ORGANIZING A LESSON ON "BUILDING A SIMPLE GENERATOR" TO APPLY KNOWLEDGE OF MAGNETIC FIELDS, ELECTROMAGNETIC INDUCTION AND DEVELOP STUDENTS' COLLABORATIVE COMPETENCE IN HIGH SCHOOL

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ABSTRACT

Practice shows that society cannot exist and develop if there is no cooperation. Therefore, the Collaborative Competence is one of the indispensable abilities for every person in the 21st century. Developing Collaborative Competence for students in teaching at school has become an educational trend in the world today. This article presents the organization of teaching the topic "Building a Simple Generator" applying knowledge of the Magnetic Field and Electromagnetic Induction sections to develop students' Collaborative Competence. The research uses a combination of methods: Theoretical analysis and synthesis; experimental methods. As a result, the research has built a teaching process on the topic "Building a Simple Generator" to develop students' Collaborative Competence. Pedagogical experiments show that the expression level of Collaborative Competence in the later stage is higher than the previous stage. From there, we can initially conclude that organizing teaching on the topic "Building a Simple Generator" is feasible, contributing to help students form and develop their Collaborative Competence.

TỔ CHỨC DẠY HỌC CHỦ ĐỀ "CHẾ TẠO MÁY PHÁT ĐIỆN ĐƠN GIẢN" NHẰM VẬN DỤNG KIẾN THỨC PHẦN TỪ TRƯỜNG, PHẦN CẢM ỨNG ĐIỆN TỪ VÀ PHÁT TRIỂN NĂNG LỰC HỢP TÁC CỦA HỌC SINH Ở TRƯỜNG TRUNG HỌC PHỔ THÔNG

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TỪ KHÓA

Năng lực hợp tác
Máy phát điện
Từ trường
Cảm ứng điện từ
Dạy học Vật lí

TÓM TẮT

Thực tiễn cho thấy xã hội không thể tồn tại và phát triển nếu ở đó không có sự hợp tác. Bởi vậy, năng lực hợp tác là một trong những năng lực không thể thiếu đối với mỗi con người trong thế kỉ XXI. Do đó, phát triển năng lực học tập hợp tác trong dạy học ở trường học đã trở thành một xu thế giáo dục của thế giới hiện nay. Bài báo trình bày việc tổ chức dạy học chủ đề "Chế tạo máy phát điện đơn giản" vận dụng kiến thức phần Từ trường và phần Cảm ứng điện từ nhằm phát triển năng lực hợp tác của học sinh. Nghiên cứu sử dụng phối hợp các phương pháp: Nghiên cứu lí luận và thực nghiệm sư phạm. Kết quả nghiên cứu đã xây dựng quy trình dạy học chủ đề "Máy phát điện đơn giản" nhằm phát triển năng lực hợp tác của học sinh. Thực nghiệm sư phạm cho thấy mức độ biểu hiện của năng lực hợp tác ở giai đoạn sau cao hơn giai đoạn trước. Từ đó có thể kết luận rằng việc tổ chức dạy học chủ đề "Máy phát điện đơn giản" là khả thi, góp phần phát triển năng lực hợp tác của học sinh.

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1. Introduction

Currently, the comprehensive renovation of Education and Training (E&T) has shifted the educational process from primarily equipping knowledge to developing comprehensive competencies and qualities of learners. The General Education Program- The Overall Curriculum of the Ministry of Education and Training (2018) has identified Collaborative Competence (CC) as one of the 10 core competencies that need to be formed and developed for students [1]. Therefore, in teaching, the formation and development of CC for students is very necessary. In the teaching process, to develop CC for students, it is essential to create an environment where students have many opportunities to collaborate, including organizing thematic teaching so that students have the opportunity to work in groups, which is one of the effective methods to develop CC for students [2]. Consequently, students have the environment, conditions, and space to work together, share, and perform common learning tasks, hence having many opportunities to develop CC. Additionally, with thematic teaching, students will enhance communication activities, support members when it is necessary, respect the interests and achievements of group members, and encourage both individual and group activities [3]. Physics is a subject that uses many experiments (EX), especially in the high school physics program, where there are many content areas that can be utilized in thematic teaching activities to develop devices using the knowledge learned, suitable for group activities and developing CC for students [4], [5]. The creation of simple models utilizing the physics theories that have just been learned not only helps students to reinforce the content of the lessons but also creates an environment where students have the opportunity to work together, exchange ideas, share, and assist one another. This serves as a condition for developing competencies in students, especially CC [6], [7].

