BUILDING STEM TOPICS IN BLENDED LEARNING ABOUT ENERGY TO CONTRIBUTE TO SUSTAINABLE DEVELOPMENT EDUCATION

Chu Ngoc Anh, Tran Thanh Thuy, Pham Khanh Chi, Dang Thi Minh Phuong, Bui Thuy Nga, Tuong Duy Hai*

Faculty of Physic, Hanoi National University of Education, Hanoi, Vietnam

ARTICLE INFORMATION

Journal: *Vinh University Journal of Science Educational Science and Technology*
p-ISSN: *3030-4857*
e-ISSN: *3030-4784*

Volume: 53
Issue: 3C
***Correspondence:** haitd@hnue.edu.vn*

Received: *02 July 2024*
Accepted: *28 August 2024*
Published: *20 September 2024*

Citation:
Chu Ngoc Anh, Tran Thanh Thuy, Pham Khanh Chi, Dang Thi Minh Phuong, Bui Thuy Nga, Tuong Duy Hai (2024). Building STEM topics in Blended learning about energy to contribute to sustainable development education.
Vinh Uni. J. Sci.
Vol. 53 (3C), pp. 28-39
doi: 10.56824/vujs.2024c085c

OPEN ACCESS

ABSTRACT

With the goal of education aimed at sustainable development as reflected in the 2018 General Education Program, schools in general and the subject of physics in particular need to educate students to raise awareness about energy issues and how to use energy efficiently, safely, and reasonably. Therefore, this report presents the research results on building the STEM topic "Energy" in blended learning, contributing to sustainable development education. The research results propose a process of blended learning stages and the development of teaching materials to support teachers in teaching STEM topics about energy, helping students develop competencies and the ability to cope with future challenges.

Keywords: STEM education; energy; blended learning; sustainable development education.

1. Introduction

Blended learning (B-Learning) is a relatively new teaching model worldwide (Dau, 2022). B-Learning combines traditional classroom-based instruction with online learning for a particular lesson (Cleveland-Innes, 2018). B-Learning complements face-to-face classroom learning between teachers and students and among students with online learning through ICT applications on specific lesson content (Vu, 2020). A schematic diagram of the B-Learning model is summarized in Figure 1.

Meanwhile, STEM education is an integrated teaching approach that combines the fields of Science, Technology, Engineering, and Mathematics. This form of education contributes to developing students' skills in applying knowledge to real-world situations (Sanders, 2005) to ensure comprehensive education, enhance interest in learning STEM subjects, and form and develop competencies and qualities for students. STEM education helps students connect school with the community, provides career guidance during the learning process, and allows schools to diversify their training streams (Le *et al*., 2022)

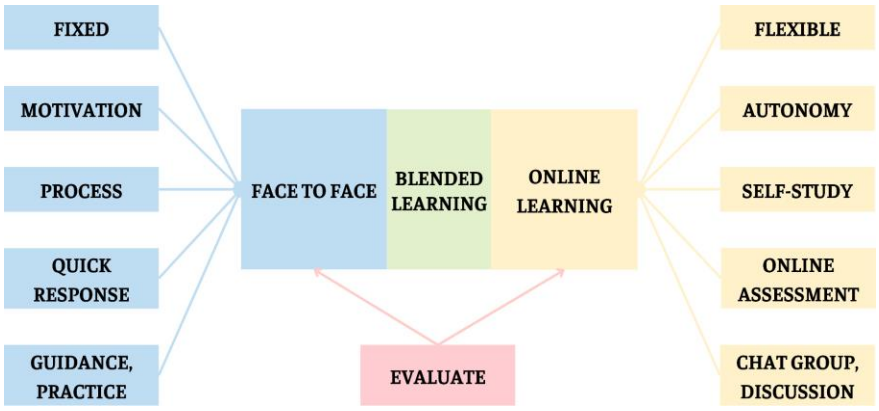

Figure 1: *Blended learning model*

STEM education topics always require students to demonstrate engineering design competence to apply their existing knowledge and experience to practical situations. They may also require students' programming and control abilities based on algorithms ranging from simple to complex in order to create technological products (Pham, 2017). As a result, STEM education helps students develop and enhance their thinking skills to solve practical problems in modern life.

STEM education applies the engineering design process and scientific inquiry to help students orient their knowledge and skills towards solving problems in real-life situations. These two processes demonstrate the relationship between the fields of Science, Technology, Mathematics, and Engineering to guide students' thinking, as described in Figure 2.

