DEVELOPMENT OF FLIPPED CLASSROOM INSTRUCTIONAL MODEL TO IMPROVE PHYSICAL INNOVATIVE ABILITY FOR UNDERGRADUATE STUDENTS

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Thesis Title Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students

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ABSTRACT

The purposes of this research were 1) to study the factors affecting physical innovative ability for undergraduate students; 2) to develop flipped classroom instructional model to improve physical innovative ability for undergraduate students and; 3) to examine the results of implementing flipped classroom instructional model to improve physical innovative ability for undergraduate students. This study consisted of 3 Phases. The population consisted of 150 former students in the first semester of the main degree of Hechi University in the 2022 academic year, and 6 lecturers of Hechi. University in Phase 1. There were 5 specialists in Phase 2 and there were 50 students from Hechi University in Phase 3. The instruments were 1) the questionnaire for students 2) the questions for lecturers 3) conformity assessment form of flipped classroom instructional model; 4) lesson plans and 5) scoring rubric. Data were statistically analyzed by percentage, mean, and standard deviation.

The results revealed the following:

1. There were 2 factors to improve physical innovative ability for undergraduate students: one was internal factors, including practical and psychological; the second was external factors, including teaching materials, teaching methods, and teaching evaluation.

2. Flipped classroom instructional model consisted of 5 parts: Principles and rational, Objectives, Contents, Teaching methods and materials, and Evaluation. The model had been evaluated programmatically (Utility standards, Feasibility standards, Appropriateness standards, and Accuracy standards) were 100% confirmed by 5 experts, and could be further implemented.

3. The results of implementing flipped classroom instructional model to improve physical innovative ability for undergraduate students it was found that 92% of 50 students was at a Good level (80% Good level). Therefore, it could be inferred that the flipped classroom instructional model was successful in improving students' physical innovation ability.

Keywords: Flipped Classroom Instructional Model; Physical Innovative Ability; Undergraduate Students

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May we progress together and grow together!

Zhong Youkun

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Chapter 1
Introduction

Rationale

The university physics course is a vital mandatory elementary curriculum in science and engineering school at colleges and universities, and serves as the underpinning for all natural disciplines. University physics explores the fundamental structure and the interactions between matters, the elementary forms of motion, and the laws governing their mutual transformations. The aim of the university physics course is to provide students with comprehension of the contents and methods of physics, the working language, the concepts and images of physics. Furthermore, the video provides students with the opportunity to not only grasp the concepts and methodologies of physics research problems, but also acquire knowledge that enhances their ability to develop innovation ability and connect theory with real-life situation. The teaching principle of the university physics course emphasizes the importance of fundamental knowledge while introducing advanced and cutting-edge concepts. This approach ensures that the foundation of university physics education is strong and reflects the current trends. The university Physical Innovative ability encompasses four main aspects, namely learning ability, analytical ability, comprehensive ability, and imaginative ability (Hechi University, 2022).

In the process of teaching university physics course, it was found that there were several problems on students' learning as follows: Item 1: Learning ability; Item 2: Analytical ability; Item 3: Comprehensive ability; Item 4: Imaginative ability (Wang, 2022).

In terms of the research on flipped classroom instructional model: Wang (2023) believed that the application of flipped classroom was conducive to cultivating students' innovation ability and expanding students' thinking, which was different from the "inculcating" in traditional teaching and advocated students' independent thinking. Geng (2023) proposed the opinion that flipped classroom instructional model could invert the traditional learning time sequence, empowering students to take charge of their own learning and facilitating their active involvement in class. Liu (2023) showed that the flipped classroom instructional model incorporated information technology into education and teaching, diversified

instructional formats, and prioritized student-centered teaching. Flipped classroom instructional model included the following advantages: 1) Eliminating the problem of busy students missing classes. 2) Allowing students to review and grasp important concepts at their own convenience. 3) Creating an engaging and interactive learning environment. 4) Facilitating timely communication among students (Zhong, 2023). Li (2022) demonstrated that flipped classroom instructional model could improve teacher-student interaction, effectively stimulate students' initiative and independent learning, foster innovative thinking skills, and allow teachers to better understand students' weaknesses. As a result, teaching can be tailored to individual needs, leading to improved teaching outcomes.

Based on the above theoretical basis, the author realized the importance of the research "Development of Flipped Classroom Instructional Model to Improve Physical Innovative ability for Undergraduate Students".

Research Questions

1. What are the factors affecting physical innovative ability for undergraduate students?

2. Is flipped classroom instructional model to improve physical innovative ability for undergraduate students appropriate for further implementation and how?

3. What are the results of implementing flipped classroom instructional model to improve physical innovative ability for undergraduate students?

Research Objectives

1. To study the factors affecting physical innovative ability for undergraduate students.

2. To develop flipped classroom instructional model to improve physical innovative ability for undergraduate students.

3. To examine the results of implementing flipped classroom instructional model to improve physical innovative ability for undergraduate students.

Research Hypothesis

After the implementation of flipped classroom instructional model, students' physical innovative ability must be improved at a good level≥ 80% (good level).

Scope of the Research

Population

The total of 300 freshmen from 6 classes of students with different levels of learning achievements who enrolled in the university physics course in Hechi University in semester 1st academic year 2023. Those sections involve the following.

Class A: 50 students

Class B: 50 students

Class C: 50 students

Class D: 50 students

Class E: 50 students

Class F: 50 students

The sample group

The 50 students who enrolled in the Hechi University Physics Course from Class C were obtained by cluster random sampling.

The variables

Independent variable

Flipped classroom instructional model

Dependent variables

Undergraduate students' physical innovative ability

Contents

According to undergraduate students' physical innovative ability in this study, the researcher chooses Unit 4 for the experiment.

Time frame

Semester 1st of academic year 2023 (September 1st – December 31st 2023)

Advantages

For the students: they can fully tap students' learning potential, form cultivation of students' independent and innovative thinking, and promote their all-around development. At the same time, this teaching model fully reflects the education reform to the innovation ability of college teachers.

For the lecturers: they can teach a new information technology, which not only enriches teachers' plans, but also promotes students' learning channels, improves students' self-learning innovation ability, and develops the formation of students' scientific literacy. In addition, lectures actively accumulates typical lessons, summarizes common problems and solutions in the process of implementation flipped classroom instructional model.

For the university: flipped classroom instructional model focuses on teaching, which effectively improves the level of classroom teaching management and university intelligent teaching management.

Definition of Terms

The factors affecting physical innovative ability refer to the internal and external factors collected from questionnaires for students and interviews for lecturers designed by the researcher. The internal factors involve the information about students, while external factors consist of information about the teacher and circumstances. Furthermore, the factors will be derived through structured interviews conducted with the lecturers.

The development of flipped classroom instructional model refers to a new instructional frame work which consists of the stable teaching activities and procedures. Such a developed instructional model with 5 components: 1) Principle & Rationale, 2) Objectives, 3) Contents, 4) Methods of teaching & Materials and 5) Evaluation (Lawrence, 2016), is confirmed by the experts in 4 aspects standards: 1) utility standards, 2) feasibility standards, 3) propriety standards and 4) accuracy standards (The program Evaluation Standards, 1994) as follows.

Utility standards are intended to ensure that the developed instructional model will serve the information needs of intended users.

Feasibility standards are intended to ensure that the developed instructional model will be realistic, prudent, flexible, and frugal.

Propriety standards are intended to ensure that the developed instructional model will be conducted in conformity to teaching principles and provide positive results.

Accuracy standards are intended to ensure that the developed instructional model shows a measure of closeness to a true value.

The flipped classroom model instructional model refers to involve teachers creating videos for students to watch at home or outside the classroom. Students come to class to engage in face-to-face interaction and complete assignments. Qin (2021) proposed the specific content of each link in the flipped classroom instructional model is as follows:

Step 1: Create teaching videos. First of all, it should be clear what the student must master and what the video needs to show in the end;

Step 2: Collect teaching videos. It is important to consider the variations between teachers and classes.

Step 3: Apply teaching videos. Students' ideas should be considered in the production process to adapt to different students' learning methods and habits.

Step 4: Organize classroom activities. After the content is delivered to students outside of the class, there will be a greater need for high-quality learning activities in the classroom. Student-created contents, independent problem solving, inquiry-based activities, project-based learning should be included (Pang, 2020).

Physical innovative ability refers to the thinking process of solving problems in novel and original methods. Innovation ability can break through the boundaries of conventional thinking, think about problems with unconventional or even unconventional methods and perspectives, and propose distinctive solutions, thus producing novel, unique and socially significant thinking results. Innovation ability consists of four criteria, and each criterion is a score (Wang, 2022).

Item 1: Learning ability

Standard 1: Physics self-directed learning awareness

Standard 2: Physics study habits

Standard 3: Learning outcomes

Item 2: Analytical ability

Standard 1: Descriptions of physical phenomena

Standard 2: Instructing physics experiments

Standard 3: Preview physical results based on physical phenomena and experiments

Item 3: Comprehensive ability

Standard 1: Physical phenomena explanation

Standard 2: Physical theory elaboration

Standard 3: Application of physical laws

Item 4: Imaginative ability

Standard 1: The building of physical models

Standard 2: Thinking about physical patterns

Standard 3: New theories are derived from physical models

Undergraduate students refers to students who enrolled in the university Physics Course in semester 1st academic year 2023 in Hechi University.

Hechi University refers to a government university located in the northwest of Guangxi Province, China.

Research Framework

The researcher studied the objectives of university physics from Hechi University, development of flipped classroom instructional model (Pang, 2020, the program Evaluation Standards, 1994), students' physical innovative ability. (Wang, 2022). The following is the basic framework of this study in figure 1.1.

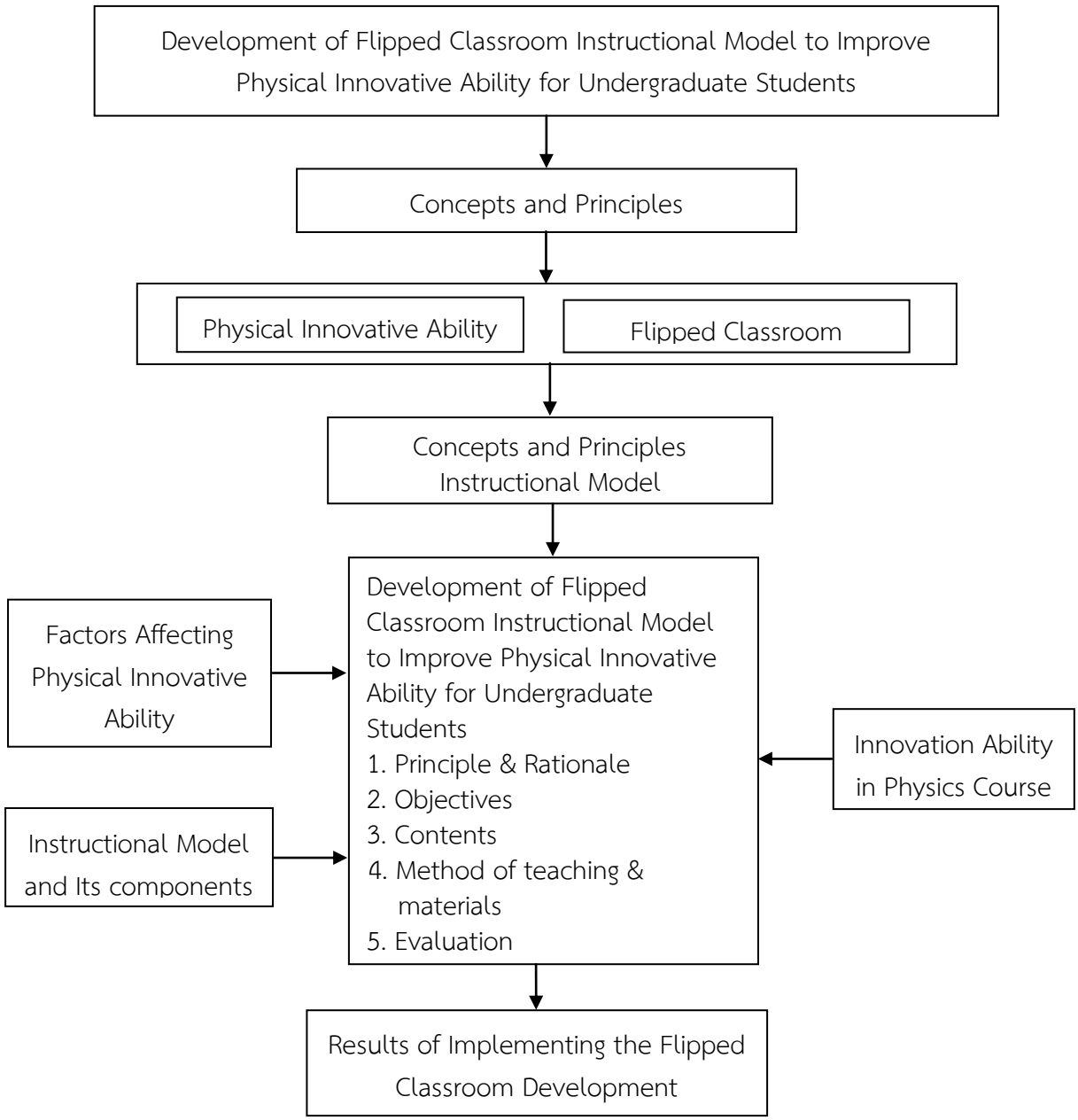

Figure 1.1 Research Framework

Chapter 2
Literature Review

In the research on "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students", the researcher consulted the relevant literature in order to build the theoretical framework for the research.

1. University physics course in Hechi University

2. Differences and connections between flipped classroom instructional model and traditional classroom teaching mode

3. Physical innovative ability

4. Relevant research

The details are as follows:

University Physics Course in Hechi University

Teaching principle

1. The principle of paying attention to fundamental theoretical knowledge and essential concepts on university physics.

2. The principle of cultivating students' innovative thinking.

3. The principle of applying flipped classroom instructional model in university physics courses.

4. The principle of cultivating students' innovative thinking.

5. The principle of integrating physics course instruction with professional skill development.

Objectives

1. Proficient in the fundamental and advanced principles in university physics courses.

2. Familiar with the basic application of physical theory knowledge.

3. Related issues and practical problems in class.

4. Professional information skills and creative thinking approaches.

Curriculum structure

The physics courses at Hechi University are as follows:

Table 2.1 Curriculum structure in university physics courses in Hechi University

Unit	Chapter	Contents	Times (48 hrs.)
Unit 1: Kinematics of a Particle	1.1	Reference system, coordinate system	8 hrs.
	1.2	Displacement, velocity, acceleration	
	1.3	Description of curve motion	
Unit 2: Particle Dynamics	2.1	Kinematics of simple harmonic vibration	10 hrs.
	2.2	Momentum and conservation of momentum	
	2.3	Law of conservation of kinetic energy, potential energy and mechanical energy	
	2.4	Law of conservation of angular momentum	
Unit 3: Fundamentals of Rigid Body Mechanics	3.1	Description of rigid body and fixed axis rotation of rigid body	6 hrs.
	3.2	The law of rotation of rigid bodies	
	3.3	Kinetic energy theorem for fixed axis rotation of rigid bodies	
	3.4	Angular momentum theorem for fixed axis rotation of rigid bodies	
Unit 4: Mechanical Vibration and Mechanical Waves	4.1	Newton's laws of motion	16 hrs.
	4.2	Simple harmonic vibration	
	4.3	Huyghens principle	
	4.4	Gauss theorem in electric fields	
Unit 5: Electrostatic Field	5.1	Electric field and electric field intensity	8 hrs.
	5.2	Self-inductive and mutual inductive	
	5.3	Loop theorem in electric fields	

Unit 4 was chosen by the research for implementing the developed model in the present study.

Flipped Classroom Instructional Model

The scholar's definitions on the flipped classroom instructional model are as follows:

Wang (2022) defined the flipped classroom instructional model as a teaching method, in which teachers and students had more time to answer questions and internalize knowledge.