The knowledge in the sections on Magnetism and Electromagnetic Induction is closely related to daily life and practical reality, suitable for high school students' level of understanding [8], [9]. The scientific and technical applications of these topics are still novel, intriguing, and engaging for students. After studying the section on Electromagnetic Induction, students will understand the concept of induced current and the methods to generate induced current. Thus, organizing a lesson on 'Building a Generator' will help students better understand the basic principles of generating electricity from the phenomenon of electromagnetic induction. Additionally, as students explore, design, and build a simple generator model, they will also grasp the operational mechanisms of the device. These activities require students to work in groups, interact, and collaborate during the research process, from planning the design of the model to conducting experiments and reporting the results of their generator. This content is entirely suitable for organizing group learning and developing students' collaborative competence.

From the above analysis, researching and organizing the lesson "Building a Simple Generator" using knowledge from the sections on Magnetism and Electromagnetic Induction is highly significant both scientifically and practically in the context of competency-based education in our country today.

2. Research methodology

The study uses a combination of methods: theoretical research methods (analyzing and synthesizing theories related to the research issue); experimental pedagogy methods.

2.1. Theoretical Research and Application

Research the theoretical basis of the 2018 physics education program, the issue of CC, developing CC for students, analyze the content knowledge of the Magnetism and Electromagnetic Induction sections, and apply them in organizing the thematic teaching "Building a Simple Generator."

2.2. Experimental Pedagogy

2.2.1. Purpose of the Experiment

This study is conducted to test the feasibility and effectiveness of the designed teaching processes to develop students' CC.

2.2.2. Experimental Program

- Experimental Subjects: 102 11^{th}- grade students from Thuan Hoa High School, Hue City (Students have already learned about the concepts related to electromagnetic induction and the conditions for the presence of induced current in a circuit).
- Duration: 4 periods over 2 weeks.
- Method of Evaluating Experimental Pedagogy Results: Observation method through students' expressions, design plans, and products based on criteria in the evaluation sheet. The product design is assessed according to criteria such as the details on the design plan, the presentation of the design plan, and the materials used. The product model is evaluated based on criteria including the product's effectiveness (when the magnetic flux changes through the area S of the coil, an induced current will appear in the coil, and the closed circuit will light up the LED).

To facilitate the observation and assessment of students' collaborative competence, we randomly selected one group from each experimental class, ensuring that the chosen groups were of similar cognitive levels before the intervention. This was done to evaluate the impact on the development of students' collaborative competence. A total of 18 students were selected for the observation and assessment of the component competences of collaboration. Following the case study method, the selected student group will represent the other groups in the class.

3. Results and Discussion

3.1. Results of Theoretical Research

3.1.1. Concept of Collaboration Competence

There are various perspectives on CC. According to Tran Quynh (2019), CC is the competence of individuals when participating in collaborative activities based on sharing, exchanging, supporting, helping, and coordinating with members to effectively solve common tasks in a meaningful situation [7]. According to Le Thi Minh Hoa (2015), CC is a type of competence that allows individuals to flexibly and organizedly combine the necessary knowledge for collaboration, skills, attitudes, values, and personal motivations to effectively meet the requirements of collaborative activities in a specific context. In this, each individual demonstrates positivity, self-discipline, interaction, and high responsibility based on mobilizing their knowledge and skills to effectively solve collaborative activities [10]. From these perspectives, it can be understood that CC is the ability to interact mutually, where each individual demonstrates positivity, self-discipline, interaction, and high responsibility, based on mobilizing their knowledge and skills to effectively solve common tasks.

3.1.2. Structure of Collaborative Competence

To form and develop competencies in students (including Collaborative Competence), we first need to clearly identify the components that constitute that competence [9]. Based on the characteristics of CC and the requirements for CC that students should achieve at each educational level as guided by the Ministry of Education and Training (2018), we propose the structure of CC to include component competencies (ComC) and corresponding behavioral expressions as shown in Table 1 [11].

