THE UNIVERSITY OF DANANG
**UNIVERSITY OF SCIENCE AND EDUCATION**

# APPLYING THE FLIPPED CLASSROOM MODEL IN TEACHING THE “DYNAMICS” SECTION OF GRADE 10 PHYSICS TO DEVELOP STUDENTS’ PHYSICS COMPETENCY

**Major: Theory and Methods of Teaching Physics**

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**SUMMARY OF THE DOCTORAL DISSERATION**
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# INTRODUCTION

## 1. Rationale for the Study

The rapid development of science and technology and the context of the Fourth Industrial Revolution require comprehensive reforms in general education, shifting towards the formation and development of students' core competencies, particularly self-directed learning, problem-solving, critical thinking, and the application of knowledge to real-life contexts. The 2018 General Education Curriculum emphasizes a competency-based approach, focusing on learners' ability to "know – do – apply". In physics education, the urgent need to innovate teaching methods and assessment in alignment with the development of physics competence has become increasingly apparent, especially with the support of digital technologies.

The flipped classroom model—a form of blended learning—allows students to acquire theoretical knowledge at home and devote in-class time to application-based activities, discussion, and problem-solving. This approach is well suited to developing physics competence, enhancing learning motivation, and fostering learner autonomy. The "Dynamics" unit in Grade 10 Physics contains rich, practical content; however, when taught using traditional methods, it is difficult to achieve competency development goals. Therefore, the topic *"Applying the flipped classroom model in teaching the Dynamics section for Grade 10 Physics to develop students' physics competence"* was selected for this study.

## 2. Research Objectives

To propose and validate a procedure for designing the organization of teaching according to the flipped classroom model to develop physics competence; on that basis, to organize the teaching of the Dynamics section in Grade 10 Physics according to the proposed procedure and evaluate the impact of this intervention model on the development of the components and behavioral indicators of students' physics competence.

**3. Research Hypothesis**

If the Dynamics section in Grade 10 Physics is taught according to the proposed procedure, in which activities in each phase are designed in association with the components of physics competence, behavioral indicators, and corresponding assessment tools, then students in the experimental class will show statistically and practically significantly greater development of physics competence than those in the control class when initial differences are controlled; additionally, students' level of participation in activities across the phases of the model will be positively correlated with their degree of physics competence development.

**4. Research subject and scope**

***4.1.Research subject*:** Teaching and learning activities of teachers and students in teaching the Dynamics Section- Grade 10 using the flipped classroom model to develop physics competence.

***4.2.Research scope***

Content: The Dynamics Section - Grade 10 – Physics.

Time: From September 2020 to September 2024.

Location: High schools in Danang city.

**5. Research tasks**

**6. Research methods**

**7. Novel Contributions of the Dissertation**

***7.1. Theoretical contributions***

- Identify the concept and structure of physics competence, comprising three components and sixteen behavioral indicators.

- Propose three measures for developing physics competence, a three-stage procedure for designing teaching organization according to the flipped classroom model oriented toward physics competence development.

- Propose a process for organizing teaching activities according to the flipped classroom model to develop physics competence.

***7.2. Practical contributions***

- Design of six teaching processes for the Dynamics unit – Grade 10 Physics using the flipped classroom model.

- Development of assessment tools for physics competence.

- Application of modern statistical methods to analyze the feasibility and effectiveness of developing students' physics competence through flipped classroom learning.

## 8. Structure of the Dissertation

# CHAPTER 1. OVERVIEW OF RESEARCH ON THE FLIPPED CLASSROOM MODEL AND ITS APPLICATION IN COMPETENCY-ORIENTED TEACHING

## 1.1. Studies on the Flipped Classroom Model

### *1.1.1. Development of Theoretical Perspectives on the Flipped Classroom Model*

This dissertation approaches the flipped classroom as a **pedagogical model rather than merely a technical teaching strategy**. Instead of viewing it simply as a reversal of instructional space and sequence, the flipped classroom is conceptualized as a restructuring of learning activities aimed at developing learner competence. The focus is not on technology itself but on the organization, support, and facilitation of learners' knowledge construction. From this perspective, the flipped classroom is considered an active learning model emphasizing personalization and constructivist learning, in which students play a central role in the cognitive process, while teachers act as facilitators who design and sustain an effective learning environment.

### *1.1.2.* Studies on the Characteristics and Pedagogical Impacts of the Flipped Classroom Model

Compared with traditional classrooms, the flipped classroom has basic pedagogical characteristics in terms of the structure of teaching organization, the roles of teachers and students, teaching media and digital learning materials, implementation conditions, and factors influencing the organization of teaching.

A synthesis of studies on the characteristics and pedagogical impacts of the flipped classroom model shows a fairly clear consensus that the model creates a flexible learning environment, increases interaction, supports personalization of learning, and facilitates learners' higher-order thinking development. Notably, most studies emphasize the general effectiveness of the flipped classroom in terms of teaching organization, increased interaction, or its impact on learning outcomes, motivation, self-directed learning, critical thinking, and collaborative competence, but have not examined in depth the mechanism for developing subject-specific competence through the design of pre-class, in-class, and post-class activities. For physics, this is a notable gap because the nature of the subject requires not only the acquisition of conceptual knowledge but also students' ability to observe, model, experiment, explain phenomena, and apply knowledge in real-life contexts. Therefore, research on organizing instruction according to the flipped classroom model in connection with developing physics competence needs to be further clarified in both theoretical foundations and practical implementation in general education.

