity 2 (Present and explain the results of the experiments) Indicator: ST14	39/43 (90.7%)	1/43 (2.3%)	3/43 (7.0%)	0 (0%)
3	Activity 4 (Self-induction) Indicators: ST8, ST10, ST14	12/43 (27.9%)	25/43 (58.1%)	6/43 (14.0%)	0 (0%)
4	Activity 5 (Foucault current) Indicators: ST13, ST14	0/43 (0 %)	22/43 (51.2%)	21/43 (48.8%)	0 (0%)
5	Activity 5 (Current carrying wire) Indicators: ST8, ST14	1/43 (2.3%)	30/43 (69.8%)	12/43 (27.9%)	0 (0%)
6	Activity 6 (Answer open-ended question) Indicators: ST13	1/43 (2.3%)	16/43 (37.2%)	26/43 (60.5%)	0 (0%)

Analyze the indicators of creative and problem solving competence Indicator: ST6. Propose the experiment to test the hypothesis (shown 2 times in Activity 4. Study the electromagnetic induction, Activity 5. Learn Fu-electric current. The problem of moving conductor): In activity 4, when students are asked to propose experiments to identify how to change the magnetic flux, there are 37 of 43 (86%) students reach level 1, 2 and above. In activity 5, when students are asked to make experiments to check the direction of induced current in the conductor segment, and electromotive force e in the electric wire segment that is proportional to B, l, v, there are 31 of 43 (72%) students reach level 1, 2 and above. By analyzing students' tasks, it is found that, the task in Activity is more complicated. Thus, although the number of students reaching level 1 and 2 decreases in activity 5, it can be concluded that students' creative and problem solving competence is improved, as shown in ST6 Indicator.

CONCLUSION AND RECOMMENDATIONS

1. Conclusions

Some conclusions can be drawn from the results of the study as follows:

(1) Teachers and students must have computers to connect to the Internet and know to use computer and the Internet in B-learning.

(2) Online learning environment allows students to take on the learning tasks, discuss in groups and perform the learning tasks (learning new knowledge, doing the exercises integrated with images, videos; studying the technical applications via videos and simualation…) and help teacher should record and analyze students' learning process to make some changes to their in-class teaching activities.

(3) Face-to-face learning environment allows students to discuss in groups, do experiments, practice, studying the technical applications, studying the technical applications, report the final results.

(4) Lab equipment plays an important role in solving difficulties and problems students face in their learning process when learning chapter Electromagnetic induction.

(5) There should be a variety of learning materials provided for students to self study and work in their groups to solve the problems.

(6) Face-to-face learning environment, online learning environment is convenient to implement measures to develop students' creative and problem-solving competency in learning physics.

(7) Blended learning can help develop students' creative and problem-solving competency in learning physics. The learning activities should be designed based on behavioral indicators of problem solving and creative competence and measures to develop students' creative and problem-solving competency in learning physics.

(8) Results collected from teaching experiments confirm the hypothesis of the study.

2. Some recommendations for implication

For a better implication of blended learning in teaching physics to develop students' creative and problem-solving competence, the author would like to propose some recommendations as follows:

(1) Regularly encourage and get students familiar with self-study (self-discover new problems, suggest hypotheses, gain new knowledge, and propose new experimental plans.

(2) Create opportunities for students to regularly use online learning materials for their self-study.

(3) Enhance the use of blended learning to teach physics at the different grade levels.

(4) Provide training courses for teachers of physics to familiarize with topic-based (content -based) teaching (design different contents into 01 lesson) to develop students's creative and problem-solving competence in particular.

(5) Increase the training for teachers of physics on the use of online classes in their teaching.

3. Some suggestions for further studies

(1) Evaluate the behavioral indicators of creative and problem solving competence with a larger number of students, and at more diverse levels of students, and in different regions.

(2) Study the use of blended learning with different teaching contents at different grade levels.

(3) Continue to develop learning materials and experiment equipment for offline classes, as well as to develop E-learning lectures.

(4) study the provision of training for teachers on the use of blended learning approach. Propose solutions to increase the effectiveness of the use of blended learning to improve students' creative and problem solving competence.

LIST OF THE AUTHORS PUBLICATIONS

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