Table 1. *The component competencies of Collaborative Competence*

Component competencies of CC	Behavioral Expressions
1. Organizing Group Collaboration and Individual Work as Group Members	1.1. Organizing group collaboration 1.2. Focusing attention 1.3. Identifying specific group tasks 1.4. Completing assigned group tasks
2. Group Work	2.1. Participation in group' planning 2.2. Collaboration with group members 2.3. Responsibility in group tasks 2.4. Clear and persuasive communication
3. Listening and sharing	3.1. Listening to others' opinions 3.2. Sharing and providing support to other group members.
4. Resolving conflicts and active cooperation	4.1. Exchanging and unifying opinions 4.2. Encouraging all members to actively participate in group activities.
5. Self-Assessment and Mutual Evaluation	5.1. Self-Assessment when participating in discussions and group activities. 5.2. Evaluation the abilities of other members during discussions and group activities.

3.1.3. Teaching Process of the "Building a Simple Generator" Theme to Develop Students' Collaborative Competence

The teaching method for the theme of building a model to develop students' collaborative competence primarily involves group learning. This method engages students in activities of inquiry and discovery, action orientation, experiential learning, and product creation. The organization of this theme captivates students by involving them in group constructivist activities. The content of the theme is mainly derived from the knowledge students have already learned or are currently learning. It requires students to flexibly apply knowledge and various skills such as problem-solving, practical skills, and group activities to successfully complete the assigned tasks.

The technical design process of a model to develop collaborative competence for students consists of several steps, though these steps do not necessarily need to be carried out sequentially but can be implemented concurrently, supporting each other. This process includes the following steps: Step 1: Synthesis of knowledge and identification of issues and activity requirements. This step helps students review foundational knowledge and identify research tasks. Step 2: Proposal and selection of solutions. In this step, student groups will develop model design proposals based on guided questions from the teacher and choose appropriate design solutions. Step 3: Model fabrication. For this activity, students will prepare tools for fabricating the product according to the design proposal, then proceed with fabrication in class. Step 4: Operation and verification of results. This step involves operating and testing the fabricated model to verify whether it meets the initial requirements. The final step involves students evaluating the products of each group and assessing collaborative competencies to adjust and evaluate the products and draw lessons for future classes. In the technical design process of a model, this step serves as both a goal and a condition for implementing the subsequent steps [12]. Figure 1 describes five steps of the technical design process of a model to develop collaborative competence for students.

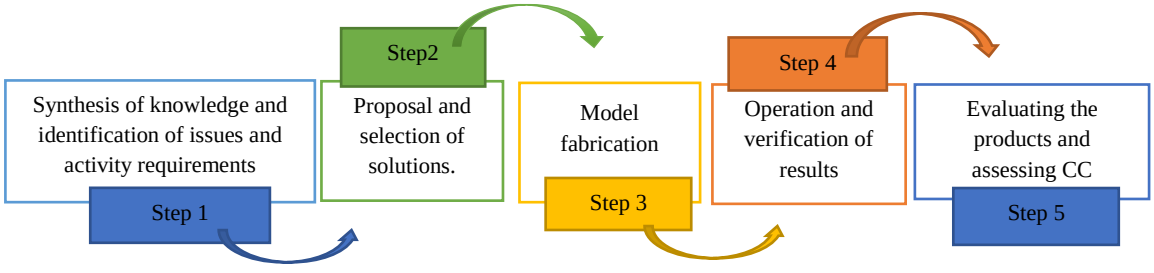

Figure 1. *Process of Technical Model Design for Developing Collaborative Competence (CC) of Students*

3.1.4. Organization of Teaching the Topic "Building a Simple Generator"

Based on the process of designing a technical model to develop students' CC and the table of component competencies (ComC) of collaborative competence in Table 1, we have illustrated the process of organizing the teaching of the topic "Building a Simple Generator" as shown in Table 2.