#### *1.1.3. Studies on the Practical Implementation of the Flipped Classroom in General Education*

Research indicates that the flipped classroom has been widely implemented across educational levels and subjects. Empirical evidence and systematic reviews confirm its potential to improve learning outcomes, motivation, and self-regulated learning competence. Effective implementation requires a comprehensive shift in pedagogical design, learner-centered orientation, and enabling conditions such as technological infrastructure, digital competence of teachers and students, quality learning materials, and institutional support. Recent Vietnamese studies suggest that the model is feasible and effective when flexibly adapted to subject characteristics, particularly in physics education.

From an overview of studies on the practical implementation of the flipped classroom model in general education, it can be seen that: first, the model has been shown to be adaptable to various subjects and educational contexts; second, its effectiveness depends strongly on the quality of learning materials, the organization of in-class activities, and the degree of coherence among learning phases; and third, most existing studies have focused on learning outcomes, motivation, or self-directed learning competence, whereas there remains a lack of studies that examine the application of the model to develop subject-specific competence through a coherent instructional design with explicit criteria and assessment tools. This constitutes a significant research gap for further studies on applying the flipped classroom model in physics teaching in general education from a competence-development perspective.

## 1.2. Studies on Competency-Based Education

### *1.2.1. Research on Competence and Competency-Based Education*

### *1.2.2. Research on Physics Competence and Competence-Oriented Physics Teaching*

Physics competence is defined as comprising three components: (1) Physics cognitive competence, (2) Competence in exploring the natural world from a physics perspective, and (3) Competence in applying learned knowledge and skills. Studies indicate that teaching associated with experiential learning, experimentation, and real-world problem-solving effectively promotes physics competence.

An overview of previous studies confirms that physics competence is an integrated construct and has initially been specified in terms of components, behavioral indicators, and assessment tools. Teaching for the development of physics competence requires the organization of active, experience-rich learning activities associated with problem solving, experimentation, and real-world application. However, many studies remain limited to individual subjects and short experimental durations, and their assessment tools have not been standardized with clear competence criteria. Therefore, there remains a lack of studies that simultaneously integrate three requirements: reliance on a unified physics competence framework aligned with the 2018 General Education Curriculum, connection with a clearly structured instructional organization model, and applicability in technology-supported and flipped classroom teaching. On this basis, the dissertation adopts the three-component framework of physics competence in the 2018 General Education Curriculum [8] and further specifies it into behavioral indicators and quality criteria for designing learning activities and assessment within the flipped classroom model.

**1.3. Research on the Practical Application and Effectiveness of the Flipped Classroom Model in Developing Physics Competence**

An overview of existing studies shows that the flipped classroom has potential to support the development of physics competence, especially the competence to apply knowledge in practice. However, current studies still have several limitations: (i) a lack of large-scale empirical studies at the general education level on the effectiveness of the flipped classroom for developing physics competence; (ii) the absence of standardized or reliability-tested assessment tools for physics competence, which makes it difficult to measure learners' competence development objectively and accurately; (iii) assessment tools tend to be qualitative and have not fully integrated process assessment and learning-product assessment; and (iv) the intervention mechanism and specific variables influencing the teaching process have not been clarified. Therefore, the dissertation is oriented toward developing an intervention model with an impact mechanism that elicits behavioral indicators through each of students' learning activities, while also developing tools for measuring students' competence that are not limited to knowledge but also include the ability to construct and apply knowledge to solve practical situations.

**Conclusion of Chapter 1**

# CHAPTER 2. THEORETICAL AND PRACTICAL FOUNDATIONS FOR ORGANIZING FLIPPED CLASSROOM–BASED INSTRUCTION TO DEVELOP STUDENTS' PHYSICS COMPETENCE

## 2.1. Theoretical Foundations of Competency-Oriented Teaching

### *2.1.1. Concept of Competence*

Competence is understood as an individual's ability, manifested through the integrated mobilization of knowledge, skills, and psychological attributes such as interest, belief, and willpower, to successfully perform a type of task in a specific context—particularly real-life contexts—thereby demonstrating personal responsibility toward issues of life and society.