Chen (2023) defined flipped classroom teaching as the product of the combination of modern information technology and education.

Chen (2019) defined the main differences between flipped classroom and traditional teaching mode: 1) Traditional teachers transferred decision-making power from teachers to students in the teaching process. Teachers shared learning contents with students before class, formulated specific learning contents and tasks, and students made learning plans according to the learning contents released by teachers. In class, students had the opportunity to engage in interactions with one another and seek assistance from the teacher by asking questions. 2) Based on the rapid development of mobile Internet, flipped classroom instructional model enabled students to receive learning contents through computers and mobile phones promptly and carry out communication activities conveniently.

Chen (2017) defined flipped classroom instructional model as follows: teachers recorded the teaching contents before class, and students learned independently, freely controlled the learning progress, changed the traditional teaching methods in class. Students mastered knowledge independently in the process of cooperative exploration and knowledge internalization, and completed homework after class.

According to the above definition, flipped classroom instructional model means that teachers use information technology to record detailed explanations of various knowledge points in teaching micro-videos and pass them to students with the help of learning management platforms.

Confirmatory factor analysis

To ensure the appropriateness of developed instructional model before implementation, the developed instructional model is confirmed depending on program evaluation standards in 4 aspects: 1) utility standards, 2) feasibility standards, 3) propriety standards, 4) accuracy standards (The program Evaluation Standards,

1994), Teaching model evaluation standard composition chart so as Figure 2.1.

Utility standards are intended to ensure that the developed instructional model will serve the information needs of intended users.

Feasibility standards are intended to ensure that the developed instructional model will be realistic, prudent, flexible, and frugal.

Propriety standards are intended to ensure that the developed instructional model will be conducted in conformity to teaching principles and provide positive results.

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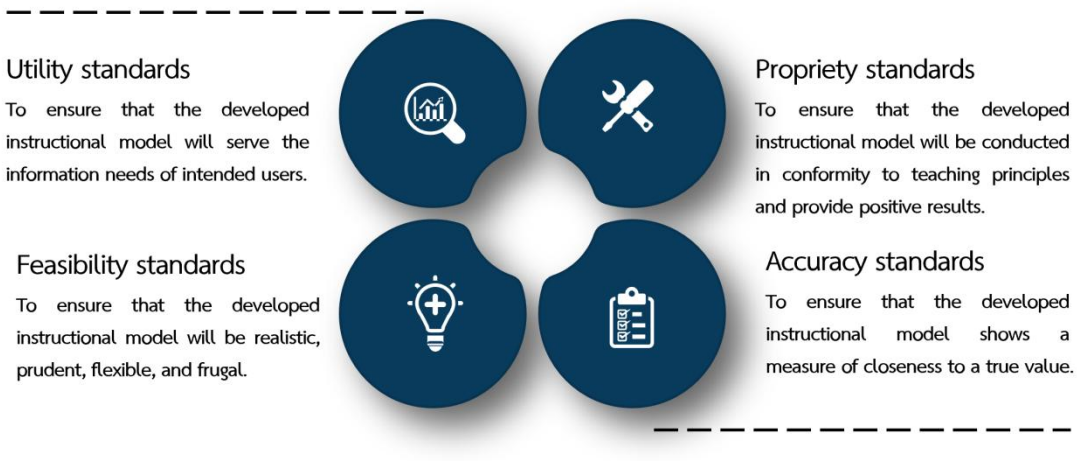

Figure 2.1 Teaching model evaluation standard composition chart (Xing, 2020)

The background of flipped classroom instructional model based on university physics.

Background

For many years, the teaching mode of university physics has been mainly teacher-centered, including blackboard writing, teaching media, and other means to convey the teaching contents to students. This teaching approach turns students into the subject of classroom learning. In the whole course of teaching activities, the teacher is always the leader, while the students are passively receiving education. The consequence of this teaching approach is a deficiency in teacher-student

interaction and communication. In other words, teachers fulfill the role of educators, while students passively receive knowledge. The media serves as an important tool to assist teachers in instilling the contents of the textbook to students, and the textbook is the core content delivered in the teaching process. Hence, the teacher assumes the role of leader, while the student takes on the position of subject. In sum, teachers, students, teaching materials, and the media together create an enduring and stable education system. Koloff's approach, consisting of five stages, embodies the conventional teacher-centered approach to education. Based on this theory, he put forward and developed five basic methods-discovery method, teaching method, practice method, teaching method, and experimental research method, which are called five-step teaching method in science education. This teaching strategy highlights the inherent conflict between "what to teach" and "how to teach". He held the view that the core of a learning task was not how much content was taught, but the development of specific abilities were required by students. Five-step teaching method helps teachers to organize classroom teaching effectively and play a controlling role in teaching. Nonetheless, the most significant drawback lied in its excessive focus on teachers as the primary catalyst for learning, disregarding the passion and innovation demonstrated by students. Consequently, this approach hindered the development and advancement of students' capacity for innovative thinking.

Constructivist learning theory

Constructivism states that the process of learning involves active engagement from learners as they create their own knowledge system. This process involves forming a comprehension of new information by building upon previous knowledge and experience, or restructuring existing knowledge and experience. At the same time, the process of knowledge construction needs to be context-based, and learning should be combined with situational practice to acquire knowledge. In addition, constructivism emphasizes teacher-student interaction, allowing learners to complete learning tasks together through cooperation and communication with the outside world. Teaching should not make students passively accept knowledge, but create an ideal learning situation, strengthen students' cooperation, guide students to actively construct new concepts, and promote students' acquisition of knowledge. Under the guidance of constructivism theory, teachers will conduct teaching in a

favorable teaching environment based on students' accumulated knowledge and experience in teaching activities, organize students to explore questions in the form of group cooperation, and encourage students to respect others' views and construct knowledge scientifically. In this process, educators should enhance students' comprehension and utilization of knowledge in diverse scenarios (Sha, 2018).

The theoretical basis of the flipped classroom

After an in-depth study of relevant academic literature, combined with researchers' insights into flipped classroom instructional model, it was found that there were many theoretical supports behind flipped classrooms. Bloom's mastery learning theory, constructivism theory, mixed learning theory, and learning-before-teaching theory had a significant impact on flipped classroom instructional model. These theories offer educators a novel viewpoint to explore the concept of flipped classroom instructional model.

Mastery learning theory

Benjamin Blum, the famous American educator, psychologist, and professor of education at the University of Chicago, first proposed the idea of mastery teaching theory in the 1950s and 1960s. He thought that the theory of mastering learning was an educational model that followed the principle of "teaching students based on their individual abilities". Mastery learning theory meant providing all students with individualized support and additional study time to ensure that the majority of students could achieve predetermined mastery goals under the guiding philosophy of "all students can learn well." It emphasized the importance of training students at different levels in the same way. Blum emphasized that almost all students could perform well if teachers guided them in an organized way, provide timely assistance when they were in trouble, give them ample time to acquire knowledge, and set clear learning standards for them. Therefore, mastery learning theory emphasized the importance of cultivating learners' autonomy. In the 1950s and 1960s, Bloom noted that most students showed a high degree of similarity in their ability to learn creatively, how quickly they learned, and how motivated they were to learn.

Constructivism theory

The fundamental principles of constructivism can be succinctly expressed as follows: it takes students as the core, emphasizes students' active exploration and discovery of knowledge, and actively constructs the meaning of what they have

learned, rather than just transferring knowledge from teachers' thinking to notebooks, or even transferring knowledge from textbooks to students' notebooks.

Firstly, teachers guide students to re-integrate the existing knowledge structure, to form an organic connection with the new knowledge, and obtain the meaning construction. When confronted with new information, new ideas, and new propositions, each student constructs their interpretation based on their initial knowledge and experience. This kind of active construction is not only reflected in the transformation of the existing cognitive structure, but also in the reorganization of the original knowledge structure. Secondly, it is also reflected in the solution of new problems or new situations. Learning is a journey of individual construction of knowledge, which represents the initiative of learning. Learning is not solely an isolated individual behavior, but rather a social relationship that is formed through the interaction among groups. The social interaction plays a crucial role in the learning process. The sociality of learning determines that it is both individual and group, that is, it can share or exchange various resources within a certain range. Learning involves the internalization of pertinent knowledge and skills, as well as the mastery of corresponding tools acquired through active engagement with a specific social culture. Typically, this process necessitates cooperation and interaction within a learning community. A learning community is a group structure with a certain scale of teachers, students, teaching materials, etc., which can effectively promote communication and dialogue between learners and individuals. The completion of learning tasks depends on the interaction between all participants in the learning process. Constructivism theory pays attention to learners' active exploration, discovery, and construction of their own experience and cognition. Thirdly, the situational nature of the learning process. Fourthly, the sociality of learning. The builder holds the view that knowledge is not an abstract concept independent of the active scenario, and the knowledge can only be truly understood when it is applied in a real situation. Therefore, in Glasersfeld's research, learning should be closely integrated with actual situational social activities (Xu, 2016).

Blended learning theory

Teachers guided students to re-integrate the existing knowledge structure, formed an organic connection with the new knowledge, and obtained the meaning construction. This was a kind of learning concept reflected on the pure technology

environment when network learning entered the downturn period. Blended learning, as a new learning model, had become one of the hot spots in the field of education at home and abroad. The idea of blended learning was to choose different communication tools and information methods based on various problems encountered in education. It emphasized learner, took attention to cultivating students' independent ability and cooperative spirit, and advocated "learning determines to teach". This was a teaching method proposed, which combined the advantages of multiple teaching modes (He, 2014).

Blended learning has the following characteristics

Dai (2019) defined blended learning as follows:

First of all, the so-called "blended" learning was a teaching method that combined more than two forms of media to achieve better learning results. The integrity of the theory of "blended learning" was mainly reflected in two key areas: "blended learning" had a deep theoretical foundation. The "hybrid" methods were diverse and operable. Blended learning theory was a diversified theoretical system, which integrated a variety of different theoretical viewpoints, including behaviorist learning theory, cognitivism learning theory, constructivism learning theory, instructional system design theory, activity theory, and creative education theory. The so-called "mixing" referred to the integration of multiple aspects related to "teaching" and "learning". The organic integration of instructional methods, learning environments, instructional media, and instructional components is of great significance.

Then, blended learning has become a trend due to the development of information technology and network technology. Corporate training was the starting point for the practice of "blended learning". This approach was being used in a variety of corporate environments. At the same time, it could improve the organizational culture, and promote the development of enterprises. Blended learning was extensively used in a multitude of industries and sectors, especially in the field of education. In terms of school education, many countries have also incorporated the concept of blended learning into practice. In the realm of education, blended learning has emerged as the most alluring novel instructional approach. In the realm of primary, secondary, and higher education, numerous scholars and educators have embraced blended learning as part of education reform,

initiating extensive discussions and research on the topic. In 2009, the U.S. Department of Education conducted a comprehensive analysis based on empirical data on higher education from 1996 to 2008 and pointed out that compared with only face-to-face classroom teaching and distance online learning, blended learning methods were the most effective learning strategies.

Finally, the concept and practice of "blended learning" also changed gradually. The progress of the theory of "blended learning" mainly focused on four core areas: Firstly, the definition and contents of "blended learning theory" would be gradually enriched and improved; Secondly, the methods and strategies of blended learning would become more diversified. Thirdly, the topics covered by blended learning (especially course content) would become broader, and this trend would be reflected in all courses. Fourthly, the practice of the theory of "blended learning" would gradually deepen, and more individuals, educational institutions, business organizations, various institutions, and countries would be involved. As blended learning continues to progress, the internationalization and globalization of education would get a huge boost to some extent. Learn first, teach later

The theory of learning before teaching

The fundamental concept of "learning before teaching" aimed to transform the traditional teaching model by shifting the dynamics between educators and learners. This allowed students to take center stage in the learning process, while teachers assumed the role of mentors and facilitators. Teaching was more targeted and based on students' self-directed learning, so the order of instruction was adjusted so that students learned first and teachers taught later. The first thing to note was that in the teaching approach of "learning before teaching", the central concept was to have students practice first in order to develop their initial understanding. Additionally, the "post-teaching" method could help nurture students' self-learning ability. The "post-teaching" model allowed students to further expand the range of practical activities and deepen their understanding, which formed the basis of their practical and understanding abilities. Through repeated experiments, the correct reflection of things or phenomena-rational understanding - was gradually established. Such "repeated practice and understanding" was consistent with the core principles of epistemology. Therefore, "learning first" and "teaching later" were compatible in theory. Moreover, from the perspective of psychology, the concept of

"learning first" emphasized the importance of learning subjects, respected the diversity and uniqueness of students' psychology, and stimulated students' learning potential to the maximum extent. Thirdly, "learner-centered" reflected the return and development of human nature, emphasizing subjective factors, such as independent inquiry, cooperation and communication, reflection, and evaluation in the learning process. All of these viewpoints were enthusiastic accolades for humanistic psychology. Furthermore, the concept of "learning before teaching" underlined the pivotal role of teachers in the educational process, emphasized the importance of teacher-student interaction. Finally, from the theoretical perspective of education and teaching, the concept of "learning before teaching" covered "subjective teaching", "hierarchical teaching", "differentiated teaching", "teaching according to aptitude" and "teaching for non-teaching purposes" (Zheng, 2018).

Cognitive and behavioral tendencies

Jiang (2021) thought people's cognitive and behavioral patterns would also have an impact on flipped classroom teaching methods. Therefore, this paper discussed the relationship between students' cognitive tendency and classroom learning state from the perspective of psychology, to provide a basis for promoting teaching design. The cognitive tendency referred to the perception and attitude of an individual towards himself and the external things during his growth journey, including the perception and attitude of optimism and pessimism, which played an important role in producing anxiety, depression, and other emotions.

The behavioral tendency was the psychological characteristics manifested in people's behaviors, and such psychological characteristics were often manifested in people's behaviors. Such as a person's personality, temperament, ability, and other aspects of psychological characteristics would be reflected in the behavior.

In the three dimensions of learning attitude, cognitive level scored the highest, followed by behavioral tendency, and emotional experience scored the lowest.

Flipped classroom instructional model involved teachers creating videos that students could watch outside of their home or classroom. Afterwards, they gather in class for interactive discussions and their assignments.

Yang (2023) believed that flipped classroom instructional model effectively highlighted the central role of students, consequently fostering their enthusiasm for learning and improving the efficacy of classroom instruction.

Zhou (2016) believed that flipped classroom instructional model enabled busy students to no longer miss classes and timely communication between students.

Tang (2021) held the view that "deep learning", flipped classroom instructional model, could bring significant teaching results and effectively improve students' skills and qualities in multiple areas.

He (2014) proposed the "peer teaching method" based on cooperative learning in large classes.

This paper mainly discussed the design of the teaching process, the selection and application of teaching methods, and the transformation of teachers' roles. In the flipped classroom instructional model, the details of each step were as follows:

1) When making a teaching video, the first task was to clarify the contents that students needed to master and the video should present in the end;

2) In the process of video collection and production, the differences between teachers and classes should be fully considered;

3) In production activities, the views and needs of students should be fully taken into account to better adapt to the learning styles and habits of different student groups;

4) The organization of classroom activities is essential. After students were given extracurricular content, they should be motivated to engage in high-quality learning in the classroom, enabling them to apply their acquired knowledge in a specific context. These included student-generated contents, independent problem-solving methods, inquiry-based activities, and project-specific learning.

Wu (2016) divided the teaching process of flipped classroom instructional model into:

1) Arrangement of the teaching tips before class (micro-class).

2) Creation flipped classroom teaching strategies based on students' pre-class previews.

3) Curriculum teaching quality evaluation documents have been formulated.

4) Implementation of flipped classroom teaching methods

5) Application the scientific inquiry assessment paper for assessment.

After extensive statistical analysis, the experimental data indicated as follows: 1) The flipped classroom instructional model enhanced students' innovation ability;

2) The implementation of the flipped classroom instructional model improved students' learning performance; 3) The flipped classroom instructional model enhanced teachers' teaching ability.