Table 2. *Process of Organizing Teaching the Topic "Building a Simple Generator"*

Teacher and Students Activities	Competence	Expected Products
- The teacher reviews the previously learned content on Magnetic Fields and Electromagnetic Induction. The teacher instructs the student groups to work collaboratively to create a mindmap illustrating the knowledge from these two sections. - The teacher discusses and instructs students to apply the knowledge they have learned about Magnetic Fields and Electromagnetic Induction to design and construct a simple electric generator. The student groups will discuss to identify the research tasks and the questions that need to be answered to solve the problem.	- **ComC 1. Organizing Group Collaboration and Individual Work as Group Members** 1.1. Organizing group collaboration 1.2. Focusing attention 1.3. Identifying specific group tasks **ComC 2. Group Work** 2.1. Participation in group' planning	- Responses of students. - Mindmap of the content on Magnetic Fields Electromagnetic Induction - Study task documentation
- The students propose criteria for the product. The teacher provides a suggested framework of criteria to support the students. The students and the teacher agree on the product evaluation criteria and initially develop a plan to execute the task. The teacher presents a set of guiding questions to help the students complete their plan. - The students develop a model design based on the guiding questions provided by the teacher and select the appropriate design solution. Each group presents their design, explaining the operational mechanism and layout of the device. The teacher evaluates and comments on the designs of each group, guiding them to make adjustments if necessary. Following this, the teacher and students agree on the essential elements of a complete design.	- **ComC 1. Organizing Group Collaboration and Individual Work as Group Members** 1.3. Identifying specific group tasks 1.4. Completing assigned group tasks **ComC 2. Group Work** 2.1. Participation in group' planning 2.2. Collaboration with group members 2.3. Responsibility in group tasks 2.4. Clear and persuasive communication	- Group discussion content outcome table - Design blueprint of a simple electric generator model
- The students prepare the tools and materials needed for constructing the product according to the design plan, and then proceed with the construction in class. The students use the product evaluation criteria to adjust their products.	- **ComC 2. Group Work** 2.2. Collaboration with group members 2.3. Responsibility in group tasks 2.4. Clear and persuasive communication	- Simple electric generator model
- The students operate the simple electric generator models and compare the results against the criteria outlined in the product evaluation criteria table.	- **ComC 3. Listening and sharing** 3.1. Listening to others' opinions 3.2. Sharing and providing support to other group members. **ComC 4. Resolving conflicts and active cooperation** 4.1. Exchanging and unifying opinions 4.2. Encouraging all members to actively participate in group activities.	- Product operational results

Teacher and Students Activities	Competence	Expected Products
- The teacher organizes a session for students to present their products, providing feedback and making necessary adjustments. The students are required to clarify the strengths and weaknesses of their products and propose ideas for improvement. Other groups contribute their feedback. The teacher gives an overall assessment of the session and evaluates the CC of the student groups.	- **ComC 5. Self-Assessment and Mutual Evaluation** 5.1. Self-Assessment when participating in discussions and group activities. 5.2. Evaluation the abilities of other members during discussions and group activities.	- Results of the product evaluation criteria table - Evaluation result of students' CC

3.2. Pedagogical Experiment Results

The evaluation results of collaborative competence according to each component competency described in Table 1 were analyzed in conjunction with observation results to identify changing factors. From this, the feasibility of the instructional process in designing a simple electric generator model applying the knowledge from the Magnetic Fields and Electromagnetic Induction section to develop students' CC was determined.

Based on the component competencies of CC and the CC evaluation criteria table constructed in Table 2, each evaluation criterion was divided into four levels: Level 1 (low level); Level 2 (medium level); Level 3 (high level); Level 4 (very high level). We conducted a pedagogical experiment to evaluate the development of CC of students in the teaching sessions. For convenience in observation and evaluation, the teacher randomly selected 3 student groups, each consisting of 6 students, totaling 18 students, to evaluate the CC of students in two phases: - Phase 1: After completing the first 2 sessions; - Phase 2: After completing the next 2 sessions.