### *2.1.2. Structure and Components of Physics Competence*

*a. Components of Physics Competence in the 2018 General Education Curriculum 2018*

*b. Scientific Basis for Proposing Principles to Identify Components of Physics Competence*

*c. Principles for Proposing Components and Behavioral Indicators of Physics Competence*

*d. Procedure for Constructing the Structure of Physics Competence in Flipped Classroom–Based Teaching* *e. Proposed concept of physics competence and competence components*

The study defines **physics competence** as: *"the ability to identify laws governing motion, interaction, and conservation in the natural world in order to understand physical phenomena and processes, and to apply this understanding to solve problems in real-life contexts, thereby forming appropriate attitudes and behaviors toward the surrounding world in pursuit of sustainable development."*

*f. Proposed behavioral indicators of physics competence*

*g. Structure of Physics Competence*

Based on the implementation procedure, the study proposes the structure of physics competence with the following bases for identifying competence components and behavioral indicators:

- Basis for Proposing Competence Components

Drawing on the structure of physics competence in the 2018 General Education Curriculum and the process of forming scientific competence—which includes cognition, exploration, and application—the study adopts three core competence components and proposes their concepts as follows:

+ Physics Cognitive Competence**:** *The ability of students to recall, describe, explain, and organize knowledge related to physics.*

+ Competence in Exploring the Natural World from a Physics Perspective**:** *The ability to investigate and explore objects, phenomena, and processes in daily life and nature through activities such as prediction, investigation, data collection, data analysis, and the use of physics-related scientific evidence to answer learners' questions and draw conclusions.*

+ Competence in Applying Learned Knowledge and Skills: *The ability to integratively apply knowledge and scientific inquiry skills to solve real-world problems and to form appropriate attitudes toward the surrounding world in pursuit of sustainable development.*

- Basis for Determining Levels of Quality Criteria: The study determines performance levels based on differences in students' autonomy when performing behaviors, the complexity of tasks, and the degree of behavioral completion. Specifically:

+ **Level 1:** Unable to perform simple tasks or exhibits many errors in behavioral execution

+ **Level 2:** Performs familiar tasks with support; behavioral execution still contains some errors.

+ **Level 3:** Partially independent in performing modified tasks; behavior is relatively accurate.

+ **Level 4:** Fully independent in performing complex tasks; behavior is accurate and complete.

The determination of levels for each criterion is conducted flexibly, depending on the nature of each behavioral indicator and the targeted competence objectives of the assessment task. Depending on the characteristics of each indicator, emphasis may be placed on one or two specific criteria.

## 2.2. Theoretical Foundations of the Flipped Classroom Model

### *2.2.1. Concept of the Flipped Classroom Model*

The flipped classroom model is an instructional approach in which students' acquisition of foundational knowledge occurs outside the classroom through digital learning materials, while in-class time is devoted to discussion, practice, and problem-solving activities. The model flexibly integrates online and face-to-face learning, aiming at personalized learning; teachers act as designers and organizers, while students actively construct and apply knowledge.

#### ***2.2.2. Role of the Flipped Classroom in Developing Students' Physics Competence***

#### ***2.2.3. Forms of Organizing Instruction Using the Flipped Classroom Model***

The study adopts a partial flipped classroom model with asynchronous implementation, allowing students to choose their own time to complete online learning tasks while flexibly integrating in-class teaching methods according to lesson content. This model enables the segmentation of knowledge into small, accessible units, providing a foundation for in-class exploratory and discussion-based activities. Asynchronous learning supports personalization of learning pace, enhances learner autonomy, facilitates adaptive learning strategies, and promotes knowledge construction in alignment with cognitive constructivist theory.

#### ***2.2.4. Physics Content Suitable for Flipped Classroom–Based Instruction***

#### ***2.2.5. Principles for Designing Teaching Activities Oriented Toward Developing Physics Competence Using the Flipped Classroom Model***

### **2.3. Practical Foundations for Competency Development Through the Flipped Classroom Model**

#### ***2.3.1. Teacher Survey***

The results indicate that teachers' perceptions of the usefulness and ease of use of the flipped classroom model directly influence their intention to adopt it. Ease of use is affected by the design of learning management systems with simple interfaces, ease of access, support for multiple learning material formats and devices, integration of games and digital resources, and learning analytics capabilities. Favorable school conditions and teachers' TPACK competence (content knowledge, pedagogical skills, and technology integration skills) also positively influence these perceptions.

#### *2.3.2. Student Survey*

Most students expressed strong agreement with the benefits of the flipped classroom model, particularly in terms of proactive pre-class knowledge acquisition, flexible learning schedules, and diverse learning formats. Pre-class learning helps consolidate and retain knowledge more effectively. Students evaluated platforms such as Google Classroom, Microsoft Teams, and LMS systems as user-friendly and easy to use; however, male students reported higher confidence in technology use than female students, suggesting the need for enhanced technical support and training. Major challenges included limited online learning skills, technological infrastructure constraints, and reduced direct interaction with teachers. Students expressed a desire to expand the flipped classroom model to other subjects, with learning management systems that feature user-friendly interfaces, integrated interaction tools, and immediate feedback.