Tang (2020) gave a detailed classification of the teaching process of flipped classroom instructional model:

1) Conduct pre-class teaching design.

2) Develop flipped classroom teaching strategies.

3) Prepare teaching evaluation documents.

4) Distribute instructional videos before class.

5) Implement flipped classroom teaching methods.

6) Practice after class.

The experiment proved that the flipped classroom instructional model could effectively stimulate students' innovative motivation, and improve the quality of teaching.

The roles of lecturers and students

The roles of lecturer

The lecturer created a teaching video based on the requirements, shared it with the students for pre-class preview to gather more specific learning insights, and then modified the teaching approach based on the students' feedback. In the implementation of teaching, flipped classroom instructional model was carried out with students as the main body, allowing students to raise questions and discuss ways to solve problems in groups, to improve students' innovation ability and level.

The roles of students

The core of classroom teaching was formed by the active involvement of students in teaching practice. They discussed and participated in the whole process of problem-solving, improved their innovation ability and level, and actively participated in the learning of corresponding platforms and small videos before class to strengthen teaching practice.

Differences and connections between flipped classroom instructional model and traditional classroom teaching mode

Advantages of flipped classroom instructional model

Li (2021) proved experience in the classroom showed that flipped classroom could enhance the interaction between teachers and students, effectively stimulated students' active learning and subjective initiative, cultivated students' innovative thinking ability, and enabled teachers to more comprehensively grasp students' shortcomings in learning, pre-class preparation, and knowledge acquisition. This approach facilitated personalized teaching based on the students' abilities.

Wang (2023) believed that that adopting the flipped classroom approach could effectively cultivate students' independent learning and innovative thinking, which was different from the traditional "irrigation" teaching method, encouraged students to think independently.

Geng (2023) believed that flipped classroom could reverse the learning time order and give students the initiative in learning, thus promoting students' active participation in the classroom.

Liu (2023) believed that flipped classroom instructional model integrated information technology into education and teaching, enriched teaching forms, and emphasized student-centered and student-centered teaching.

In summary, flipped classroom instructional model is of the following advantages:

1. Flipped classroom instructional model can somewhat address the limitations of traditional teaching approaches and motivate students to move from passive knowledge absorption to active exploration and learning. 1) Improve the ability of independent learning and innovation. 2) Cultivate students' innovation ability of independent learning and thinking.

2. Flipped classroom solves some problems that teachers talk about students, but students don't understand and teachers don't explain. Instead, students address each student's personality in the form of asking questions, which promotes each student's understanding of knowledge.

3. Online learning is mainly realized through a micro-video, in which the teacher will explain the contents in detail and integrate the various knowledge points into a micro-video for students to watch at home. The biggest advantage of this kind of self-viewing micro-video is its vivid image and easy to remember.

4. When students watch at home, they have the right to adjust their own pace of watching, continuously observe, and repeat many times.

5. Considering the unique innovation ability of each student, some students make faster progress while others make slower progress. Traditional classroom instructional model do not fully take into account the needs of each student, and a flipped classroom is a concrete demonstration of personalized teaching methods.

6. Video resources are widely shared, which is very beneficial to the sharing of high-quality educational resources. The balanced development of education is of positive value to us.

According to relevant references, the flipped classroom teaching model developed mainly includes three parts: before class, during class and after class. Before class, teachers arrange students to watch the pushed teaching videos and preview teaching resources in advance, and ask relevant questions. In class, teachers use the teaching platform to answer before class, and carry out independent practice and group discussion on students' answer results; Teachers feedback teaching information in real time and carry out personalized teaching guidance; Finally, the teacher summarizes and strengthens the teaching content. After class, teachers use the teaching platform to answer the relevant questions raised by students in the learning process and assign homework. The flipped classroom teaching mode is embodied in the closed-loop structure of the three links before class, during class and after class, and always reflects the student-oriented status in the teaching process. The flipped classroom teaching model developed is shown in Figure 2.2.

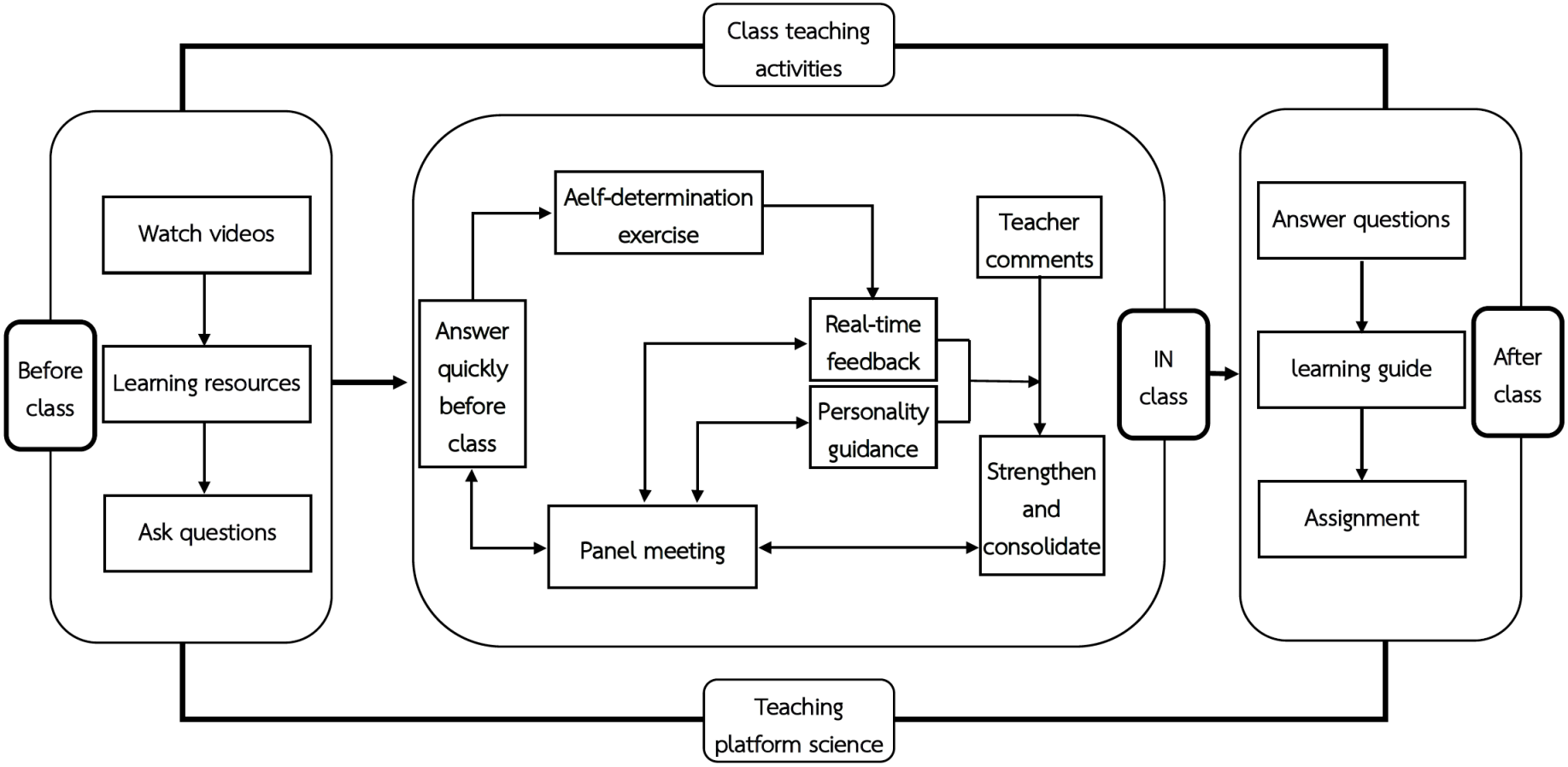

Figure 2.2 Flipped classroom teaching model (Zhu, 2018)

Physical Innovative Ability

Zhang (2021) defined physical innovation ability as creatively asking questions, answering questions, creatively designing experiments, and creatively learning.

Zhang (2016) defined physical innovation ability as a kind of innovative thinking ability based on physics.

Zhu (2022) proposed that the capacity for innovation described referred to the process of using innovative and novel ways to solve problems. Only in this way of thinking, can we go beyond the traditional thinking framework, adopt non-traditional methods and perspectives to think about problems, and propose innovative solutions, thus producing novel, unique, and socially significant thinking results. It consists of four criteria, each of which is a score: Item 1: Learning ability; Item 2: Analytical skills; Item 3: Comprehensive competence; Item 4: Imagination.

Fu (2020) viewed innovation as the capacity to create novel production functions.

In short, physical innovation is a way to solve problems with new eyes, new models, and methods. Flipped classroom instructional model is considered as a strategy to cultivate students' innovative thinking in university physics courses.

Related Research

Li (2015) viewed flipped classroom as one of the focus issues of great concern in the education sector, and also a major technological innovation that affects the quality of classroom teaching. In the context of the new curriculum reform of high school physics in China, how to build an efficient flipped classroom has become an important topic for teachers to study. In the teaching process of secondary school physics, adopting the teaching strategy of flipped classroom can significantly improve the teaching effect, and at the same time, it can also stimulate the innovative thinking of students, which will undoubtedly have a far-reaching positive impact on the reform of physics education.

Gu and Xu (2018) showed teachers could guide students' independent inquiry with problem-driven teaching practice activities, strengthen knowledge formation with experimental manipulation, enrich classroom content with pre-course preparation, and deepen learning effect with post-course summarization. The reform of the teaching mode of flipped classroom not only helped students construct an

accurate image of the physical model, but also successfully reproduced the physical process, further promoted the wide application of a variety of information resources, and stimulated students to observe, think about, and master the laws and nature of physics. Diversified assessment was conducted on this basis in order to tailor the teaching to learners at different levels and achieve the teaching objectives. In order to solve the difficult-to-understand knowledge points encountered by students in the process of self-study, teachers should strengthen the communication and in-depth discussion between teachers and students. By practicing diversified and comprehensive assessment methods, teachers could change students' passive learning into active learning.

Su (2023) emphasized educators should pay attention to the cultivation of students' core qualities and comprehensive skills. As an important course in middle school, high school physics was not only a consolidation of knowledge, but also an important way to exercise their thinking ability and hands-on ability and other comprehensive qualities. In order to achieve this goal, teachers should provide students with more opportunities and space for independent innovation in the process of physics teaching. The traditional teaching mode emphasized too much on the transmission of knowledge and neglected the cultivation of students' thinking ability, which was not conducive to the development of students' core literacy in physics. Flipped classroom helped to stimulate students' independent thinking and practical ability, which greatly improved students' enthusiasm for learning physics. Therefore, teachers should actively utilize the flipped classroom teaching mode to carry out teaching work. Flipped classroom could not only effectively combine classroom teaching and pre-course learning, but also have strong interactivity. When teachers applied this teaching method to high school physics laboratory teaching, it could not only significantly improve the quality of teaching, but also cultivate and exercise students' experimental investigation ability, so as to improve students' core literacy in the subject of physics.

Wu (2022) pointed out with the continuous progress and development of China's education system, the subject of physics had received more and more attention in terms of teaching innovation. The junior high school stage was the basic period for the formation of the entire physics curriculum system, and it was also the most crucial time to learn physics well, so teachers must pay attention to the

development of junior high school physics teaching work. When carrying out teaching activities, teachers need to continuously innovate and improve their teaching content and methods to ensure that their teaching methods better meet students' learning requirements. Therefore, junior high school physics teachers must actively change the traditional teaching methods, improve their teaching quality through effective means, and promote the further improvement of classroom teaching quality. For middle school students, physics was a relatively complex and difficult to master. Therefore, teachers need to design energetic and interesting classroom sessions, help students understand physics knowledge more deeply through the flipped classroom approach, simplify and visualize the content in the textbook that was difficult to master, so as to change students' attitudes towards physics learning, let them better feel the breadth of physics knowledge and fun, and gradually cultivate their enthusiasm for physics learning.

Wu (2021) proposed that in order to enhance the effectiveness and interest of high school physics classroom teaching, taking "Uniformly Variable Linear Motion and Vehicle Driving Safety" as a case study, a combination of gamification and flipped classroom teaching mode was adopted, and interesting teaching links were designed to fully stimulate the students' interest in learning and motivate them to think on their own, so as to enhance the core literacy of high school students in physics.

Zheng (2021) pointed out as the knowledge structure of the senior secondary physics course presents obvious systematicity and complexity, it set quite strict standards for students in terms of learning and understanding. Under the traditional teaching mode, the lack of a certain degree of interactive communication and cooperative discussion made it difficult for students to be fully integrated into it. Therefore, teachers should skillfully adopt the teaching strategy of flipped classroom when teaching, so that students could concentrate more on the learning of the physics course, and ensured that the pre-study before the class, the learning in the classroom and the review after the class could be carried out efficiently and with high quality.

Gong (2021) proposed that in the implementation of the teaching mode of flipped classroom, teachers were encouraged that they should give the leading role in the classroom to students and make them the core participants in the classroom.

At the same time, teachers could also guide and supervise the classroom teaching, so as to promote students to better fulfill their learning tasks and improve the quality of teaching. The teaching mode of flipped classroom, due to its unique characteristics, had become an effective complementary means for modern university campuses in the face of teaching problems, which had a positive significance for the further reform of university physics education.

Dai (2019) proposed that flipped classroom instructional model and independent learning ability of junior high school students helped to stimulate students' independent learning and innovative spirit, while broadening their range of thinking.

Yang and Wang (2017) pointed out that the teaching mode of flipped classroom had completely changed the traditional way of education, which combined information technology and network teaching environment to learn classroom knowledge before class and internalized the knowledge through the teacher's guidance in the classroom. This new teaching method had played a positive role in stimulating students' enthusiasm for learning and improving the effect of classroom teaching. At present, most colleges and universities in China used traditional teaching methods, and with the development of Internet technology, online courses had become a new form of teaching resources, which provided more space for college students to make independent choices. Integrating the flipped classroom method into the teaching process of college physics could effectively make up for the problems of limited laboratory teaching resources, insufficient class time and simple imitation. Therefore, according to the uniqueness of university physics laboratory teaching, we conducted an in-depth study based on the flipped classroom teaching mode, aiming to really improve the overall quality of university physics laboratory teaching.

Zhang (2019) proposed that in order to make the physics classroom better meet the needs of cultivating students' innovative ability, we adopted the teaching method of three stages and four links under the flipped classroom model, and utilized the "Ruiyi Cloud" teaching system to carry out the teaching practice of flipped classroom. It had been proved that organizing teaching through the chain of problems, using classroom discussion to generate knowledge, and adopting the way of "problem-feedback-innovation" to organize classroom teaching could more effectively cultivate students' innovative ability.

Jia (2018) proposed that accompanied by the rapid progress of information technology, this technology had been widely integrated into teaching activities in recent years, and at the same time, the way of education in schools was continuously undergoing changes. The traditional teaching mode could no longer meet the requirements of modern education. With the background of junior high school physics teaching, the innovative teaching method of flipped classroom was deeply studied and analyzed, which had a guiding value for practical application.

Yang and Zhang (2017) proposed that Micro-course was a kind of teaching content organization with "knowledge point" as the center and teaching content representation with "micro-video" as the main carrier, which had the teaching characteristics and effects of miniaturization of teaching content and contextualization of teaching resources, and met the needs of personalized teaching and learning psychology in micro-era. Reconstructing the traditional classroom teaching mode and realizing the online and offline hybrid teaching mode with the help of modern educational technology had become one of the inevitable trends of China's higher education teaching reform. In the current reform and practical exploration of university physics classroom teaching mode, teachers adopted the teaching mode of "combining micro-courses and flipped classroom" by strengthening the construction of university physics MOOC platform and the construction of micro-courses teaching content, in order to promote the personalized development of the teaching mode of university physics, and then promoted the teaching mode of university physics classroom in local undergraduate colleges and universities.