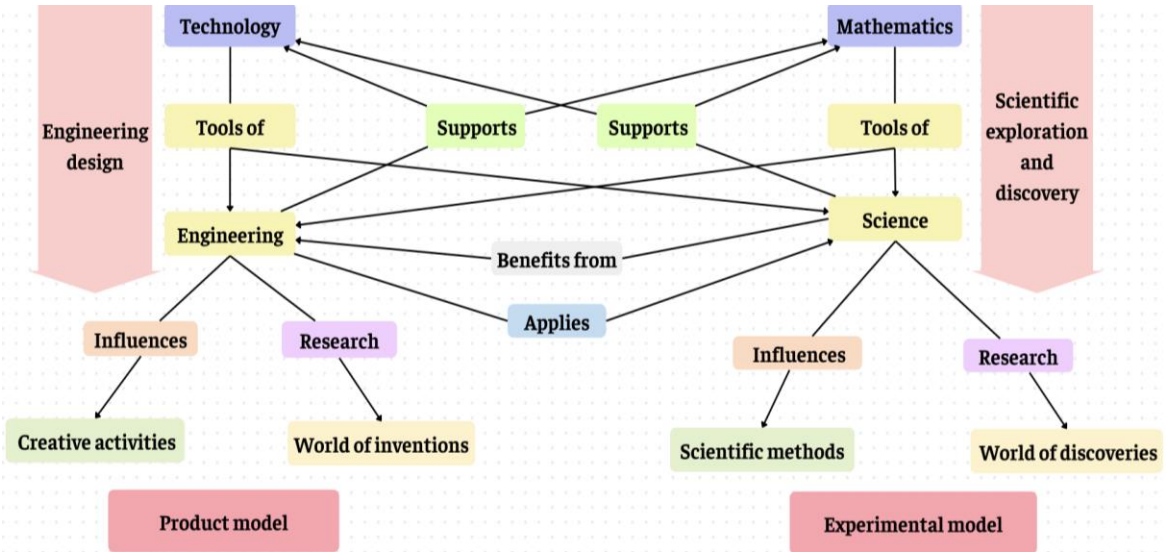

Figure 2: *Interrelationships between domains in the engineering design process and the scientific inquiry process*

In STEM education, the two methods, “Engineering Design” and “Scientific Inquiry”, play an essential and complementary role in enhancing students' theoretical and practical skills. In the “Engineering Design” method, engineering and technology are

regarded as fundamental tools to support mathematics and science, fostering creativity and the development of new product models. Students are encouraged to explore the "world of inventions," applying theoretical knowledge to real-world projects to develop design and problem-solving skills, thereby creating product models.

On the other hand, the "Scientific Inquiry" method emphasizes using science and mathematics as the primary tools for research and discovery. This approach teaches students how to develop scientific methods, gradually uncover new inventions, enhance their research and creative abilities, and ultimately build experimental models.

When these two methods are combined in a comprehensive educational program, students gain access to scientific methods and experience hands-on learning, applying knowledge to solve real-world problems. This helps develop creative thinking and essential skills needed to face challenges in the modern world, forming a solid foundation for students' future personal and professional development.

2. Research methodology

This research utilizes specific methodologies from the field of educational theory to analyze the 2018 General Education Program, focusing on the concept of energy introduced in the 2018 program across various subjects and grade levels. The study aims to formulate STEM-based energy topics suitable for B-learning instruction and to evaluate the practicality of the proposed content, learning materials, and STEM teaching approach through a survey administered to relevant stakeholders.

3. Results and discussion

3.1. B-Learning STEM teaching process

Based on the requirements, objectives, and content of the 2018 General Education Program, the study proposes a B-Learning STEM learning plan consisting of three main phases: preparation, implementation and conclusion. During preparation: Build foundational knowledge and stimulate students' interest through online and offline activities - the implementation focuses on developing STEM skills through real-world projects and encouraging critical thinking and creativity. The final phase is the conclusion: Consolidating knowledge, assessing learning outcomes, and providing opportunities for students to share and learn from their experiences. In each phase, a combination of direct, online activities and student assessment should be employed: Online activities: Utilizing online learning platforms, communication tools, and visual materials to create an engaging learning environment; Face-to-Face activities: Organizing hands-on activities, group discussions, and presentations of results; Assessment: Combining both online and offline assessments to keep track of students' learning progress. The phases and activities of the B-Learning STEM teaching process are illustrated in Figure 3.