### 2.4. Development of Students' Physics Competence Through the Flipped Classroom Model

#### *2.4.1. Scientific Basis for Proposing Principles of Physics Competence Development in the Flipped Classroom*

#### ***2.4.2. Principles for Proposing Measures to Develop Students' Physics Competence in Flipped Classroom–Based Teaching***

#### ***2.4.3. Measures for Developing Students' Physics Competence Through the Flipped Classroom Model***

*a. Measure 1: Organizing activities for problem identification and foundational knowledge preparation in the pre-class phase to develop physics cognitive competence*

*b. Measure 2: Organizing inquiry and exploratory learning activities during the in-class phase to develop competence in exploring the natural world from a physics perspective.*

*c. Measure 3: Organizing activities for applying learned knowledge and skills to solve real-world problems during the in-class and post-class phases.*

### **2.5. Procedure for Implementing Flipped Classroom–Based Instruction Oriented Toward Developing Physics Competence**

#### ***2.5.1. Procedure for Designing Flipped Classroom–Based Instruction Oriented Toward Physics Competence Development***

*a. Stage 1: Prepartion*

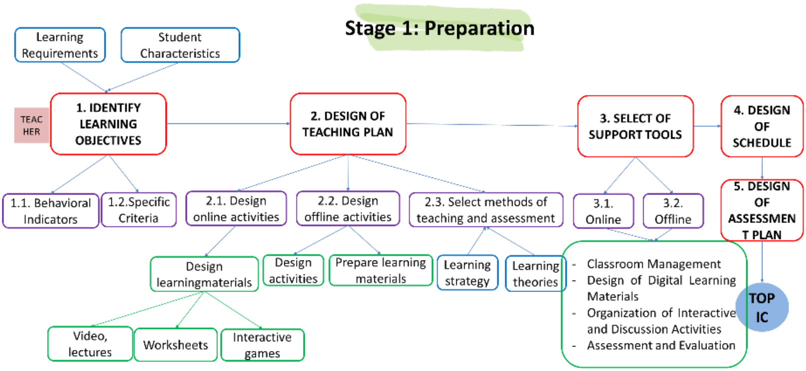


*Figure 2.6. Stage 1 – Preparation*

*b. Stage 2: Instructional Implementation*

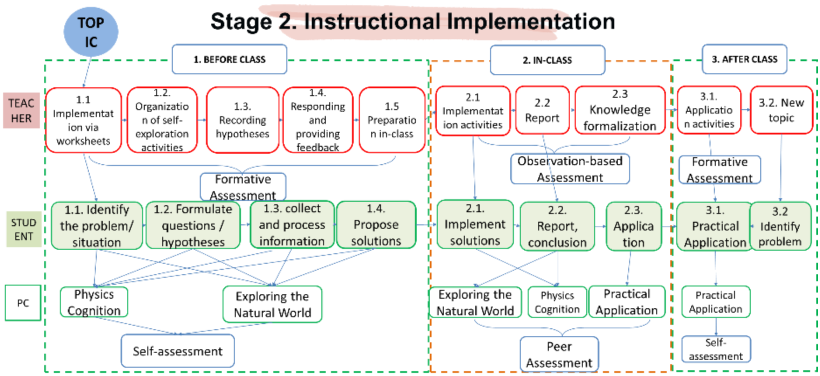


*Figure 2.7. Stage 2 – Instructional Implementation*

*c. Stage 3: Assessment and Adjustment*

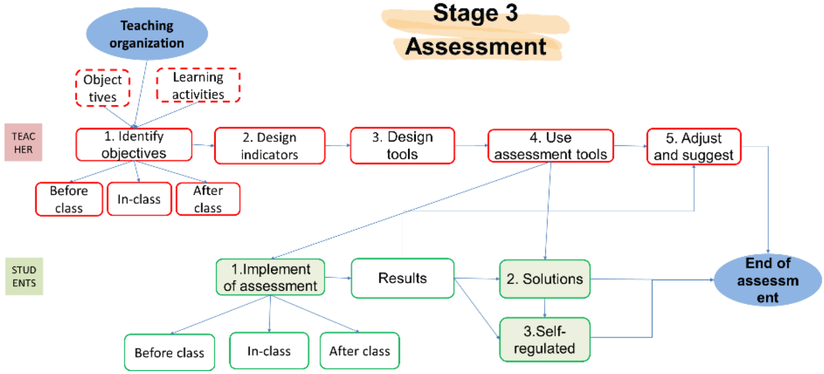


*Figure 2.8. Stage 3 – Assessment and Adjustment*

### *2.5.2. Teaching Organization Process Using the Flipped Classroom Model to Develop Physics Competence*

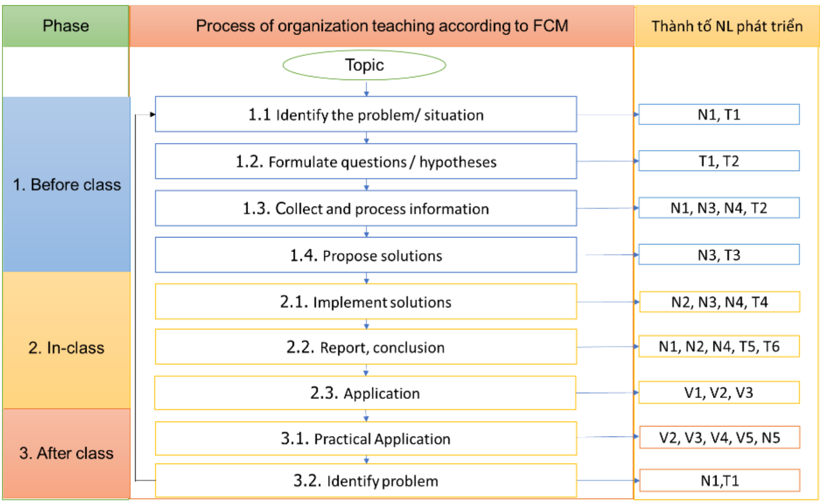


*Figure 2.9. Teaching organization process using the flipped classroom model oriented toward developing students' physics competence*