Jiao and Huang (2017) pointed out that the flipped classroom, not only in terms of technology, but also in terms of integration of disciplines, had achieved remarkable progress and application. Continuous reflection and re-practice in actual operation not only contributed to the progress of the subject curriculum, but also promoted the innovation and changed of the flipped classroom model. The construction of the "Tai micro-lesson" resources in Taizhou had further promoted the development of the "flipped classroom" in Taizhou.

Guo (2022) studied the theoretical basis of the flipped classroom and found that flipped classroom was knowledge transfer before class with the help of information technology. He (2020) proposed flipped classroom instructional model revealed that the teaching model was based on "humanistic theory" and "constructivism theory".

Li (2015) showed that flipped classroom mainly provided directions for inquiry-based learning in mobile scenes, and it was a project-based learning style based on specific design. Liu (2019) proposed that the application and thinking of micro-classrooms, MOOCs, and flipped classrooms could reshape the relationship between teaching, learning and meet the "student-centered" requirements of the new curriculum reform.

It is found that flipped classroom instructional model in university physics courses can effectively enhance students' physical innovation ability.

Chapter 3
Research Methodology

This research used a mixed method of research. This research is divided into 3 phases.

Phase 1 was conducted to answer research Objective 1: To study the factors affecting Physical Innovative ability for undergraduate students.

Phase 2 was conducted to answer research Objective 2: To develop flipped classroom instructional model to improve Physical Innovative ability for undergraduate students.

Phase 3 was conducted to answer research Objective 3: To examine the results of implementing flipped classroom instructional model to improve Physical Innovative ability for undergraduate students.

The details are as follows.

Phase 1 was conducted to answer research Objective 1: To study the factors affecting physical innovative ability for undergraduate students.

The population

Group 1: 150 former students who enrolled in the first semester of university Physics Courses from Hechi University in the academic year 2022.

1) Class A: 50 students major in mathematics and applied mathematics
2) Class B: 50 students majoring in physics
3) Class C: 50 students majoring in chemistry

Research instrument

The questionnaire for students

Designing instrument 1

1. Study university physics courses and factors affecting Physical Innovative ability.

2. Design a questionnaire on factors to improve Physical Innovative ability of the students majoring in university physics for checking correctness and completion.

3. Submit the draft questionnaire to the instructor to check whether it is correct and complete by 5 experts (list name in Appendix A) through index of Item-Objective Congruence (IOC) according to the criteria shown below (Phongsri, 2011).

+1 = Sure that the contents are related to the topics

0 = Not sure that the contents are related to the topics

-1 = The contents are not Guangxi Province related to the topics

The IOC value of an acceptable item must not be less than 0.5. IOC calculated from the verification measures 1.00.

4. Design the Likert 5-scale questionnaire according to the following scoring criteria.

Score rating criteria

5 means the highest

4 means high

3 means moderate

2 means few

1 means the fewest

Quality validation

Using IOC by 5 experts to test the quality of questionnaire.

Data collection

1. Ask for permission for data collection.

2. Collect data from the assigned students using the developed questionnaire.

Data analysis

The factors affecting Physical Innovative ability obtained from the students,

Using the MEAN interpretation criteria proposed by Phongsri (2011).

4. 51-5. 00 means the highest

3. 51-4. 50 means high

2. 51-3. 50 means moderate

1. 51-2. 50 means few

1. 00-1. 50 means the fewest

Descriptive Statistics, frequency, mean (μ), standard deviation (σ)

Target group

Group 2: 6 lecturers of university physics courses from 3 schools of Hechi University.

2 lecturer from the School of Mathematics and Physics

2 lecturer from the School of Chemistry and Biology

2 lecturer from the School of Big Data

Research instrument

The interview for the lecturers

Designing instrument 2

1. Study literature and factors affecting Physical Innovative ability for university students.

2. Design an open interview draft on influencing factors cultivating Physical Innovative ability.

3. Present the draft of open-ended interview to the instructor to check for checking correctness and completeness.

4. Assess the validity of open-ended interview on factors affecting Physical Innovative ability for university students by 5 experts (List name from Appendix A) through Index of Item-Objective Congruence (IOC) according to the following criteria (Phongsri, 2011).

+1 = Make sure the content is relevant to the topic

0 = Not sure if the content is related to the topic

-1 = Make sure the content is not related to the topic

The acceptable items must have the IOC values not less than 0.5. The IOC calculated from the validation measures 1.00.

Data collection

1. Ask for permission for data collection.

2. Collect data from the assigned lecturers using the developed interview.

Data analysis

Content analysis

Output Phase 1

Factors influencing the Physical Innovative ability for university students.

Table 3.1 Summary of the research methods in Phase 1

Topic	Details
Research process	Analysis internal and external factors.
Research Objectives 1	To examine the factors affecting physical innovative ability for undergraduate students.
Conduct research	Design the internal and external factors that affect the physical innovative ability for undergraduate students. Design questionnaire survey and interview outline.
Target group	Population -150 university students. Key Information - 6 lectures.
Instruments	Questionnaire. Interview.
Data analysis	Descriptive statistics, frequency, mean, standard, deviation
Results	Factors influencing undergraduate students' physical innovative ability.

Phase 2 was conducted to answer research objective 2: To develop flipped classroom instructional model to improve physical innovative ability for undergraduate students.

Designing instrument 1 (The handout applies flipped classroom instructional model to improve undergraduate students' physical innovative ability.)

1. Design the development of flipped classroom instructional model to improve physical innovative ability for undergrate students, which consists of the stable teaching activities and procedures. Such a developed flipped classroom instructional model with 5 components: 1) Rational and Principle) Take the results from objective 1), 2) Objectives, 3) Contents, 4) Method of Training and Materials and 5) Evaluation by scoring rubric in 4 aspects standards: 1) Utility standards, 2) Feasibility standards, 3) Propriety standards and 4) Accuracy standards.

2. Assess the validity of the questionnaire of the appropriateness of the training curriculum by 5 experts (List name in Appendix A) through Item-Objective Congruence (IOC) according to the criteria as shown below (Phongsri, 2011):

+1= if you think the issues can measure the appropriateness of the training curriculum.

0= if you are not sure the issues can measure the appropriateness of the training curriculum.

-1= if you think the issues cannot measure the appropriateness of the training curriculum.

The acceptable items must have the IOC values not less than 0.5. The IOC calculated from the validation measures 1.00.

Designing instrument 2 (The confirming the accuracy of the handout to improve physical innovative ability for undergraduate students).

1. Design the contents after the experts finishing IOC, which contains the criteria to be agree or disagree.

2. Assess the validity of the questionnaire of the appropriateness of flipped classroom instructional model by 5 experts (List name in Appendix A) according to the criteria to be agree or disagree.

Data collection

1. Ask for permission of data collection.

2. Collect appropriateness of the training curriculum in terms of accuracy standards, propriety standards, feasibility standards, and utility standards from the 5 experts (List name in Appendix A) using the developed conformity assessment form of flipped classroom instructional model.

Data analysis

Descriptive analysis i.e. frequency and percentage.

The acceptable items must not be less than 100.%

Output Phase 2

The appropriateness of flipped classroom instructional model is confirmed by experts for further implementation.

Table 3.2 Summary of the research methods in Phase 2

Topic	Details
Research process	Conformity assessment form of instructional model in terms.
Research Objectives 2	Develop flipped classroom instructional model to improve physical innovative ability for undergraduate students.
Conduct research	Design a handout according to the principles and rationality, objectives, contents, teaching methods and evaluation of flipped classroom instructional model.
Target group	5 experts confirming development problem based on flipped classroom instructional model.
Instruments	The handout for 5 experts through Item-Objective Congruence (IOC).
Data analysis	Descriptive analysis i.e. frequency and percentage. The acceptable items must not be less than 100.00%.
Results	The applicability of flipped classroom instructional model has been affirmed by experts and can be further implemented. The acceptable item is 100.00%.

Phase 3 was conducted to answer research objective 3: To examine the results of implementing flipped classroom instructional model to improve Physical Innovative ability for undergraduate students.

Population

The total of 300 freshmen from 6 classes of students, with different learning achievements who enrolled in the university Physics Course of Hechi University in Semester 1st academic year 2023. Those sections involve the following.

Class A: 50 students

Class B: 50 students

Class C: 50 students

Class D: 50 students

Class E: 50 students

Class F: 50 students

The sample group

The 50 students who enrolled in the university Physics Course from Class C are obtained by cluster random sampling.

Research design

Table 3.3 Posttest only experimental design

Group	X	T1
Sample group	Flipped classroom instructional model	Physical innovative ability

X - Flipped classroom instructional model

T1 - Physical Innovative ability

Research instruments

1. Lesson plans using flipped classroom instructional model
2. Rubric scoring form

Designing instrument 1

1. Study contents, objectives, methods of teaching, materials, evaluation.
2. Design lesson plans by format given.
3. Present the lesson plan to the advisors for checking correctness, completion and improvement.
4. Assess the validity of the designed lesson plans by 5 experts (List name from Appendix A) through Item-Objective Congruence (IOC) according to the criteria shown below (Phongsri, 2011).

+1 = Sure that the contents are related to the topics

0 = Not sure that the contents are related to the topics

-1 = Sure that the contents are not related to the topics

The acceptable items must have the IOC values not less than 0.5. The IOC calculated from the validation measures 1.00.

5. Conduct a try-out of the developed lessons plans with another group of samples for further improvements and implementation with the sample group.

Designing instrument 2

Rubric scoring form

1. Study the rubric scoring criteria to assess the effectiveness of flipped classroom instructional model with 4 dimensions. Dimension 1) learning ability, 2) analytical ability, 3) comprehensive ability, 4) imaginative ability.

2. Design rubric scoring criteria.

3. Present 1.00 about the developed rubric scoring criteria to the advisors for checking correctness, completion and improvement.

4. Assess the validity of the designed rubric scoring criteria by 5 experts (List name from Appendix A) through Item-Objective Congruence (IOC) according to the criteria as shown below (Phongsri, 2011).

+1 = Sure that the descriptors are related to the issue of assessment

0 = Not sure that the descriptors are related to the issue of assessment

-1 = Sure that the descriptors are not related to the issue of assessment

The acceptable items must have the IOC values not less than 0.5. The IOC calculated from the validation measures 1.00.

Data collection

1. Ask for permission of data collection

2. Collect students' performance by using rubric scoring before assessment by external raters.

Data analysis

Categorize students' performance according to rubric scoring criteria into their levels descriptor.

Output Phase 3 (rubric scoring criteria)

Results of implementing flipped classroom instructional model – students' performance according to rubric scoring criteria into their levels descriptor.

Physical Innovative ability is the skill and ability to develop new thinking and improve creativity. After mastering the physical innovation abilities, such as learning ability, analytical ability, comprehensive ability, and imaginative ability, students will facilitate the learning of subject knowledge, make the structure of professional knowledge more complete, and promote the application and transformation of knowledge. Students can use two questionnaires to find out whether their Physical Innovative ability has been enhanced:

Item 1: Learning ability

Standard 1: Physics self-directed learning awareness

Standard 2: Physics study habits

Standard 3: Learning outcomes

Item 2: Analytical ability

Standard 1: Descriptions of physical phenomena

Standard 2: Instructing physics experiments

Standard 3: Preview physical results based on physical phenomena and experiments

Item 3: Comprehensive ability

Standard 1: Physical phenomena explanation

Standard 2: Physical theory elaboration

Standard 3: Application of physical laws

Item 4: Imaginative ability

Standard 1: The building of physical models

Standard 2: Thinking about physical patterns

Standard 3: New theories are derived from physical models

This is my grading scale, largely adapted from IDIIL's "Four Indicators for Evaluating Students' Creative Ability in Physics," divided into six items and 20 criteria. The first item is learning ability, the second is analytical ability, the third is comprehensive ability, and the fourth is imaginative ability. Separately, students were evaluated on each of the four indicators in terms of the degree of improvement in their ability to innovate in physics. Individually, students were assessed on each of the four measures based on their level of improvement in their physical innovative ability, with a potential score ranging from 1 to 5 for each indicator. The maximum possible score for all four indicators combined was 20.

5 mean Excellent

4 mean Good

3 mean Medium

2 mean Improved

1 mean Fail

Table 3.4 Scoring criteria sheet

Item	Score				
	5	4	3	2	1
	Perform all or nearly all of the following tasks well	**Do almost all of the following tasks well**	**Complete most of the following tasks**	**Inability to complete most or many of the following tasks**	**Cannot complete any of the following tasks**
1 Learning ability					
Standard 1: Physics self-directed learning awareness	Physical independent learning consciousness is very strong	Strong consciousness of independent learning of physics	The consciousness of independent learning in physics is general	The consciousness of independent learning of physics is weak	The consciousness of independent learning of physics is very weak
Standard 2: Physics study habits	Have a good physics preview, lectures, review habits	Physics preview, lectures, review habit is good	Physics preview, lectures, review habits are general	Poor habits of physics preview, listening to lectures and reviewing	Basically no physical preview, lectures, review habits
Standard 3: Learning outcomes	In physics knowledge, methods and other aspects of the harvest	In physics knowledge, methods and other aspects of high harvest	In physics knowledge, methods and other aspects of the general gain	Low gain in physical knowledge and methods	There is no gain in physical knowledge, methods, etc
2. Analytical ability					
Standard 1: Descriptions of physical phenomena	Objective and complete description of physical phenomena	The description of physical phenomena is more objective and complete	Basically objective and complete description of physical phenomena	The description of physical phenomena is not objective or complete	Completely unable to describe physical phenomena objectively and completely

Table 3.4 (Continued)

Item	Score				
	5	4	3	2	1
	Perform all or nearly all of the following tasks well	**Do almost all of the following tasks well**	**Complete most of the following tasks**	**Inability to complete most or many of the following tasks**	**Cannot complete any of the following tasks**
Standard 2: Instructing physics experiments	Carry out physics experiment guidance comprehensively	The guidance of physics experiment is more comprehensive Basically	it can guide the physical experiment	Poor guidance for conducting physical experiments	Can not guide the conduct of physics experiments
Standard 3: Preview physical results based on physical phenomena and experiments	It is very accurate to predict physical results based on physical phenomena and physical experiments	It is more accurate to predict physical results based on physical phenomena and physical experiments	The root predicts physical results based on physical phenomena and physical experiments	Poor prediction of physical results based on physical phenomena and physical experiments	Physical results cannot be predicted from physical phenomena and physical experiments
3. Comprehensive ability					
Standard 1: Physical phenomena explanation	Has a complete understanding of physical phenomena	Have a complete understanding of physical phenomena	A complete understanding of physical phenomena	Poor understanding of physical phenomena	Unable to understand physical phenomena
Standard 2: Physical theory elaboration	The explanation of physical theory is very accurate	The physical theory is more accurate	Physical theory explains the general	Poor explanation of physical theory	Physical theory cannot be elaborated
Standard 3: Application of physical laws	The application of physical theorems is very comprehensive and concrete	The application of physical theorems is more comprehensive and specific	The application of physical laws is at an average level	Poor application of physical laws	The application of the laws of physics cannot be carried out

Table 3.4 (Continued)

Item	Score				
	5	4	3	2	1
	Perform all or nearly all of the following tasks well	Do almost all of the following tasks well	Complete most of the following tasks	Inability to complete most or many of the following tasks	Cannot complete any of the following tasks
4. Imaginative ability					
Standard 1: The building of physical models	It can build perfect physical models based on physical processes	It can establish a better physical model according to the physical process	Can build physical models based on physical processes	Physical models based on physical processes are poor	It is not possible to build physical models based on physical processes
Standard 2: Thinking about physical patterns	The thinking on physical models is very sound	The thinking of physical model is more perfect	Consider the physical model in general	Poor thinking on physical models	Unable to think about physical models
Standard 3: New theories are derived from physical models	It is very accurate to deduce new physical theories from physical models	It is more accurate to deduce the new physical theory according to the physical model	New physical theories can be derived from physical models	It is not accurate enough to derive new physical theories from physical models	New physical theories cannot be derived from physical models

The criteria from Item 1: Learning ability
Standard 1: Physics self-directed learning awareness
Standard 2: Physics study habits
Standard 3: Learning outcomes

Score Range	Meaning
13 - 15	Excellent
10 -12	Good
7 - 9	Moderate
4 - 6	Improved
Less than 4	Fail

The criteria from Item 2: Analytical ability

Standard 1: Descriptions of physical phenomena
Standard 2: Instructing physics experiments
Standard 3: Preview physical results based on physical phenomena and experiments

Score Range	Meaning
13 - 15	Excellent
10 -12	Good
7 - 9	Moderate
4 - 6	Improved
Less than 4	Fail

The criteria from Item 3: Comprehensive ability

Standard 1: Physical phenomena explanation
Standard 2: Physical theory elaboration
Standard 3: Application of physical laws

Score Range	Meaning
13 - 15	Excellent
10 -12	Good
7 - 9	Moderate
4 - 6	Improved
Less than 4	Fail

The criteria from Item 4: Imaginative ability

Standard 1: The building of physical models
Standard 2: Thinking about physical patterns
Standard 3: New theories are derived from physical models

Score Range	Meaning
13 - 15	Excellent
10 -12	Good
7 - 9	Moderate
4 - 6	Improved
Less than 4	Fail

Criteria to evaluate physical innovative ability over all 12 Standards

Score Range	Meaning
49 - 60	Excellent
37 - 48	Good
25 - 36	Moderate
13- 24	Improved
Less than 13	Fail

Table 3.5 Conduct research from Phase 3

Topic	Details
Research process	Conformity assessment form of lesson plans and rubric scoring in terms
Research objective 3	To study the results of flipped classroom instructional model to improve physical innovative ability for undergraduate students.
Conduct research	Design a handout and implement teaching. This paper discusses the teaching principles, teaching objectives and contents, teaching methods and teaching evaluation based on flipped classroom instructional model.
Target group /Key informants	by 5 experts through Item-Objective Congruence (IOC) according to the criteria
Instrument	The lesson plan and rubric scoring for 5 experts through Item-Objective Congruence (IOC)
Data analysis	Descriptive analysis, i.e. frequency and percentage. The number of acceptable items shall not be less than 100.00%. Descriptive analysis, i.e. mean and standard deviation. The Physical Innovative ability of undergraduate students reaches a good level ≥80%.