The activities in the above process demonstrate the following prominent features:

- **Comprehensiveness:** Including both theoretical knowledge and practical skills;
- **Diversity:** Combining various teaching methods and learning support tools;
- **Technology integration:** Utilizing modern technological tools;

- **STEM skills development:** Focusing on core STEM skills;
- **Personalization:** Creating personalized learning pathways for each student;
- **Interdisciplinary:** Integrating STEM with other subjects;
- **Continuous assessment:** Monitoring and adjusting the learning plan;
- **Community building:** Creating an interactive learning environment.

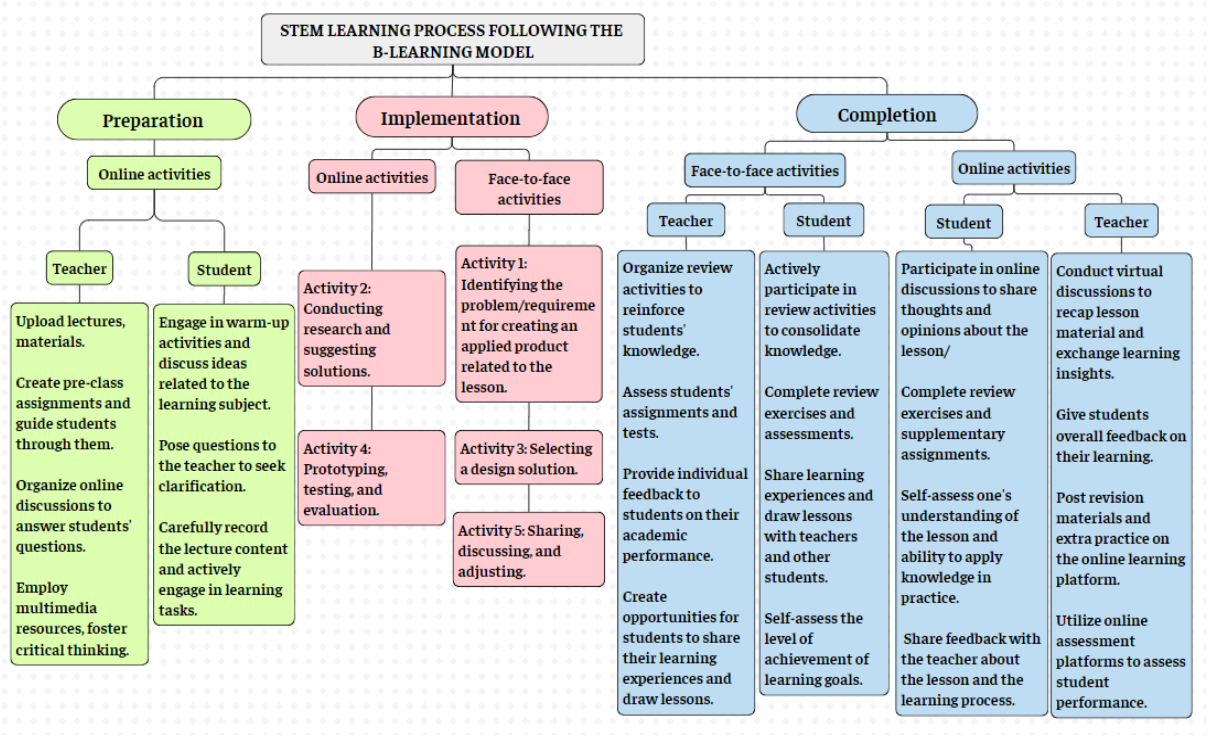

Figure 3: *STEM learning process following the B-Learning model*

3.2. Analysis of the Energy content in the 2018 General Education Curriculum

In the 2018 General Education Curriculum, energy content consistently spans all grade levels (from primary to high school) and is highly integrated across various subjects. The analysis of energy content themes according to grade levels and subjects in the 2018 General Education Curriculum is shown in Figure 4.

The subject of Physics plays a crucial role in presenting energy content across six significant fields: mechanics, thermodynamics, electromagnetism, optics, sound, and nuclear physics. These fields are closely interconnected, reflecting the critical role of physics education in sustainable development in general and in energy content in particular.