## **Conclusion of Chapter 2**

# CHAPTER 3. DESIGNING TEACHING PROCESS FOR THE DYNAMICS SECTION ACCORDING TO THE FLIPPED CLASSROOM MODEL TO DEVELOP STUDENTS' PHYSICS COMPETENCE

## 3.1. Analysis of the Grade 10 Physics Curriculum under the 2018 General Education Curriculum 2018

## 3.2. Analysis of Knowledge Content in the Dynamics Section– Grade 10 Physics

## 3.2. Objectives and teaching process for the Dynamics Section in the 2018 General Education Curriculum

## 3.3. Designing the Teaching Process for the Topic "Newton's Three Laws" in the Dynamics Unit Using the Flipped Classroom Model to Develop Students' Physics Competence

### *3.3.1. Developing Physics Competence Through the Phases of the Teaching Process*

### *3.3.2. Developing physics competence through the phases of the teaching process*

### *3.3.3.* Teaching Process for Newton's First Law

I. Objectives

II. Equipment and Learning Materials

III. Teaching Process Organization

1. Identification of the Sequence of Teaching Activities and Content Development

| **Activity** | **Activity Content (Time Allocation)** | **Instructional Methods and Techniques** | **Assessment Basis** |
|---|---|---|---|
| **Pre-class** | | | |

| | | | |
|---|---|---|---|
| 1.1 – 1.2 | Problem situations and prediction | Online (Activities 1.1 and 1.2 on Google Classroom) | Students' responses on Google Classroom |
| 1.3 – 1.4 | Formation of knowledge about Newton's First Law and inertia | Online (Activities 1.3 and 1.4 on Google Classroom) | Worksheet for Activity 1.4 |
| **In-class** | | | |
| 1 | Review of self-study knowledge (8 minutes); presentation of conclusions from Galileo's experiment (7 minutes) | Games; group-based learning | Worksheet No. 1 |
| 2.1 | Investigation of the experiment related to Newton's First Law (10 minutes) | Group-based learning | Worksheet No. 2 |
| 2.2 | Summary of Newton's First Law and inertia (10 minutes) | Group-based learning | Worksheet No. 3 |
| 2.3 | Application activities (10 minutes) | Group-based learning | Worksheet No. 4 |
| **Post-class** | | | |

| | | | |
|---|---|---|---|
| 3.1 | Application of knowledge to real-life contexts | Online (digital worksheets) | Online worksheets |
| 3.2 | Identification of new research problems | Online | — |

2. Organization of Specific Teaching Activities

2.1. Phase 1: Pre-class

2.2. Phase 2: In-class

2.3. Phase 3: Post-class

***3.3.4. Teaching Process for Newton's Second Law***

**Conclusion of Chapter 3**

## CHAPTER 4. PEDAGOGICAL EXPERIMENT

### 4.1. Purpose of the Pedagogical Experiment

### 4.2. Participants and Methods of the Pedagogical Experiment

#### *4.2.1. Round 1 of the Pedagogical Experiment*

Experimental group: Class 10/6 (38 students) at Nguyen Trai High School; Classes 10A2 and 10A17 at FPT Danang High School. Control group: Class 10/5 (39 students) at Nguyen Trai High School.

#### *4.2.2. Round 2 of the Pedagogical Experiment*

Experimental group: Class 10/5 (38 students) at Nguyen Khuyen Secondary and High School; Class 10/26 (45 students) at Phan Chau Trinh High School; Class 10/8 (45 students) at Nguyen Hien High School. Control group: Class 10/3 (40 students) at Nguyen Khuyen Secondary and High School; Class 10/9 (42 students) at Phan Chau Trinh High School; Class 10/7 (42 students) at Nguyen Hien High School.

### 4.3. Research Problem

**4.4. Methods of the Pedagogical Experiment**

**4.5. Tasks of the Pedagogical Experiment**

**4.6. Procedure of the Pedagogical Experiment**

**4.7. Development of Assessment Tools for Evaluating Physics Competence in Flipped Classroom–Based Learning**

***4.7.1. Principles for Developing Assessment Tools in Competency-Oriented Physics Teaching Using the Flipped Classroom Model***

***4.7.2. Procedure for validating assessment tools***

***4.7.3. Forms of Assessing Physics Competence Development in Flipped Classroom Teaching***

**4.8. Research Design and Data Collection and Analysis Procedures**

***4.8.1. Research Design***

***4.8.2. Measurement instruments and procedures for validating the instruments***

***4.8.3. Procedures for Collecting, Processing, and Analyzing Quantitative Data***

**4.9. Evaluation of Pedagogical Experiment Results**

***4.9.1. Qualitative Evaluation of the Flipped Learning Process***

*a. Qualitative evaluation after Round 1*

*b. Qualitative evaluation after Round 2*

*c. Analysis of the relationship among learning activities, components of physics competence, and assessment evidence in the experimental lessons*