Table 3.5 (Continued)

Topic	Details
Output	The suitability of the Lesson plan and rubric scoring has been confirmed by experts and can be used for teaching experiments.

The following is the main link of the implementation of flipped classroom instructional model to improve students' physical innovative ability as follows: Firstly, based on the actual situation of the university, questionnaire survey was conducted among the students of science and engineering in Hechi University, and interviews were conducted with physics teachers to grasp the internal and external causes of improving students' physical innovative ability. Secondly, design the steps of flipped classroom instructional model and write flipped classroom teaching plan. Thirdly, carry out flipped classroom in combination with the written teaching plan. Judging from the four dimensions of students' learning ability, analytical ability, comprehensive ability and imaginative ability, flipped classroom instructional model can improve students' physical innovative ability as shown in Figure 3.1.

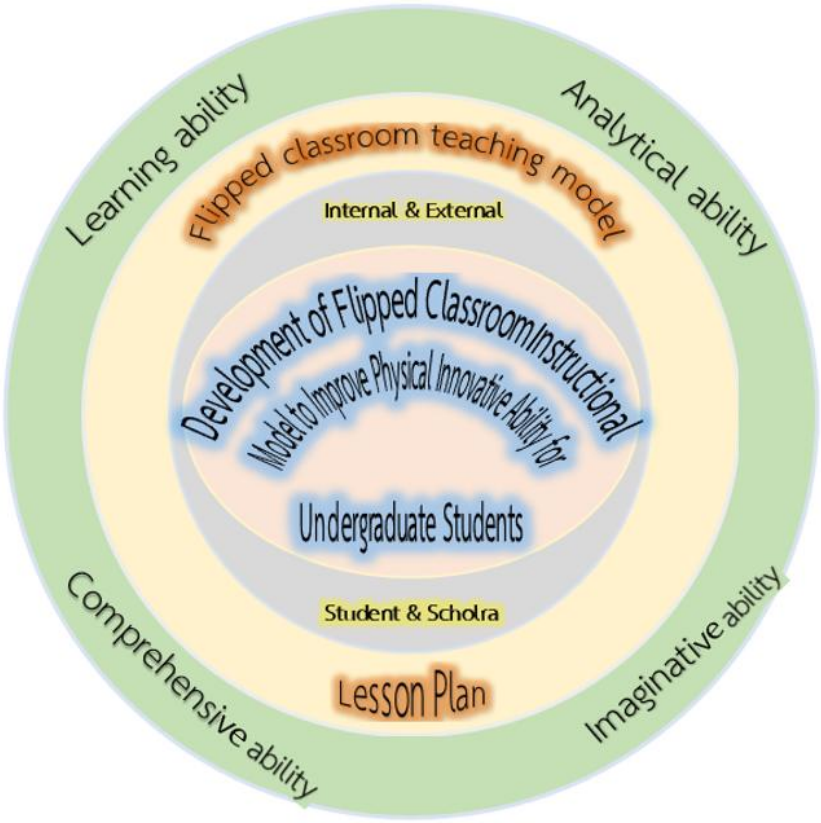

Figure 3.1 Teaching implementation diagram of improving students' physical innovative ability according to flipped classroom instructional model

Chapter 4
Results of Analysis

In the study of “Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students”, the researcher studied the documents concerning the following.

Part 1: Analysis results serving Objective 1-To study the factors affecting physical innovative ability for undergraduate students.

Part 2: Analysis results serving Objective 2-To develop flipped classroom instructional model to improve physical innovative ability for undergraduate students.

Part 3: Analysis results serving Objective 3-To examine the results of implementing flipped classroom instructional model to improve physical innovative ability for undergraduate students.

Data analysis results are as follows.

Part 1: Analysis results serving Objective 1-To study the factors affecting physical innovative ability for undergraduate students.

This section presents analysis results serving Objective 1, using table and description in terms of MEAN, standard deviation, interpretation (Level of Attitude), and ranking of all factors in overview. After the questionnaire, items of all factors are presented likewise.

The amount students of Hechi University.

50 students from School of Mathematics and Physics.

50 students from School of Artificial Intelligence and Manufacturing.

50 students from School of Big Data and Computer Science.

Statistical analysis is as follows:

Table 4.1 Common data of the respondent in overall (N=150)

Data	Frequency	Percentage
Gender		
A. Male	86	57.30
B. Female	64	42.70
Total	**150**	**100.00**
Age		
A. below 18 yrs.	1	0.70
B. 18-20 yrs.	67	44.70
C. 21-23 yrs.	78	52.00
D. over 23 yrs.	4	2.60
Total	**150**	**100.00**

From table 4.1, the common data of the respondent in overall shows that 86 students of the respondents are male, representing 57.30% of the total participants. The female respondents make up 42.70% of the total participants. The age distribution is relatively concentrated, 21-23 years old is the most common, 52.00% of the respondents belong to this category.

Table 4.2 Interviewee - professional structure (N=150)

Major	Frequency	Percentage
A. Mechanical design manufacture and automation	50	33.33
B. Mathematics and applied mathematics	50	33.33
C. Computational science and technology	50	33.33
Total	**150**	**100.00**

The objects of this survey are from three majors of the subordinate schools in Hechi University, Major 1. Mechanical design manufacture and automation, Major 2. Mathematics and applied mathematics, Major 3. Computational science and technology. There are 50 students from each major, accounting for 33.33%.

Table 4.3 The result of questionnaire from students in overview

Factors	μ	σ	Interpretation	Ranking within All Factors
Internal Factor				
1. Students know that physics course is an important compulsory course for students.	4.37	.79	High	2
2. Students feel that physics course is the great significance to personal's Physical Innovative ability.	4.29	.81	High	3
3. Students believe that the good technique in teaching to improve physical innovative ability in physics course.	4.45	.71	High	1
4. Students believe that materials and learning resources to improve physical innovative ability in physics course.	4.29	.81	High	3
5. Students are industrious in their learning (Assignments, Projects, Participation, etc.) with the highest potential themselves	4.23	.86	High	6
6. Students feel that homework projects to give full play to own strengths in physics course.	4.01	.93	High	15
7. Students feel that physics course is the great significance to personal growth and development in future.	4.23	.84	High	6
8. Students feel that the assignments assigned by the lecturers and the feedback can help students better apply what they have learned.	4.11	.88	High	13
9. Students can master physical innovative ability by flipped classroom instructional process in physics course.	4.23	.83	High	6

Table 4.3 (Continued)

Factors	μ	σ	Interpretation	Ranking within All Factors
10. Students are satisfied with the friendly cooperation and interaction between students and teachers or peers in the physics course.	4.25	.90	High	5
11. Students feel that homework or project work assigned by lecturers and students can help students better apply the knowledge they have learned.	4.09	.85	High	14
12. Students feel that the evaluation project work assigned by lecturers and students can help students better apply the knowledge they have learned.	4.12	.78	High	11
13. Students have new ideas based on their responses to learning about physical innovative ability in physics course.	4.12	.84	High	11
14. Students learn through flipped classroom instructional model to enhance their physical innovative ability.	4.15	.83	High	10
15. Students can develop their sense of accomplishment and pride through different activities in physics course.	4.19	.81	High	9
Total Average	**4.21**	**.83**	**High**	
External Factor				
1. The lecturer uses modern teaching methods Physics course (such as mobile phones, computers, APP platforms effectively, demonstrations, exploration, etc.) to stimulate students' interest in physical innovative ability.	4.21	.85	High	10

Table 4.3 (Continued)

Factors	μ	σ	Interpretation	Ranking within All Factors
2. The lecturer combines traditional classroom evaluation methods with various modern intelligent online evaluation systems.	4.21	.81	High	10
3. The lecturer can guide students to realize that the learning of physics course and physical innovative ability has a positive impact on their future development.	4.26	.82	High	4
4. The lecturer pays more attention to students' ability to apply physical innovative ability and its impact in physics course.	4.25	.84	High	5
5. The lecturer chooses appropriate teaching methods according to the characteristics of physics course and the tasks and goals of physical innovative ability.	4.23	.83	High	8
6. The lecturer combines the teaching method he teaches objectives, the knowledge and flipped classroom instructional model in physics course to enhance undergraduate students’ physical innovative ability.	4.30	.75	High	2
7. The lecturer can stimulate students' interest and meet the contemporary needs of students, such as the physics competition.	4.15	.81	High	13
8. The lecturer chooses suitable materials and emerging network resources.	4.23	.82	High	8

Table 4.3 (Continued)

Factors	μ	σ	Interpretation	Ranking within All Factors
9. The textbook fully considers the content and objectives of physics courses and physical innovative ability training.	4.15	.82	High	13
10. The materials can fully support students' learning in physics courses and physical innovative ability training.	4.21	.81	High	10
11. The materials can fully support students' learning in physics courses and physical innovative ability training.	4.13	.86	High	15
12. The materials and environment can enhance undergraduate students' physical innovative ability.	4.24	.81	High	7
13. The availability of learning spaces and the project based learning can affect students' interest in physics courses.	4.27	.84	High	3
14. Provides a teaching mode with a stable high-speed network anytime, anywhere on campus as a teaching guarantee, and supports project based flipped classroom instructional model to enhance undergraduate students' physical innovative ability.	4.25	.84	High	5
15. The environments is clean and bright, with desks and chairs, blackboards, podiums, computers, projectors, large screens, loudspeakers and other multimedia facilities to facilitate the teaching process.	4.39	.83	High	1
Total Average	**4.23**	**.82**	**High**	

Table 4.3 indicates that internal factors affecting the physical innovative ability are found to be at a high level overall (μ=4.22). Considering each item individually, it was found that **No.3** (Students believe that the good technique in teaching to improve Physical Innovative ability in physics course) has the highest mean (μ=4.45), followed by **No.1** (Students know that physics course is an important compulsory course for students) (μ=4.37), and the lowest mean is **No.6** (Students feel that homework projects to give full play to own strengths in physics course) (μ=4.01).

For external factors affecting physical innovative ability of university students, the overall level is moderate (μ=4.23). Considering each item individually, it was found that **No.15** (The environments is clean and bright, with desks and chairs, blackboards, podiums, computers, projectors, large screens, loudspeakers and other multimedia facilities to facilitate the teaching process) has the highest mean (μ=4.39), followed by **No.6** (The lecturer combines the teaching method he teaches objectives, the knowledge and flipped classroom instructional model in physics course to enhance undergraduate students' physical innovative ability) (μ=4.30), and the lowest mean is **No.11** (The materials can fully support students' learning in physics courses and physical innovative ability training) (μ=4.13).

Table 4.4 Common data of the respondent major in mechanical design manufacture and automation (N=50)

Data	Frequency	Percentage
Gender		
A. Male	46	92.00
B. Female	4	8.00
Total	**50**	**100.00**
Age		
A. below 18 yrs.	0	0
B. 18-20 yrs.	35	70.00
C. 21-23 yrs.	15	30.00
D. over 23 yrs.	0	0
Total	**50**	**100.00**

From table 4.4, the common data of the respondent majoring in mechanical design manufacture and automation, the most gender is male, 92.00%. The most age is 18-20 yrs., 70.00%.

Table 4.5 The result of questionnaire from students major in mechanical design manufacture and automation (N=50)

Factors	μ	σ	Interpretation	Ranking within All Factors
Internal Factor				
1. Students know that physics course is an important compulsory course for students.	4.54	0.79	Highest	1
2. Students feel that physics course is the great significance to personal's physical innovative ability.	4.38	.83	High	3
3. Students believe that the good technique in teaching to improve physical innovative ability in physics course.	4.50	.76	High	2
4. Students believe that materials and learning resources to improve physical innovative ability in physics course.	4.26	.85	High	4
5. Students are industrious in their learning (Assignments, Projects, Participation, etc.) with the highest potential themselves.	4.20	.93	High	7
6. Students feel that homework projects to give full play to own strengths in physics course.	3.98	.92	High	15
7. Students feel that physics course is the great significance to personal growth and development in future.	4.02	.98	High	14
8. Students feel that the assignments assigned by the lecturers and the feedback can help students better apply what they have learned.	4.04	.90	High	10

Table 4.5 (Continued)

Factors	μ	σ	Interpretation	Ranking within All Factors
9. Students can master physical innovative ability by flipped classroom instructional process in physics course.	4.20	.95	High	7
10. Students are satisfied with the friendly cooperation and interaction between students and teachers or peers in the physics course.	4.26	.94	High	4
11. Students feel that homework or project work assigned by lecturers and students can help students better apply the knowledge they have learned.	4.04	.88	High	10
12. Students feel that the evaluation project work assigned by lecturers and students can help students better apply the knowledge they have learned.	4.06	.79	High	9
13. Students have new ideas based on their responses to learning about physical innovative ability in physics course.	4.04	.90	High	10
14. Students learn through flipped classroom instructional model to enhance their physical innovative ability.	4.04	.90	High	10
15. Students can develop their sense of accomplishment and pride through different activities in physics course.	4.22	.86	High	16
Total Average	**4.19**	**.88**	**High**	
External Factor				
1. The lecturer uses modern teaching methods physics course (such as mobile phones, computers, APP platforms effectively, demonstrations, exploration, etc.) to stimulate students' interest in	4.14	.97	High	11

Table 4.5 (Continued)

Factors	μ	σ	Interpretation	Ranking within All Factors
physics Innovation ability.				
2. The lecturer combines traditional classroom evaluation methods with various modern intelligent online evaluation systems.	4.22	.84	High	7
3. The lecturer can guide students to realize that the learning of physics course and physical innovative ability has a positive impact on their future development.	4.20	.88	High	9
4. The lecturer pays more attention to students' ability to apply physical innovative ability and its impact in physics course.	4.32	.89	High	2
5. The lecturer chooses appropriate teaching methods according to the characteristics of physics course and the tasks and goals of physical innovative ability.	4.24	.822	High	5
6. The lecturer combines the teaching method he teaches objectives, the knowledge and flipped classroom instructional model in physics course to enhance undergraduate students' physical innovative ability.	4.22	.84	High	7
7. The lecturer can stimulate students' interest and meet the contemporary needs of students, such as the physics competition.	4.20	.88	High	9
8. The lecturer chooses suitable materials and emerging network resources.	4.32	.79	High	2

Table 4.5 (Continued)

Factors	μ	σ	Interpretation	Ranking within All Factors
9. The textbook fully considers the content and objectives of physics courses and physical innovative ability training.	4.10	.89	High	12
10. The materials can fully support students' learning in physics courses and physical innovative ability training.	4.10	.91	High	12
11. The materials can fully support students' learning in physics courses and physical innovative ability training.	4.02	1.02	High	15
12. The materials and environment can enhance undergraduate students' physical innovative ability.	4.10	.84	High	12
13. The availability of learning spaces and the project based learning can affect students' interest in physics courses.	4.24	.92	High	5
14. Providing a teaching mode with a stable high-speed network anytime, anywhere on campus as a teaching guarantee, and supports project based flipped classroom instructional model to enhance undergraduate students' physical innovative ability.	4.28	.86	High	4
15. The environments is clean and bright, with desks and chairs, blackboards, podiums, computers, projectors, large screens, loudspeakers and other multimedia facilities to facilitate the teaching process.	4.42	.86	High	1
Total Average	**4.21**	**.88**	High	

Table 4.5 indicates that internal factors affecting the physical innovative ability are found to be at a high level overall (μ=4.19). Considering each item individually, it was found that **No.1** (Students know that physics course is an important compulsory one for students) has the highest mean (μ=4.54), followed by **No.3** (Students believe that the good technique in teaching to improve physical innovative ability in physics course) (μ=4.50), and the lowest mean is **No.6** (Students feel that homework projects to give full play to own strengths in physics course) (μ=3.98).