The physics curriculum has a particular topic titled “Physics and Environmental Protection Education” that forms the foundation for sustainable development education in environmental protection. This topic also covers technologies for harnessing renewable energy. This is a critical area of energy education for students, as natural resources are gradually depleted. It reflects the trend of transitioning from fossil fuels to renewable energy, contributing to the reduction of adverse environmental impacts.

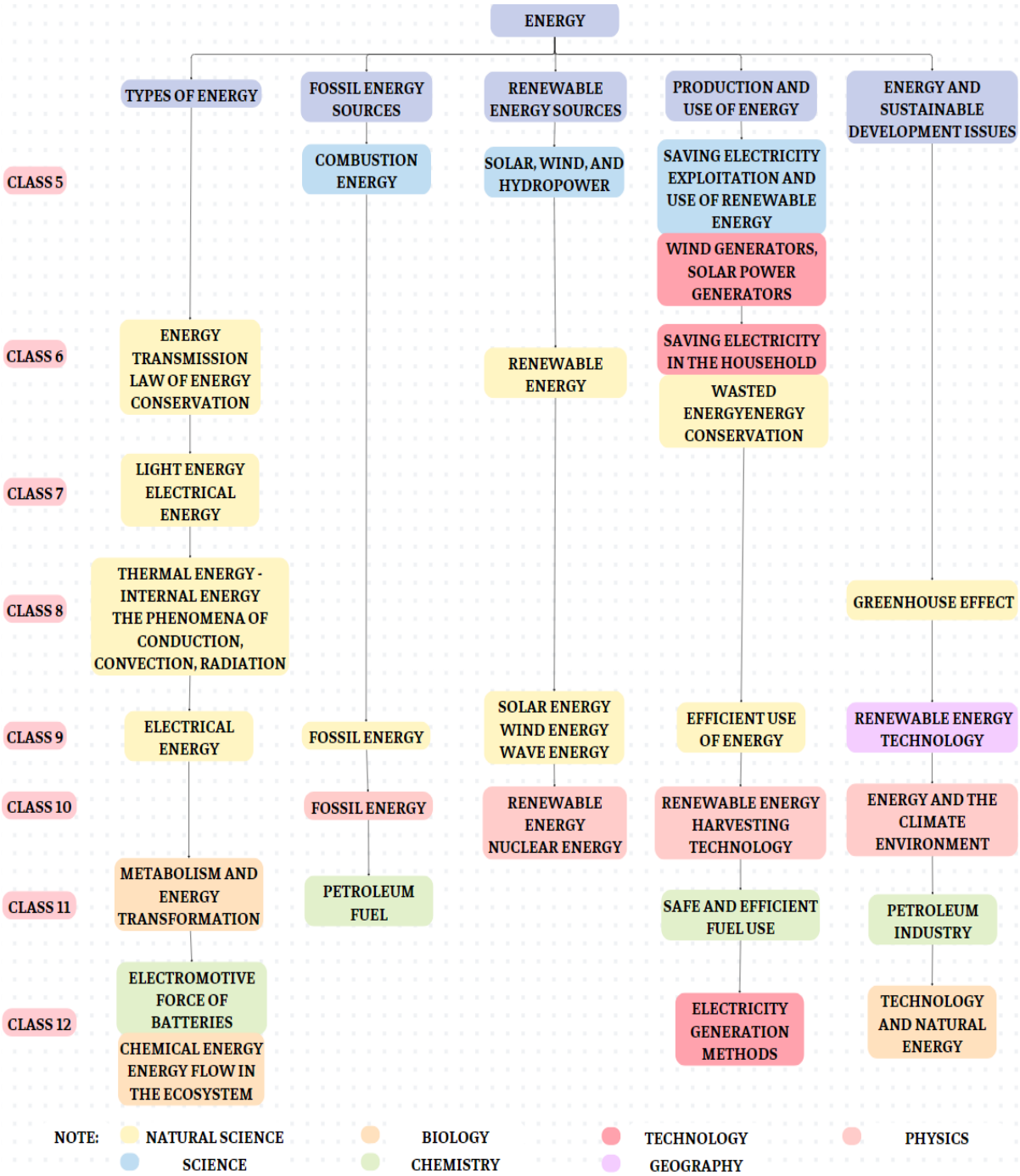

Figure 4: *The development of Energy content in the 2018 General Education Curriculum*

3.3. Proposed STEM education topics on Energy content

STEM education emphasizes solving real-world problems students encounter in specific contexts, following scientific research and engineering design processes. Depending on students' abilities in different grade levels and the content requirements for

energy, real-world problems are selected and linked to creating specific products suited to the school's conditions. This approach helps propose ideas for STEM topics. The research results propose orientations for STEM topics related to energy for each grade level based on two distinctive processes of STEM education, as shown below.