***4.9.2. Case Study on the Development of Physics Competence Through the Flipped Classroom Model***

*a. General Information about the Case Study*

*b. Qualitative Description and Analysis of Students' Physics Competence Development*

*c. Quantitative Analysis of Students' Physics Competence Development in Case Study*

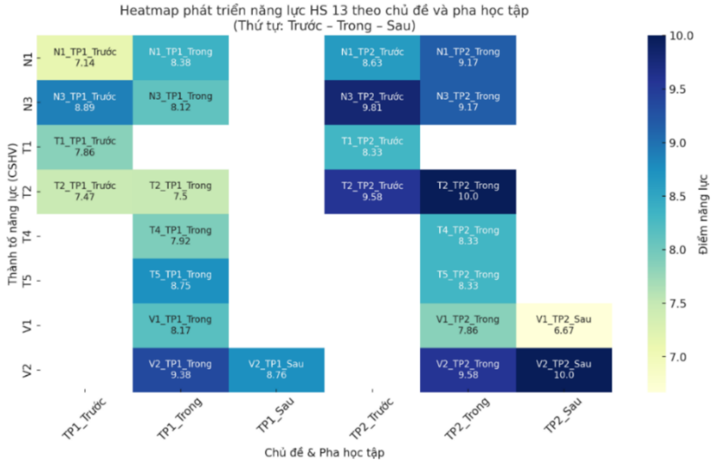


*Figure 4.6 Heat maps illustrating competence development of student no. 13 across learning phases*

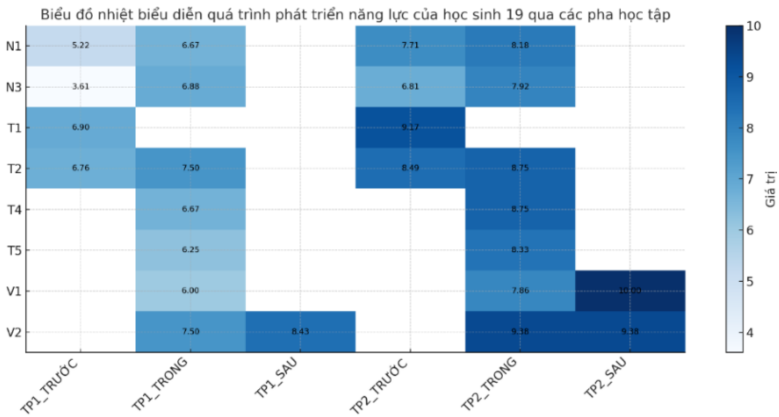

*Figure 4.7 Heat maps illustrating competence development of student no. 19 across learning phases*

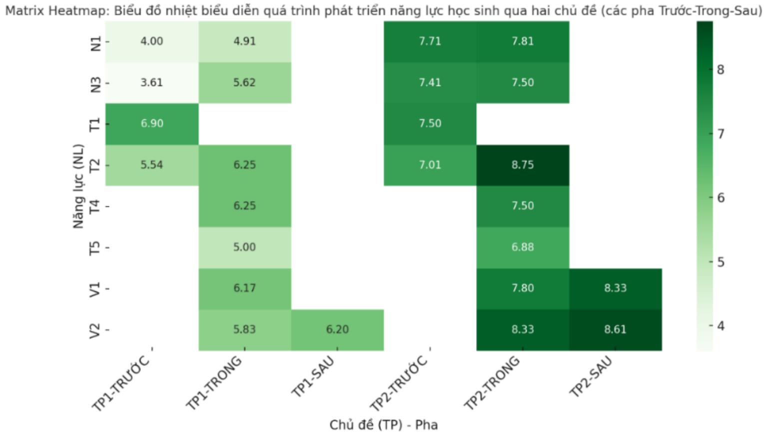


*Figure 4.8. Heat maps illustrating competence development of student no.43 across learning phases*

Radar charts are used to illustrate progression of competence development across lessons.

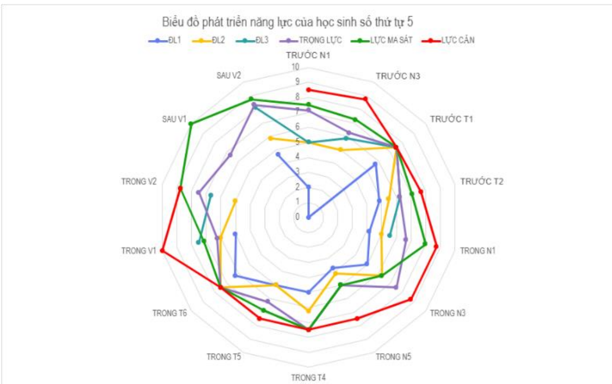


*Figure 4.9. Radar chart illustrating competence development of Student No. 5*

### ***4.9.3. Quantitative Analysis of the Effectiveness of Physics Competence Development in the Experimental Group***

*a. Effectiveness of Physics Competence Development in the Experimental Group*

*Table 4.3. Results of paired-sample statistical analysis*

| **Condition** | **Mean** | **N** | **Std. Deviation** | **Std. Error Mean** |
|---|---|---|---|---|
| Pre-intervention | 6.8800 | 45 | 1.13099 | 0.16860 |
| Post-intervention | 8.6222 | 45 | 0.57613 | 0.10077 |