For external factors affecting the learning ability of the physical innovative ability, the overall level is found to be moderate (μ=4.21). Considering each item individually, it was found that **No.15** (The environments is clean and bright, with desks and chairs, blackboards, podiums, computers, projectors, large screens, loudspeakers and other multimedia facilities to facilitate the teaching process) has the highest mean (μ=4.42), followed by **No.4** (The lecturer pays more attention to students' ability to apply physical innovative ability and its impact in physics course) (μ=4.32), and the lowest mean is **No.11** (The materials can fully support students' learning in physics courses and physical innovative ability training) (μ=4.02).

Table 4.6 Common data of the respondent major in mathematics and applied mathematics (N=50)

Data	Frequency	Percentage
Gender		
A. Male	19	38.00
B. Female	31	62.00
Total	**50**	**100.00**
Age		
A. below 18 yrs.	0	0
B. 18-20 yrs.	18	36.00
C. 21-23 yrs.	30	60.00
D. over 23 yrs.	2	4.00
Total	**50**	**100.00**

From table 4.6, the common data of the respondent major in mathematics and applied mathematics, the most gender is female, 62%. The most age is 21-23 yrs., 60%.

Table 4.7 The result of questionnaire from students major in mathematics and applied mathematics (N=50)

Factors	μ	σ	Interpretation	Ranking within All Factors
Internal Factor				
1. Students know that physics course is an important compulsory course for students.	4.40	.73	High	4
2. Students feel that physics course is the great significance to personal's physical innovative ability.	4.42	.73	High	3
3. Students believe that the good technique in teaching to improve physical innovative ability in physics course.	4.46	.68	High	1
4. Students believe that materials and learning resources to improve physical innovative ability in physics course.	4.40	.67	High	4
5. Students are industrious in their learning (Assignments, Projects, Participation, etc.) with the highest potential themselves.	4.34	.69	High	6
6. Students feel that homework projects to give full play to own strengths in physics course.	4.12	1.00	High	15
7. Students feel that physics course is the great significance to personal growth and development in future.	4.44	.71	High	2
8. Students feel that the assignments assigned by the lecturers and the feedback can help students better apply what they have learned.	4.18	.80	High	13

Table 4.7 (Continued)

Factors	μ	σ	Interpretation	Ranking within All Factors
9. Students can master physical innovative ability by flipped classroom instructional process in physics course.	4.34	.69	High	6
10. Students are satisfied with the friendly cooperation and interaction between students and teachers or peers in the physics course.	4.26	.78	High	10
11. Students feel that homework or project work assigned by lecturers and students can help students better apply the knowledge they have learned.	4.22	.82	High	12
12. Students feel that the evaluation project work assigned by lecturers and students can help students better apply the knowledge they have learned.	4.26	.72	High	10
13. Students have new ideas based on their responses to learning about physical innovative ability in physics course.	4.18	.75	High	13
14. Students learn through flipped classroom instructional model to enhance their physical innovative ability.	4.28	.73	High	9
15. Students can develop their sense of accomplishment and pride through different activities in physics course.	4.30	.74	High	8
Total Average	4.31	.75	High	
External Factor				
1. The lecturer uses modern teaching methods physics course (such as mobile phones, computers, APP platforms effectively, demonstrations, exploration,.	4.40	.70	High	2

Table 4.7 (Continued)

Factors	μ	σ	Interpretation	Ranking within All Factors
etc.) to stimulate students' interest in physical innovative ability				
2. The lecturer combines traditional classroom evaluation methods with various modern intelligent online evaluation systems.	4.34	.75	High	7
3. The lecturer can guide students to realize that the learning of physics course and physical innovative ability has a positive impact on their future development.	4.36	.75	High	4
4. The lecturer pays more attention to students' ability to apply physical innovative ability and its impact in physics course.	4.34	.77	High	7
5. The lecturer chooses appropriate teaching methods according to the characteristics of physics course and the tasks and goals of physical innovative ability.	4.28	.78	High	12
6. The lecturer combines the teaching method he teaches objectives, the knowledge and flipped classroom instructional model in physics course to enhance undergraduate students' physical innovative ability.	4.44	.64	High	1
7. The lecturer can stimulate students' interest and meet the contemporary needs of students, such as the physics competition.	4.16	.82	High	15

Table 4.7 (Continued)

Factors	μ	σ	Interpretation	Ranking within All Factors
8. The lecturer chooses suitable materials and emerging network resources.	4.26	.78	High	14
9. The textbook fully considers the content and objectives of physics courses and physical innovative ability training.	4.30	.74	High	11
10. The materials can fully support students' learning in physics courses and physical innovative ability training.	4.32	.77	High	9
11. The materials can fully support students' learning in physics courses and physical innovative ability training.	4.28	.70	High	12
12. The materials and environment can enhance undergraduate students' physical innovative ability.	4.38	.70	High	3
13. The availability of learning spaces and the project based learning can affect students' interest in physics courses.	4.36	.75	High	4
14. Provide a teaching mode with a stable high-speed network anytime, anywhere on campus as a teaching guarantee, and supports project based flipped classroom instructional model to enhance undergraduate students' physical innovative ability.	4.32	.79	High	9
15. The environments is clean and bright, with desks and chairs, blackboards, podiums, computers, projectors, large screens, loudspeakers and other multimedia facilities to facilitate the teaching process.	4.36	.80	High	4
Total Average	**4.33**	**.75**	High	

Table 4.7 indicates that internal factors affecting the physical innovative ability are found to be at a high level overall (μ=4.31). Considering each item individually, it was found that **No.3** (Students believe that the good technique in teaching to improve physical innovative ability in physics course.) has the highest mean (μ=4.46), followed by **No.7** (Students feel that physics course is the great significance to personal growth and development in future) (μ=4.44), and the lowest mean is **No.6** (Students feel that homework projects to give full play to own strengths in physics course) (μ= 4.12).

For external factors affecting the learning ability of the physical innovative ability, the overall level is found to be moderate (μ=4.33). Considering each item individually, it was found that **No.6** (The lecturer combines the teaching method he teaches objectives, the knowledge and flipped classroom instructional model in physics course to enhance undergraduate students' physical innovative ability) has the highest mean (μ=4.44), followed by **No.1** (The lecturer uses modern teaching methods physics course (such as mobile phones, computers, APP platforms effectively, demonstrations, exploration, etc.) to stimulate students' interest in physical innovative ability) (μ=4.40), and the lowest mean is **No.7** (The lecturer can stimulate students' interest and meet the contemporary needs of students, such as the physics competition) (μ=4.16).

Table 4.8 Common data of the respondent major in computational science and technology (N=50)

Data	Frequency	Percentage
Gender		
A. Male	21	42.00
B. Female	29	58.00
Total	**50**	**100.00**
Age		
A. below 18 yrs.	1	2.00
B. 18-20 yrs.	14	28.00
C. 21-23 yrs.	33	66.00
D. over 23 yrs.	2	4.00
Total	**50**	**100.00**

From table 4.8 the common data of the respondent majoring in computational science and technology the most gender is female, 58.00%. The most age is 21-23 yrs., 66.00%.

Table 4.9 The result of questionnaire from students major in computational science and technology (N=50)

Factors	μ	σ	Interpretation	Ranking within All Factors
Internal Factor				
1. Students know that physics course is an important compulsory course for students.	4.18	.83	High	5
2. Students feel that physics course is the great significance to personal's physical innovative ability.	4.08	.83	High	11
3. Students believe that the good technique in teaching to improve physical innovative ability in physics course.	4.38	.70	High	1
4. Students believe that materials and learning resources to improve physical innovative ability in physics course.	4.20	.88	High	4
5. Students are industrious in their learning (Assignments, Projects, Participation, etc.) with the highest potential themselves.	4.16	.93	High	6
6. Students feel that homework projects to give full play to own strengths in physics course.	3.94	.87	High	15
7. Students feel that physics course is the great significance to personal growth and development in future.	4.22	.76	High	2
8. Students feel that the assignments assigned by the lecturers and the feedback can help students better apply what they have learned.	4.10	.95	High	10

Table 4.9 (Continued)

Factors	μ	σ	Interpretation	Ranking within All Factors
10. Students are satisfied with the friendly cooperation and interaction between students and teachers or peers in the physics course.	4.22	.95	High	2
11. Students feel that homework or project work assigned by lecturers and students can help students better apply the knowledge they have learned.	4.02	.85	High	14
12. Students feel that the evaluation project work assigned by lecturers and students can help students better apply the knowledge they have learned.	4.04	.81	High	13
13. Students have new ideas based on their responses to learning about physical innovative ability in physics course.	4.14	.88	High	7
14. Students learn through flipped classroom instructional model to enhance their physical innovative ability.	4.14	.86	High	7
15. Students can develop their sense of accomplishment and pride through different activities in physics course.	4.06	.82	High	12
Total Average	4.13	.85	High	
External Factor				
1. The lecturer uses modern teaching methods physics course (such as mobile phones, computers, APP platforms effectively, demonstrations, exploration, etc.) to stimulate students' interest in physical innovative ability.	4.08	.85	High	10

Table 4.9 (Continued)

Factors	μ	σ	Interpretation	Ranking within All Factors
2. The lecturer combines traditional classroom evaluation methods with various modern intelligent online evaluation systems.	4.08	.83	High	10
3. The lecturer can guide students to realize that the learning of physics course and physical innovative ability has a positive impact on their future development.	4.22	.82	High	4
4. The lecturer pays more attention to students' ability to apply physical innovative ability and its impact in physics course.	4.08	.83	High	10
5. The lecturer chooses appropriate teaching methods according to the characteristics of physics course and the tasks and goals of physical innovative ability.	4.16	.89	High	7
6. The lecturer combines the teaching method he teaches objectives, the knowledge and flipped classroom instructional model in physics course to enhance undergraduate students' physical innovative ability.	4.24	.74	High	2
7. The lecturer can stimulate students' interest and meet the contemporary needs of students, such as the physics competition.	4.08	.75	High	10
8. The lecturer chooses suitable materials and emerging network resources.	4.10	.89	High	9

Table 4.9 (Continued)

Factors	μ	σ	Interpretation	Ranking within All Factors
9. The textbook fully considers the content and objectives of physics courses and physical innovative ability training.	4.06	.82	High	15
10. The materials can fully support students' learning in physics courses and physical innovative ability training.	4.22	.74	High	4
11. The materials can fully support students' learning in physics courses and physical innovative ability training.	4.08	.83	High	10
12. The materials and environment can enhance undergraduate students' physical innovative ability.	4.24	.87	High	2
13. The availability of learning spaces and the project based learning can affect students' interest in physics courses.	4.22	.86	High	4
14. Provide a teaching mode with a stable high-speed network anytime, anywhere on campus as a teaching guarantee, and supports project based flipped classroom instructional model to enhance undergraduate students' physical innovative ability.	4.14	.86	High	8
15. The environments is clean and bright, with desks and chairs, blackboards, podiums, computers, projectors, large screens, loudspeakers and other multimedia facilities to facilitate the teaching process.	4.38	.83	High	1
Total Average	**4.16**	**.83**	**High**	

Table 4.9 indicates that internal factors affecting the physical innovative ability are found to be at a high level overall (μ=4.13). Considering each item individually, it was found that No.3 (Students believe that the good technique in teaching to improve physical innovative ability in physics course) has the highest mean (μ=4.38), followed by No.7 (Students feel that physics course is the great significance to personal growth and development in future) (μ=4.22), and the lowest mean is No.11 (Students feel that homework or project work assigned by lecturers and students can help students better apply the knowledge they have learned) (μ=4.02).

For external factors affecting the learning ability of the physical innovative ability , the overall level is found to be moderate (μ=4.16). Considering each item individually, it was found that No.15 (The environments is clean and bright, with desks and chairs, blackboards, podiums, computers, projectors, large screens, loudspeakers and other multimedia facilities to facilitate the teaching process) has the highest mean (μ=4.38), followed by No.6 (The lecturer combines the teaching method he teaches objectives, the knowledge and flipped classroom instructional model in physics course to enhance undergraduate students' physical innovative ability) (μ=4.24), and the lowest mean is No.11 (The materials can fully support students' learning in physics courses and physical innovative ability training) (μ=4.08).

The amount lecturers of Hechi University.

2 lecturer works on School of Mathematics and Physics.

2 lecturer works on School of Artificial Intelligence and Manufacturing.

2 lecturer works on School of Big Data and Computer Science.

The Lecturers Interview analysis results.

Table 4.10 Common data of the respondent in Hechi University

Data	Frequency	Percentage
Gender		
A. Male	2	33.30
B. Female	4	66.70
Total	**6**	**100.00**

Table 4.10 (Continued)

Data	Frequency	Percentage
Experience teaching		
A. below 3 yrs.	0	0
B. 3-6 yrs.	2	33.30
C. 7- 9 yrs.	3	50.00
D. over 9 yrs.	1	16.70
Total	**6**	**100.00**
Age		
A. below 25 yrs.	1	16.70
B. 25-35 yrs.	2	33.30
C. 36-50 yrs.	2	33.30
D. over 50 yrs.	1	16.70
Total	**6**	**100.00**

From Table 4.10, the common data of the lecturers shows that the most common gender is female, representing 66.70% of the respondents, while male lecturers make up 33.30% of the sample.

After interviews with six lecturers, the factors that affect the physical innovative ability of university students are summarized as follows:

Internal factors

Practice: The professor holds the following views: Firstly, in the teaching of university physics courses, students should be actively guided to participate in teaching, and teachers should focus on the development of students' innovation ability; Secondly, teachers must carry out the university physics experiment seriously, with the verification experiment as the starting point, focusing on the design of experiment operation; Thirdly, teachers comprehensively help students to use physical principles to analyze phenomena in daily life, and train students to independently discover problems, analyze problems and solve problems.

Psychology: In the process of teaching university physics courses, five lecturers emphasize the cultivation of students' positive thinking and innovative thinking ability. It can be said that the university physics course is an important psychological training course, which requires students to think about problems with

their brains. The two lecturers emphasized cooperation in teaching, giving play to the spirit of team learning, and making students do while learning. In addition, the three lecturers emphasized that college physics needed to think more, ask more questions, and emphasize that learning should be treated with a positive psychological attitude towards the theoretical study and experimental operation of university physics, and be good at summarizing and improving.