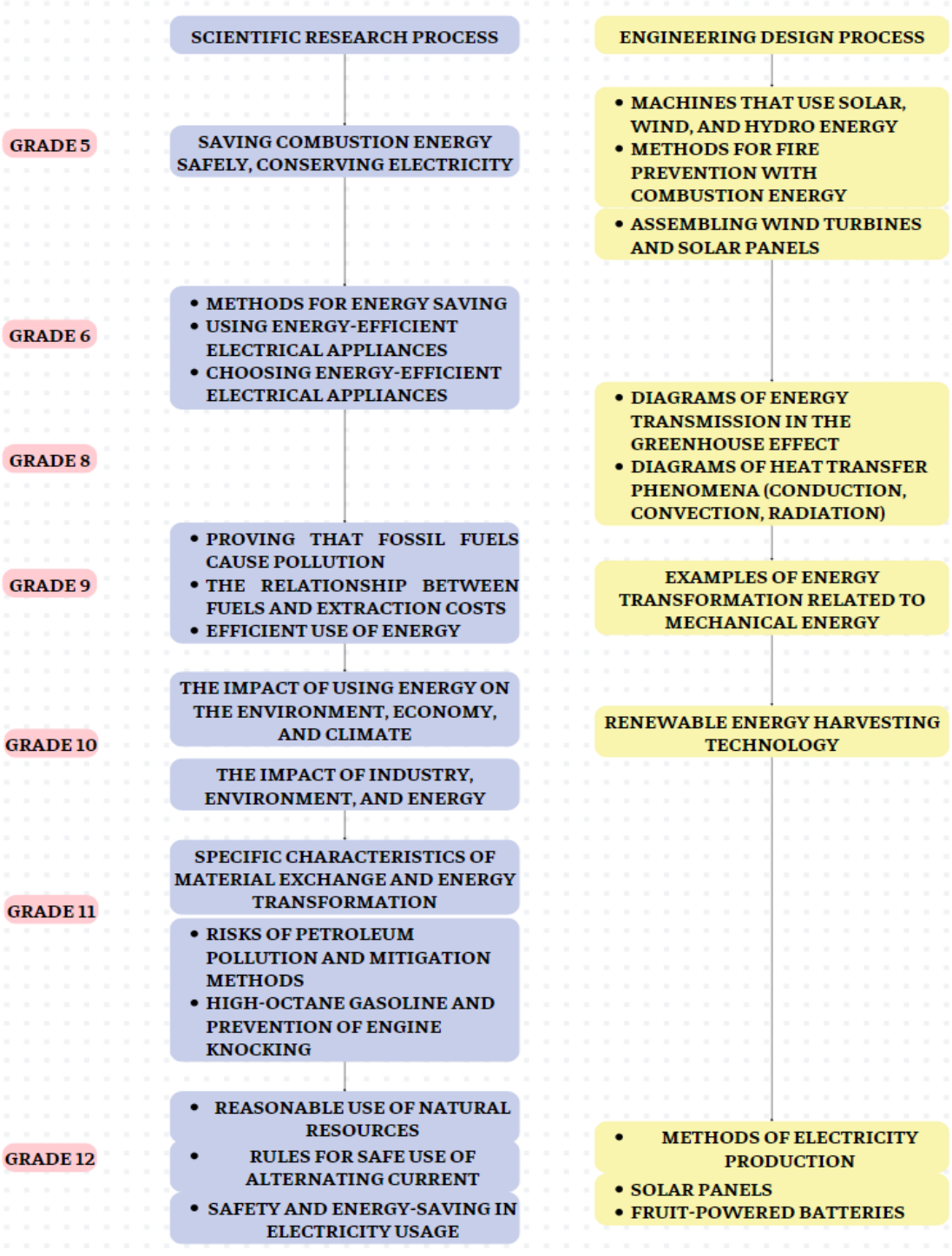

Figure 5: *Proposed STEM topics on Energy content based on STEM education processes*

3.4. Developing teaching materials to support STEM teaching on the topic of Energy content

To support teachers in implementing STEM topics related to energy content through B-Learning teaching methods, the study proposes learning materials linked to lessons on STEM topics. It illustrates the STEM topic 'Mini Wind Turbine' by applying project-based learning and the flipped classroom model. In this project, students will combine theoretical knowledge about wind energy, the operating principles of wind turbines, and practical design and construction of a mini wind turbine product. Specifically, students will access theoretical knowledge about wind energy sources and home wind turbines' structure and operating principles through materials and instructional videos. During class, they will be guided in designing and constructing a mini wind turbine model, testing, and evaluating its performance. Finally, students will present and introduce their products.