The study analyzed students' learning process across the phases of the flipped classroom and collected process-assessment data, including: online scores, calculated as students' average scores when completing online worksheets before class (TP1_NEAR and TP2_NEAR); guided learning-activity scores, calculated as the average scores of in-class activities (TP1_SCAFF and TP2_SCAFF); and far-transfer test scores, calculated as the average scores of post-class activities for each lesson (TP1_FAR and TP2_FAR). From a pedagogical perspective, this result suggests that the flipped classroom model was effective in that pre-class learning helped students form initial understanding, identify learning tasks, and prepare foundational knowledge; however, more pronounced development appeared only when students participated in guided in-class learning activities, discussion, practice, and cognitive adjustment with teacher support. Far-transfer activities or the post-intervention test further indicate that this result was maintained and transformed into the ability to apply knowledge in new tasks.

*b. Learning Outcome Progress Among Student Groups in the Experimental Class*

The Kruskal–Wallis test revealed statistically significant differences among student groups in post-intervention test scores ($\chi^2 = 38.072$, df = 2, $p < 0.001$), indicating distinct levels of physics competence development after flipped classroom implementation.

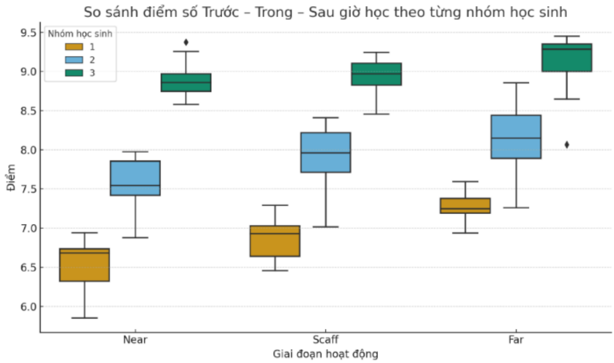


*Figure 4.13. Comparison of earning activities scores among student groups*

*c. Evaluation of the Development of Physics Competence Components Across Learning Topics*

The analysis results demonstrate the effectiveness of designing learning activities in a way that gradually expands the scope and difficulty of tasks. The substantial progress observed in far-transfer conditions also reflects students' improved ability to transfer knowledge and highlights the important role of in-class activities as a bridge that helps students become ready to solve more complex situations.

*d. Impact of the Flipped Classroom Model on Learning Outcomes Compared with the Control Group*

*Table 4.7. Statistical results and independent-sample t-test for experimental and control groups*

| Group | N | Mean | Std. Deviation | Std. Error Mean | t-value | Sig. (2-tailed) |
|---|---|---|---|---|---|---|
| Experimental | 45 | 8.6229 | 0.67597 | 0.10077 | 4.876 | 0.000 |
| Control | 42 | 7.5714 | 1.28106 | 0.19767 | | |

#### ***4.9.4. Evaluation of the Development of Behavioral Indicators Across Flipped Learning Activities***

*a. Development of Behavioral Indicators of Physics Cognitive Competence*

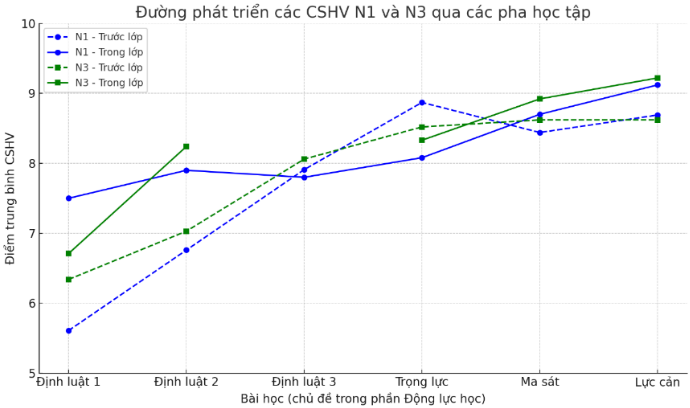


*Figure 4.14. Developmental trends of behavioral indicators N1 and N3 across pre-class and in-class phases*

*b. Development of Behavioral Indicators of Competence in Exploring the Natural World from a Physics Perspective*

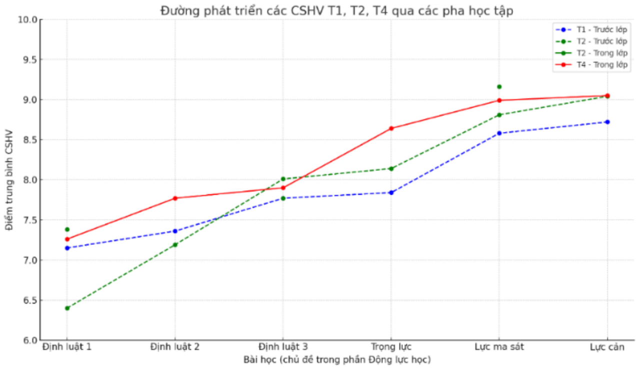


*Figure 4.15. Developmental trends of behavioral indicators T1, T2, and T4 across learning phases*