External factor

Materials: Lecturers agree that teaching materials are an important factor in teaching, and teachers must study the materials thoroughly before teaching. The three lecturers were of the opinion that the choice of teaching materials should be determined by the learning environment. However, the two lecturers believed that while paper textbooks could still be utilized as teaching materials, and it is essential for educators to consider electronic textbooks in the age of the Internet. They emphasized the importance of utilizing diverse teaching resources and adopting the flipped classroom instructional model in university physics course.

Teaching methods: Teaching methods were specific ways and strategies adopted by teachers in the teaching process, and all lecturers agreed that appropriate teaching methods could stimulate students' interest in studying university physics course. All of them recommended that university physics courses prioritize the teaching method, emphasis the demonstration of university physics, and preferably adopt the flipped classroom instructional model in order to encourage actively student to involve in the learning process. Two lecturers recommended adopting a project-based or inquiry-based approach, while one lecturer advocated for interactive teaching. The three teachers agreed that prioritizing situational teaching could enhance students' practical and problem-solving skills. They were all convinced that leveraging modern teaching tools, such as multimedia, computers, the Internet, and other auxiliary work and technology could significantly enhance the effectiveness of teaching. The four lecturers proposed that by incorporating students' major characteristics, instructors should adaptively employ a range of teaching methodologies to enhance the effectiveness of university physics courses and foster students' capacity for physics innovation.

Evaluation: Teaching evaluation was believed by all lecturers to be able to effectively assess the teaching effectiveness, offer feedback and guidance for

improvement to teachers, and allow students to reflect on their learning outcomes and knowledge proficiency. The two lecturers believed that flipped classroom should focus on evaluation of teaching effect before, during and after class. A lecturer believed that students should attach importance to self-evaluation in the learning process; the three lecturers believed that teaching evaluation should be comprehensive and objective, and the results of evaluation should be used to guide and improve teaching, not just to evaluate teachers and students.

Based on the analysis of interviews with lecturers, it has been discovered that the cultivation of students' hands-on ability is a crucial internal factor affecting their physics innovation ability. Additionally, in flipped classroom teaching, the active use of media by teachers to assist in teaching is identified as an important external factor. At the same time, appropriate teaching methods, teaching models and appropriate teaching materials can better mobilize students' enthusiasm for learning physics. Additionally, the teaching process should prioritize the feedback function of teaching evaluation and establish a closed-loop teaching structure.

Through interviews, there are two factors to improve undergraduates' physics innovation ability: first, internal factors, including practical and psychological factors; The second is external factors, including teaching materials, teaching methods and teaching evaluation. Figure 4.1 below shows this.

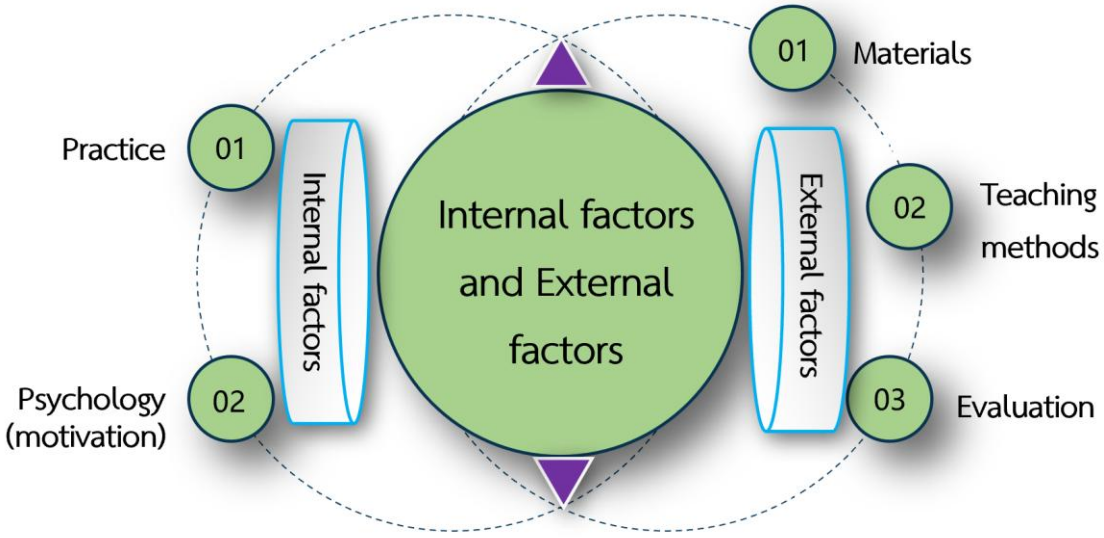

Figure 4.1 Internal and external factors influencing the flipped classroom teaching model

Table 4.11 A summary of factors affecting students' physical innovative ability

Students' opinion		Lecturers' opinion		Synthesized data	
Internal factors	External factors	Internal factors	External factors	Internal factors	External factors
(1) Knowledge accumulation. Physical innovative ability requires a wide range of knowledge, particularly interdisciplinary knowledge However, this aspect of knowledge is often what students lack, so teachers need to talk more about cross-disciplinary teaching in class.	(1) Teaching atmosphere. Students believe that the good teaching environment is the basis for students to think creatively. Students can stimulate their innovative thinking in a good teaching atmosphere.	(1) Knowledge accumulation. Only with a wide knowledge reserve, can physics innovation be carried out effectively and teachers can provide students with an objective basis for innovation.	(1) Teaching atmosphere. In the process of teaching, teachers try to innovate a good teaching atmosphere, which can stimulate students' thirst for knowledge in unknown areas, encourage students to actively ask questions, discuss and cooperate, and create an environment.	(1) Knowledge accumulation. Only with a wide knowledge reserve, active and rich knowledge is the basis for improving students' physical innovative ability. Teachers should pay attention to the teaching of interdisciplinary knowledge, improve comprehensive knowledge and ability.	(1) Teaching atmosphere. The atmosphere with a positive, interactive and creative teaching cultivates students' ability to think critically and independently. It is particularly important for stimulating students' innovative thinking.

Table 4.11 (Continued)

Students' opinion		Lecturers' opinion		Synthesized data	
Internal factors	External factors	Internal factors	External factors	Internal factors	External factors
(2) Open mind. On the basis of completing homework independently, students should learn to think from multiple angles and be good at discovering new things.	(2) Teaching methods. It is hoped that teachers can guide students to practice with their own hands through experimental teaching methods, deepen their understanding of physical processes, and cultivate students' hands-on ability.	(2) Open mind. In class, students are actively guided to find problems, analyze problems, and use the knowledge to propose solutions to problems.	(2) Teaching methods. Teachers are good at making use of experimental conditions to carry out practical teaching, guiding students to do a good job in various related experiments, and helping students to cultivate hands-on ability and independent thinking ability.	(2) Open mind. Teachers and students should jointly create a platform for finding, analyzing and solving problems. Teachers guide students to use the learned knowledge to think about problems, be good at summarizing from practice.	(2) Teaching methods. Through experiments, students can personally operate, observe and record experimental results, and deepen their understanding of physical concepts and laws. This hands-on approach helps to promote students' creativity.

Table 4.11 (Continued)

Students' opinion		Lecturers' opinion		Synthesized data	
Internal factors	External factors	Internal factors	External factors	Internal factors	External factors
(3) Experimental skills. Improving hands-on ability is the premise of physics innovation. With the guidance of teachers, students are expected to acquire a thorough understanding of the principles, steps, and practice methods, thus enabling them to autonomously accomplish experiment 1.	(3) Educational technology assistance. The hope is that teachers will utilize various forms of multimedia to support teaching and enhance students' enthusiasm for learning physics.	(3) Experimental skills. In the field of education, teachers ought to establish verification experiments and design experiments to empower students to propose new hypotheses and theories through practical investigations, and emphasize the enhancement of their experimental proficiency.	(3) Educational technology assistance. Teachers make full use of all kinds of modern multimedia teaching means to provide convenience for physics teaching, so that the phenomenon is more intuitive and students' thinking is more active.	(3) Experimental skills. Experimental skills is crucial for developing innovation abilities in the field of physics. Students need to master methods and principles, complete experiments independently under the guidance of teachers, and propose new experimental methods	(3) Support in educational technology. The use of advanced educational technology opens up new possibilities for teaching physics. These technologies can simulate complex physical phenomena.

Table 4.11 (Continued)

Students' opinion		Lecturers' opinion		Synthesized data	
Internal factors	External factors	Internal factors	External factors	Internal factors	External factors
(4) Rich imagination. Students have the ability to think across various disciplines, generate innovative research methodologies, and cultivate their creativity and imagination.	(4) Evaluation method. The teaching process should attach importance to the evaluation of scores and problem-solving ability, and combine various evaluation methods to stimulate students' innovative thinking.	(4) Rich imagination. Teachers try to expand their ideas in class and guide students to discover new areas and new ways to solve problems. Teacher cultivate students' rich imagination and innovation, to lay the foundation for the cultivation of physical innovative ability.	(4) Evaluation method. Teaching evaluation changes from diagnostic evaluation to process evaluation, and well combines the two kinds of evaluation, comprehensive evaluation of teachers' teaching and students' learning.	(4) Rich imagination. The core elements of physical innovative ability lie in imagination and creativity. Students need to have a rich imagination, be able to think creatively in different fields and come up with novel insights, and be good at developing new ways and solving problems.	(4) Evaluation method. To enhance students' innovative thinking, it is essential to utilize diverse evaluation techniques, such as assessing their classroom performance, experimental skills, teamwork capabilities, and problem-solving aptitude.

Table 4.11 (Continued)

Students' opinion		Lecturers' opinion		Synthesized data	
Internal factors	External factors	Internal factors	External factors	Internal factors	External factors
(5) Communication and cooperation. In the process of studying, teachers must learn to communicate and exchange with classmates, exchange different ideas, and learn in cooperation with others, and actively use the team thinking to improve their thinking ability, in order to achieve the purpose of physical innovation.	(5) Incentive effect. Students need the guidance of teachers, and play a role model, so that students can learn to promote innovative thinking.	(5) Communication and cooperation. In student inquiry activities, communication and cooperation refer to the exchange of ideas between teachers and students, as well as among the students.	(5) Incentive effect. Teachers actively guide students in teaching, encourage students to participate in teaching, give students full confidence, and stimulate students' innovative thinking.	Communication and cooperation are crucial components for enhancing the ability to innovate in physics. Learning and practicing require communication and cooperation. Students need to grow up in communication and achieve the purpose of improving physical innovative ability.	(5) Incentive effect. Teachers play the role of both guides and models in students' learning. Teachers' creative thinking and teaching techniques have a direct influence on enhancing students' ability to innovate.

As can be seen from Table 4.11, in terms of internal factors, improving physical innovative ability needs to start from multiple aspects, including knowledge accumulation, open thinking, problem solving ability, experimental skills, independent learning ability, imagination and creativity, critical thinking, cooperation and leadership, etc. By cultivating these abilities, students can better grasp the knowledge of physics and improve the ability of independent thinking and innovation. At the same time, it can also promote the development and progress of physical science and make positive contributions to the development of human society. In terms of external factors, external factors play an important role in the improvement of physical innovative ability. In order to improve students' innovation ability, we need to start from the above aspects, constantly optimize the teaching environment and methods, and cultivate a new generation of students with innovative spirit and practical ability.

Part 2: Analysis results serving Objective 2-To develop flipped classroom instructional model to improve physical innovative ability for undergraduate students.

The collected data of confirming the appropriateness of 5 components of instructional model are analyzed in 4 areas, i.e. utility, feasibility, propriety, and accuracy, demonstrated through the presentation of frequency and percentage by the specialists in the table and description provided below.

Table 4.12 Frequency and percentage of confirmability of utility, feasibility, propriety, and accuracy of the instructional model components in 4 areas by specialists

No.	Development of flipped classroom instructional model to improve physical innovative ability for undergraduate students	Opinion of the Specialists															
		Utility				Feasibility				Propriety				Accuracy			
		Agree		Disagree		Agree		Disagree		Agree		Disagree		Agree		Disagree	
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
1	Principle and Rationale	5	100.00	5	0	5	100.00	5	0	5	100.00	5	0	5	100.00	5	0
2	Objectives	5	100.00	5	0	5	100.00	5	0	5	100.00	5	0	5	100.00	5	0
3	Contents	5	100.00	5	0	5	100.00	5	0	5	100.00	5	0	5	100.00	5	0
4	Methods of Teaching & Materials	5	100.00	5	0	5	100.00	5	0	5	100.00	5	0	5	100.00	5	0
5	Evaluation	5	100.00	5	0	5	100.00	5	0	5	100.00	5	0	5	100.00	5	0

From Table 4.12 the confirmability of each component of the instructional model by 5 specialists 100.00 % all utility, feasibility, propriety, and accuracy.

Principle and rationale

The utility of principle and rationale of the instructional model is confirmed to be appropriate by 5 specialists; feasibility 5 specialists; propriety 5 specialists; and accuracy 5 specialists.

Objectives

The objectives of principle and rationale of the instructional model is confirmed to be appropriate by 5 specialists 100.00% of all specialists; feasibility 5 specialists 100.00%; propriety 5 specialists 100.00%; and accuracy 5 specialists 100.00%.

Contents

The contents of principle and rationale of the instructional model is confirmed to be appropriate by 5 specialists 100.00% of all specialists; feasibility 5 specialists 100.00%; propriety 5 specialists 100.00%; and accuracy 5 specialists 100.00%.

Methods of teaching & materials

The methods of teaching & materials of principle and rationale of the instructional model is confirmed to be appropriate by 5 specialists 100.00% of all specialists; feasibility 5 specialists 100.00%; propriety 5 specialists 100.00%; and accuracy 5 specialists 100.00%.

Evaluation

The evaluation of teaching & materials of principle and rationale of the instructional model is confirmed to be appropriate by 5 specialists 100.00% of all specialists; feasibility 5 specialists 100.00%; propriety 5 specialists 100.00%; and accuracy 5 specialists 100.00%.

The model component diagram of developing flipped classroom teaching model to improve the physics innovation ability of undergraduate students is shown in Figure 4.2.

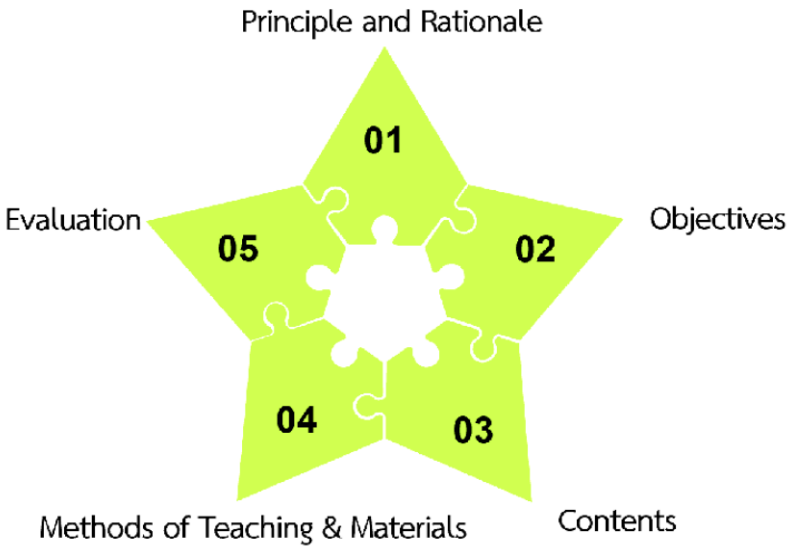

Figure 4.2 Developing flipped classroom teaching model
to improve students' physical innovation ability model component diagram

Part 3: Analysis results serving Objective 3-To examine the results of implementing flipped classroom instructional model to improve physical innovative ability for undergraduate students.

The analysis results of Objective 3 are presented in the form of tabular and descriptive analysis. According to the scoring criteria, students' physical instructional model has been achieved through the application of flipped classroom instructional model.