● **STEM topic: Mini Wind Turbine**

The STEM topic "Mini Wind Turbine" is taught in the 10th-grade Physics curriculum. This topic is organized in an integrated teaching format, with Physics as the main subject and integrated subjects such as Technology and Mathematics.

Figure 6: *B-Learning learning materials for the STEM topic "Mini Wind Turbine" for 10th grade*

Figure 7: *Access code for the lesson plan of the project "Mini Wind Turbine"*

Requirements regarding Energy content in the 2018 General Education Curriculum are as follows:

In Technology 5:

▪ Identify the main components of a wind turbine model.

▪ Describe how electricity is generated from wind.

▪ Describe the main components of a wind turbine model.
▪ Assemble a wind turbine model.
▪ Test the model's performance at different wind speeds.

In Natural Science 9:

▪ Apply the concept of mechanical energy to analyze energy transformation in simple cases.

In Physics 10:

▪ Define renewable energy and non-renewable energy.
▪ Classify fossil energy and renewable energy.

In Technology 12:

▪ Present the primary content of several main methods of electricity production (hydropower, thermal power, nuclear power, wind power, solar power), along with the advantages and limitations of each method.

Similarly, the study has developed three topics to illustrate the proposed process for integrating STEM topics related to energy content as follows:

● **STEM topic: Solar-Powered Portable Charger**

The STEM topic "Solar-Powered Portable Charger" is taught in an integrated teaching format, with Technology as the main subject and integrated subjects such as Physics and Mathematics.

Requirements regarding Energy content in the 2018 General Education Curriculum Technology 12 are as follows: Present the primary content of several main methods of electricity production (hydropower, thermal power, nuclear power, wind power, solar power), along with the advantages and limitations of each method. Technology 5 includes

▪ Identifying the main components of a solar energy model,
▪ Describing how electricity is generated from sunlight,
▪ Describing the main components of a solar energy model,
▪ Assembling a solar energy model and,
▪ Testing the model's performance under different sunlight intensities.

Figure 8: *B-Learning learning materials for the STEM topic "Solar-Powered Portable Charger" for 10th grade*

● ***STEM topic: Creating a generator using renewable water sources***

The STEM topic "Creating a generator using renewable water sources" is taught in the 9th-grade Natural Science curriculum in an integrated teaching format with Physics as the main subject and integrated subjects such as Technology and Mathematics.

The requirements regarding energy content in the 2018 General Education Curriculum in Natural Science 9 include applying mechanical energy to analyze energy transformation in simple cases. Those in Technology 12 are: Present the primary content of several main methods of electricity production (hydropower, thermal power, nuclear power, wind power, solar power), along with the advantages and limitations of each method.

Figure 9: *B-Learning learning materials for the STEM topic "Creating a generator using renewable water sources" for 10th grade*

● ***STEM Topic: Green Energy Handbook***

The STEM topic "Green Energy Handbook" is taught in the 9th-grade Natural Science curriculum in an integrated teaching format with Physics as the main subject and integrated subjects such as Technology. Requirements regarding Energy content in the 2018 General Education Curriculum:

In Natural Science 9:

▪ Apply the concept of mechanical energy to analyze energy transformation in simple cases.

▪ Discuss and identify some measures for effective energy use and environmental protection.

In Geography 10:

▪ Analyze the impact of industry on the environment and the necessity of strongly developing renewable energy sources.

In Technology 12:

▪ Present the primary content of several main methods of electricity production (hydropower, thermal power, nuclear power, wind power, solar power), along with the advantages and limitations of each method.

Figure 10: *B-Learning learning materials for the STEM topic "Green Energy Handbook" for 10th grade*

3.5. Survey on the evaluation of teachers, university students, and high school students regarding the feasibility of teaching materials

The research conducted a survey with teachers, students, and high school learners regarding the feasibility of the STEM teaching process using the B-Learning method on energy content, involving 74 participants, including three lecturers, 16 teachers, 10 high school students, and 45 students currently studying in the Physics department at Hanoi National University of Education. The survey results indicate that most participants expressed high satisfaction and agreement with the activities arranged in the process. The specific survey results are illustrated in Figure 11.