*c. Development of Behavioral Indicators of Competence in Applying Learned Knowledge*

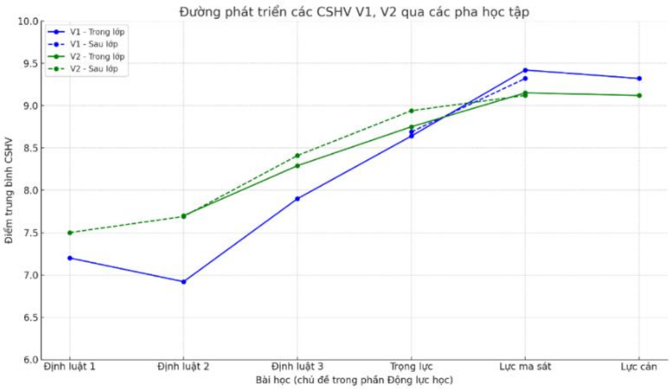


*Figure 4.16. Developmental trends of behavioral indicators V1, V2, and V3 across in-class and post-class phases*

**Conclusion of Chapter 4**

## CONCLUSIONS AND RECOMMENDATIONS

### 1. Conclusions

In relation to the research objectives and tasks, the dissertation has achieved the following key results:

***a. Theoretical Contributions***

- The dissertation systematizes prior research on competency-oriented teaching, physics competence, and the objectives of the 2018 General Education Curriculum to propose clearly defined components of physics competence and to reformulate the behavioral indicators within each component. Physics competence is structured into **three components comprising sixteen behavioral indicators**, organized into **four levels of quality criteria**.

- The study proposes a comprehensive procedure for designing and organizing instructional themes using the flipped classroom model; a procedure for organizing inquiry-based learning activities oriented toward developing students' physics competence; and specific measures for developing physics competence through flipped classroom–based teaching.

- Within the proposed procedures, the dissertation clearly specifies the roles and activities of teachers and students and integrates tables of behavioral indicators of physics competence aligned with each instructional activity. This approach explicitly identifies opportunities for physics competence development within flipped classroom learning activities.

***b. Practical Contributions***

- The dissertation conducted a large-scale survey involving **351 physics teachers** from provinces and cities in Central Vietnam, the Central Highlands, and the Southern region to investigate the current status of flipped classroom implementation. The survey examined teachers' perceptions, readiness, facilitating conditions, challenges, and needs related to the effective implementation of the flipped classroom model. Based on these findings, the study identified key issues requiring resolution and formulated guiding research questions for the dissertation.

- The study designed six teaching processes for topics and lessons within the Dynamics unit – Grade 10 Physics. For each topic or lesson, assessment tools for physics competence in flipped classroom–based teaching were developed and concretized within learning activities.

- The results of the two rounds of pedagogical experiments with the designed teaching processes, implemented at high schools in Danang city, were used for qualitative and quantitative analyses and case-study evaluation to provide evidence of the feasibility and positive impact of the model within the scope of the sample, duration, Dynamics content, and conditions of the pedagogical experiment.

**2. Limitations and Directions for Future Research**

- The experimental sample lacks broad generalizability, as the pedagogical experiments were conducted only within Danang city.

- Observing behavioral indicators of physics competence in classes with more than 40 students poses challenges; therefore, group-level observations were employed. Future research should develop more refined observation tools and extend observation periods to assess individual students' behavioral indicators more accurately.

- To further strengthen the research findings, it is recommended that the proposed procedures be applied to other content areas and topics within the 2018 General Education Curriculum. Such expansion would enable more generalizable conclusions and contribute to improving the quality of physics teaching in secondary education.

**3. Recommendations**

Based on the research findings, the dissertation emphasizes the necessity of developing students' physics competence in physics teaching. To enhance the effectiveness of competency-oriented instruction—particularly through the flipped classroom model—the following recommendations are proposed:

**First**, it is essential to enhance teachers' awareness and readiness for implementing flipped classroom–based instruction through professional development, training programs, and the sharing of practical teaching experiences. Teachers should be supported in understanding the theoretical foundations, organizational procedures, and educational value of the flipped classroom model in developing students' competence.

**Second**, there is a need to strengthen teachers' digital competence and their capacity to design and organize flipped classroom–based teaching activities in physics education. Professional development should focus on designing digital learning materials, organizing active learning activities, and assessing students' competence using specific behavioral indicators.

**Third**, digital learning materials should be designed with a personalized learning orientation to better accommodate students' diverse learning needs, paces, and learning styles. Furthermore, the application of artificial intelligence in learning analytics, personalized content recommendations, and timely feedback represents a promising research direction that can enhance instructional effectiveness and support students' competence development in the context of educational digital transformation.

**Finally**, educational institutions and educational management agencies should provide adequate support in terms of facilities, technological infrastructure, and professional mechanisms to encourage teachers to implement innovative instructional models. Such support will contribute to improving the quality of physics education and meeting the demands of current general education reform.