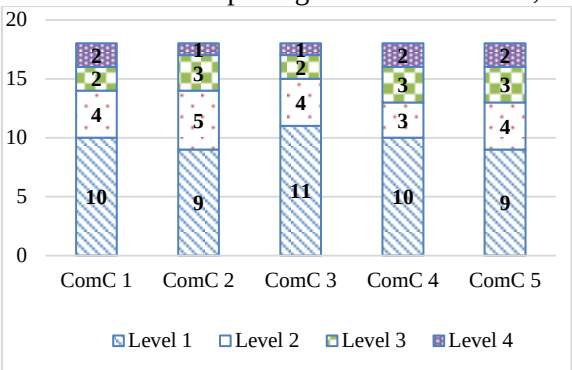

Figure 2. *Levels of CC of students in Phase 1*

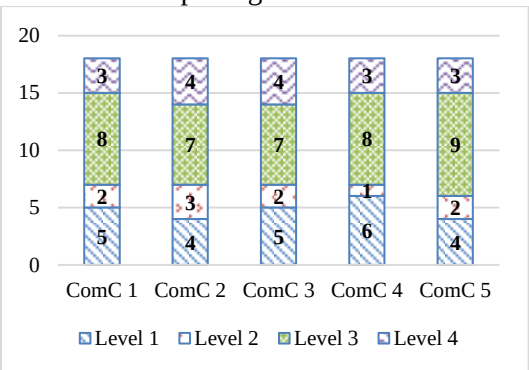

Figure 3. *Levels of CC of students in Phase 2*

In the initial phase, as shown in Figure 2, for CCs such as ComC 1: Organizing group cooperative activities and individual work as group members; ComC 2: Group work; ComC 3: Listening and sharing; ComC 4: Resolving conflicts and active cooperation; ComC 5: Self-Assessment and mutual evaluation, the number of students achieving levels 1 and 2 is significant. For example, for ComC 1, there are 10 students at level 1 (low level) and 4 students at level 2 (medium level). The number of students achieving CC for each ComC at levels 3 and 4 is relatively low. For instance, for ComC 1, there are 2 students at level 3 (high level) and 2 students at level 4 (very high level).

In phase 2 of the teaching experiment, as shown in Figure 3, the proportion of students achieving levels 3 and 4 has significantly increased, while the number of students achieving CC at levels 1 and 2 has decreased significantly. For example, for ComC 3, the number of students achieving level 3 (high level) and level 4 (very high level) has increased from 2 students to 7 students and from 1 student to 4 students, respectively. For ComC 4, the number of students achieving level 3 and level 4 has increased from 3 students to 8 students and from 2 students to 3

students, respectively. The experimental results show that organizing the teaching topic "Building of a Simple Generator" has positively impacted the development of students' CC.

Additionally, based on the teachers' observations, in the initial stages, students were still uncertain about how to plan their collaboration, and the division of tasks was not yet reasonable. Furthermore, their ability to contribute ideas to resolve conflicts and complete tasks was not highly effective. In the later stages, students became more active in communication, their collaboration planning was clearer and more detailed, and they were no longer hesitant to express their personal opinions. They began to effectively resolve conflicts. However, some limitations remained, such as slow task execution and incomplete or less persuasive expression of personal opinions.

Furthermore, after 4 sessions of learning, student groups have successfully applied the knowledge from the Magnetic Fields and Electromagnetic Induction section to design simple electric generator models (Figure 4). This not only deepens students' understanding of this section but also helps them develop the ComC of CC during group activities in implementing experiment models.

Figure 4. *Some simple electric generator models applying knowledge from the Magnetic Fields and Electromagnetic Induction section*

4. Conclusion

Through 4 sessions of teaching the topic "Building a Simple Generator", it has been shown that organizing instructional activities in designing models has created learning situations that stimulate students' interest and initial development of CC. The feasibility of the instructional process of the aforementioned topic have been demonstrated through the experimental results regarding the development of CC. This demonstrates the effectiveness of the CC evaluation criteria, as well as the guiding questions for planning provided by the teacher, which were used throughout the teaching of this topic. With these results, the process of teaching technical model design and the CC evaluation criteria of students should continue to be improved and utilized in teaching Physics in high schools to engage students in learning activities, foster autonomy, exploration, problem-solving, and application of knowledge, contributing to the formation and development of students' CC.

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