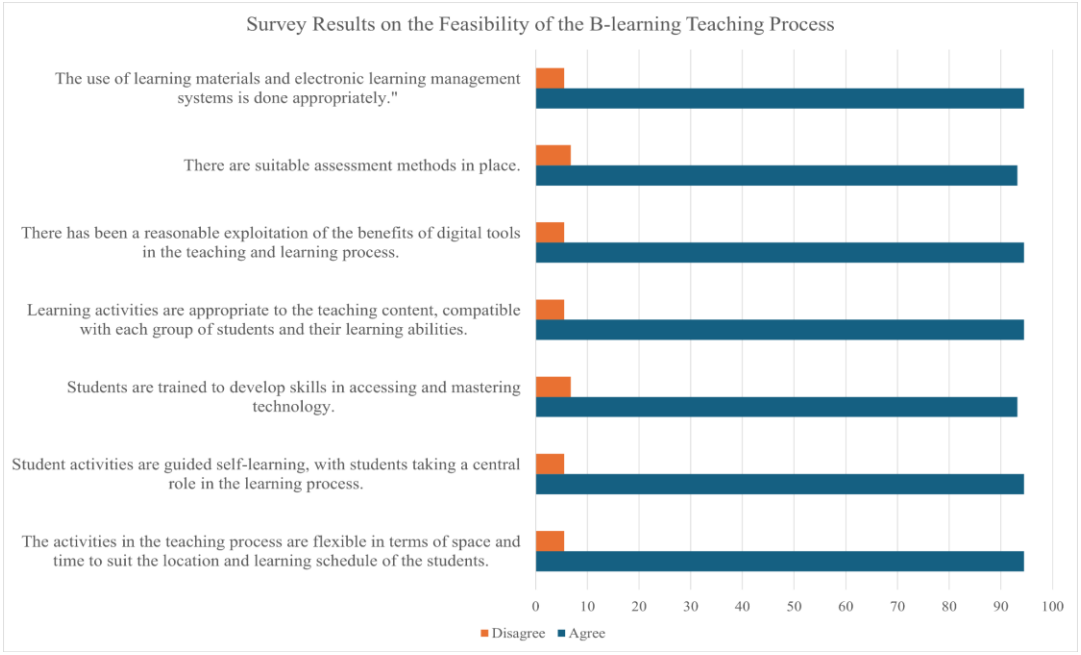

Figure 11: *Survey results on the feasibility of the B-Learning teaching process*

We surveyed the proposed STEM topic in the process to evaluate its feasibility. The results indicate that the feasibility of the STEM topic aligned with the 2018 General Education Program is rated positively, as detailed below:

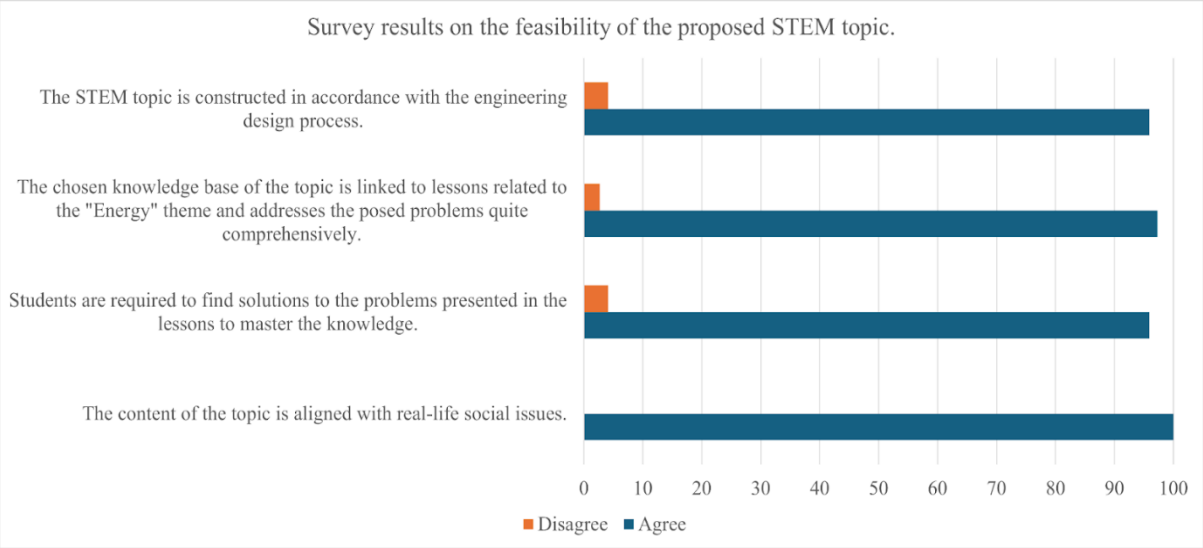

Figure 12: *Survey results on the feasibility of the proposed STEM topics*

Thus, the teaching process of the STEM topic using the B-Learning method is assessed as compatible with the orientation of the 2018 General Education Program. The teaching process clearly defines learning objectives, selects appropriate teaching methods and tools suitable for the skill levels and characteristics of the learners, and places students at the centre, maximizing the support capabilities of ICT. The content of the STEM topic is aligned with the "Energy" theme and connected to practical applications, requiring students to use knowledge from the topic to solve lesson-related problems.

4. Conclusion

This study proposes a B-Learning teaching model and demonstrates its applicability to several STEM topics. Initial evaluations suggest that this approach is viable for classroom implementation in Vietnam. The developed learning materials align closely with the foundational knowledge, provide concrete data, and offer supplementary videos and worksheets. These resources, tailored to the 2018 General Education Program's digital transformation goals, serve as valuable references for teachers and students.

REFERENCES

Cleveland-Innes, M., & Wilton, D. (2018). *Guide to blended learning*. Burnaby, Canada: Commonwealth of Learning.

Dau, T. H. T. (2022). Applying Blended Learning Paradigm in teaching introduction to Management Science for students in National Academy of Education Management. *Journal of Education Management*, 86-91. DOI: 10.53750/jem22.v14.n8.86

Le, V. N., Nguyen, T. L. A., & Nguyen, L. B. K. (2021). Integration and differentiation in the stem education subject with the development of problem-solving capacity of students. *Vinh University Journal of Science*, 60-69. DOI: 10.56824/vujs.2021ed26

Sanders, M. (2005). *STEM graduate education/research collaborator*. Virginia: Virginia Tech Faculty, Virginia Tech.

Pham, Q. T. (2017). Nature and characteristics of the STEM education model. *Vietnam Journal of Educational Sciences, The Vietnam National Institute of Educational Sciences*, 145, 61-64.

Vu, T. T. M. (2020). Blended learning and its applicability at Hung Vuong University. *Journal of Science Hanoi Metropolitan University, 37*, 122-127.

TÓM TẮT

XÂY DỰNG CHỦ ĐỀ STEM TRONG DẠY HỌC BLENDED LEARING VỀ NĂNG LƯỢNG GÓP PHẦN GIÁO DỤC PHÁT TRIỂN BỀN VỮNG

Chu Ngọc Anh, Trần Thanh Thủy, Phạm Khánh Chi, Đặng Thị Minh Phương, Bùi Thúy Nga, Tưởng Duy Hải

Khoa Vật lý, Trường Đại học Sư phạm Hà Nội, Hà Nội, Việt Nam

Ngày nhận bài 02/7/2024, ngày nhận đăng 28/8/2024

Với mục tiêu giáo dục hướng tới phát triển bền vững như đã phản ánh trong Chương trình Giáo dục phổ thông 2018, các trường học nói chung và môn Vật lý nói riêng cần giáo dục học sinh nâng cao nhận thức về các vấn đề năng lượng và cách sử dụng năng lượng một cách hiệu quả, an toàn và hợp lý. Vì vậy, báo cáo này trình bày kết quả nghiên cứu về việc xây dựng chủ đề STEM "Năng lượng" trong học tập kết hợp, góp phần vào giáo dục phát triển bền vững. Kết quả nghiên cứu đề xuất quy trình các giai đoạn học tập kết hợp và phát triển tài liệu giảng dạy để hỗ trợ giáo viên trong việc giảng dạy các chủ đề STEM về năng lượng, giúp học sinh phát triển năng lực và khả năng ứng phó với các thách thức trong tương lai.

Từ khóa: Giáo dục STEM; năng lượng; học tập kết hợp; giáo dục phát triển bền vững.