Physical innovative ability is improved by 12 criteria

Table 4.13 Students' performance results on basis of analytic and holistic rubric-score assessment

Aspects of assessment	$\bar{x}$	S.D.	Interpretation of quality level	Rank
Learning ability	13.04	2.91	Excellent	3
Analytical ability	13.18	2.46	Excellent	1
Comprehensive ability	12.92	2.79	Good	4
Imaginative ability	13.06	2.90	Excellent	2
Average (Analytic RSA)	13.09	2.77	Excellent	
Average Total Scores (Holistic RSA)	52.20	8.32	Excellent	

After the implementation of flipped classroom instructional model in university physics course, Table 4.13 shows that the average comprehensive score of students' physical innovative ability evaluated by analytical RSA has reached the excellent level ($\bar{x}$=13.09), and the overall score is excellent ($\bar{x}$=52.20). According to the results of the analytical RSA of physics innovation ability, analytical ability ($\bar{x}$=13.18) is the most significant aspect of students' physics innovation development, followed by imaginative ability ($\bar{x}$=13.06), learning ability ($\bar{x}$=13.04) and comprehensive ability ($\bar{x}$=12.92). It can be seen that training students' analytical ability and thinking imagination is particularly important for improving physical innovative ability.

As can be seen from Figure 4.3, most of the students scored between 44 and 60 points, only 4 of them scored below 31 points, and the high scores of students were in the normal distribution range.

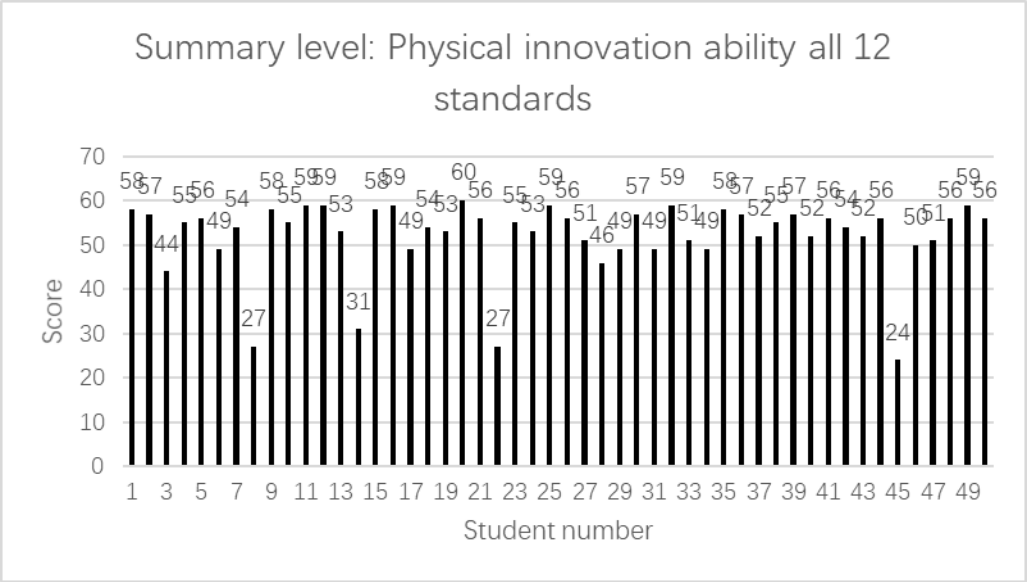

Figure 4.3 The figure of the relative score of students' physical innovative ability improved by flipped classroom instructional model

Table 4.14 Statistical table of 12 standard development levels of students' the improvement of physical innovative ability

Development level	Frequency	Percentage
Excellent	44	88.00
Good	2	4.00
Moderate	3	6.00
Improved	1	2.00
Fail	0	0

Criteria to evaluate critical thinking over all 12 Standards

Score Range	Meaning
49 - 60	Excellent
37 - 48	Good
25 - 36	Moderate
13- 24	Improved
Less than 13	Fail

Table 4.15 Statistical table of cumulative percentage of 12 standards for the improvement of students' physical innovative ability

Mark	Frequency	Percentage	Effective percentage	Cumulative percentage
60	1	2.00	2.00	2.00
59	6	12.00	12.00	14.00
58	4	8.00	8.00	22.00
57	4	8.00	8.00	30.00
56	7	14.00	14.00	44.00
55	4	8.00	8.00	52.00
54	3	6.00	6.00	58.00
53	3	6.00	6.00	64.00
52	3	6.00	6.00	70.00
51	3	6.00	6.00	76.00
50	1	2.00	2.00	78.00
49	5	10.00	10.00	88.00
46	1	2.00	2.00	90.00
44	1	2.00	2.00	92.00
31	1	2.00	2.00	94.00
27	2	4.00	4.00	98.00
24	1	2.00	2.00	100.00
Total	**50**	**100.00**	**100.00**	

According to the data in Table 4.14 and Table 4.15, the majority of students (92.00%) have good physical innovative ability. 44 students (88.00% of the total) reached the excellent level, and two students (4.00% of the total) reached the good level and three students (6.00% of the total) reached the intermediate level. One student (1.00% of the total) was at the pass level, and none was rated as poor in innovation.

In general, after the implementation of flipped classroom instructional model, it can be seen from Table 4.14 that most students (92.00%) have greatly improved their Physical Innovative ability. This result is consistent with the research hypothesis, that is, after the implementation of flipped classroom instructional model, most students (80% or higher) will improve their physical innovative ability. Therefore, it

can be drawn that flipped classroom instructional model in undergraduate classes has a significant effect on improving students' physical innovative ability.

Learning ability

As can be seen from the ability level distribution table shown in Figure 4.4, most students scored between 12 and 15, and only 3 students scored below 7, showing a normal distribution in terms of high scores.

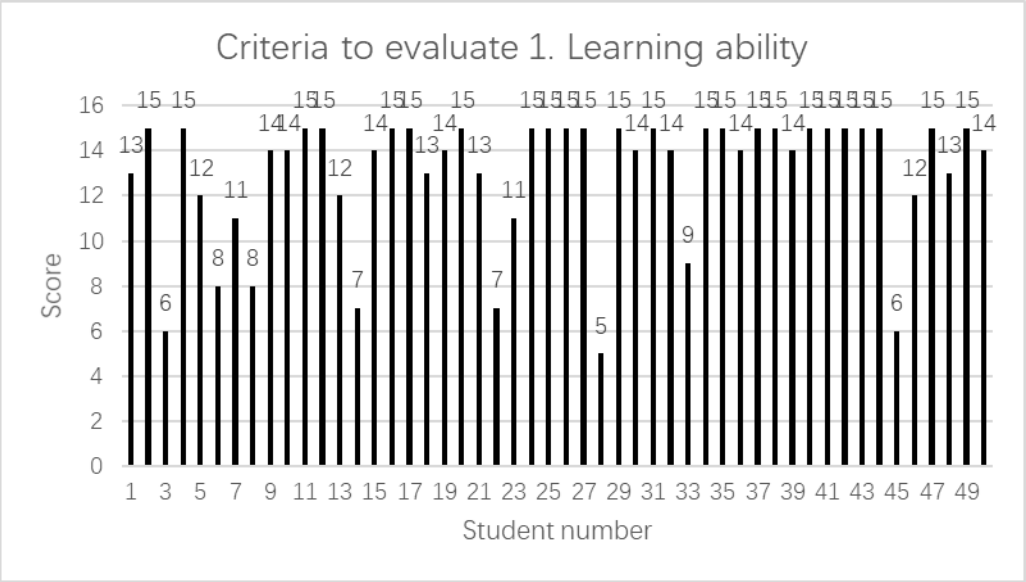

Figure 4.4 The figure of the relative score of students' learning ability standards improved by flipped classroom instructional model

Table 4.16 Statistical table of 3 standard development levels of students' learning ability

Development level	Frequency	Percentage
Excellent	37	74.00
Good	5	10.00
Moderate	5	10.00
Improved	3	6.00
Fail	0	0

Table 4.16 (Continued)

The criteria from item 1: Learning ability

Standard 1: Physics self-directed learning awareness

Standard 2: Physics study habits

Standard 3: Learning outcomes

Score Range	Meaning
13 - 15	Excellent
10 -12	Good
7 - 9	Moderate
4 - 6	Improved
Less than 4	Fail

Table 4.17 Statistical table of the cumulative percentage improvement of students' learning ability by 3 standards

Mark	Frequency	Percentage	Effective percentage	Cumulative percentage
15	24	48.00	48.00	48.00
14	9	18.00	18.00	66.00
13	4	8.00	8.00	74.00
12	3	6.00	6.00	80.00
11	2	4.00	4.00	84.00
9	1	2.00	2.00	86.00
8	2	4.00	4.00	90.00
7	2	4.00	4.00	94.00
6	2	4.00	4.00	98.00
5	1	2.00	2.00	100.00
Total	**50**	**100.00**	**100.00**	

According to the data in Table 4.16 and Table 4.7, the majority of students (84.00%) have excellent learning ability. 37 students (74.00%) achieved the excellent level, 5 students (10.00%) achieved the good level and 5 students (10.00%) achieved the intermediate level. Only three students (6.00% of the total) achieved the pass level, and none were rated as having poor academic ability.

In general, after adopting the flipped classroom instructional model, it can be seen from Table 4.16 that the majority of students (84.00%) have achieved significant improvement in learning ability. This result is consistent with the research hypothesis that more than 80% of students will improve their learning ability after the implementation of flipped classroom instructional model. Therefore, it can be concluded that the application of flipped classroom instructional model of undergraduate physics course has obvious effects on improving students' learning ability.

Analytical ability

As can be seen from the ability level distribution table shown in Figure 4.5, most students scored between 12 and 15, and only one student scored less than 7, showing a normal distribution in terms of high scores.

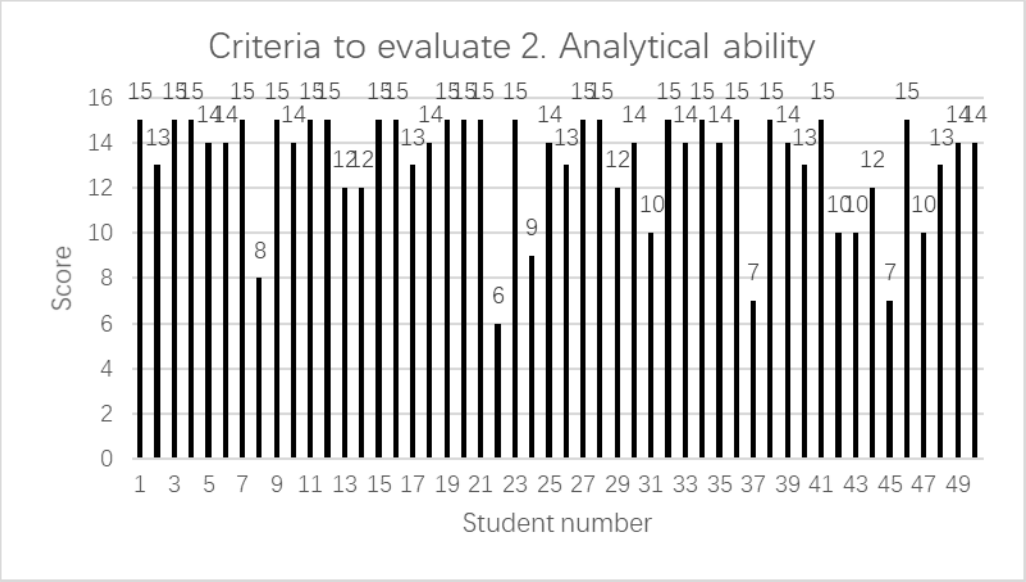

Figure 4.5 The figure of the relative score of students' analytical ability standards improved by flipped classroom instructional model

Table 4.18 Statistical table of 3 standard development levels of students' analytical Ability

Development level	Frequency	Percentage
Excellent	37	74.00
Good	8	16.00
Moderate	4	8.00
Improved	1	2.00
Fail	0	0

The criteria from item 2: Analytical ability

Standard 1: Descriptions of physical phenomena

Standard 2: Instructing physics experiments

Standard 3: Preview physical results based on physical phenomena and experiments

Score Range	Meaning
13 - 15	**Excellent**
10 -12	Good
7 - 9	Moderate
4 - 6	Improved
Less than 4	Fail

Table 4.19 Statistical table of the cumulative percentage improvement of students' analytical ability by 3 standards

Mark	Frequency	Percentage	Effective percentage	Cumulative percentage
15	21	42.00	42.00	42.00
14	11	22.00	22.00	64.00
13	5	10.00	10.00	74.00
12	4	8.00	8.00	82.00
10	4	8.00	8.00	90.00
9	1	2.00	2.00	92.00
8	1	2.00	2.00	94.00
7	2	4.00	4.00	98.00
6	1	2.00	2.00	100.00
Total	**50**	**100.00**	**100.00**	

According to the data in Table 4.18 and Table 4.19, the majority of students (90%) have excellent analytical skills. 37 students (74.00%) achieved an excellent level, eight students (16.00%) achieved a good level and four students (8.00%) achieved an intermediate level. Only one student (2.00% of the total) achieved the passing level, and none was rated as poor analytical skills.

In general, after adopting the flipped classroom instructional model, it can be seen from Table 4.18 that the majority of students (90.00%) have achieved significant improvement in their analytical ability. This result is consistent with the research hypothesis that the implementation of flipped classroom instructional model will lead to more than 80% of students improve in analytical skills. Therefore, it can be concluded that the application of flipped classroom instructional model in undergraduate physics course has obvious effects on improving students' analytical ability.

Comprehensive ability

As can be seen from the ability level distribution table shown in Figure 4.6, most students scored between 12 and 15, and only 3 students scored below 7, showing a normal distribution in terms of high scores.

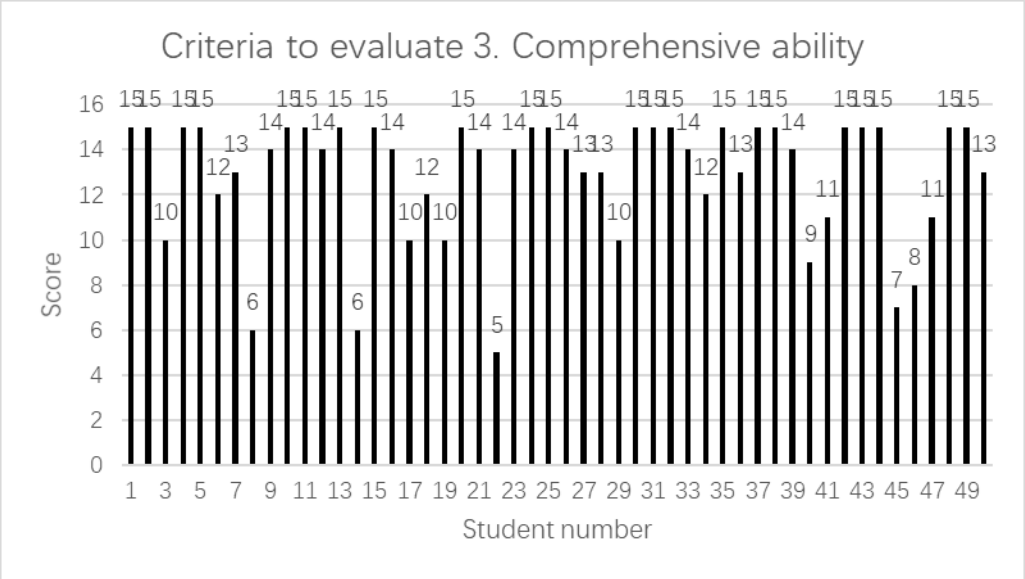

Figure 4.6 The figure of the relative score of students' comprehensive standards improved by flipped classroom instructional model

Table 4.20 Statistical table of 3 standard development levels of students' comprehensive ability

Development level	Frequency	Percentage
Excellent	35	70.00
Good	9	18.00
Moderate	3	6.00
Improved	3	6.00
Fail	0	0

The criteria from item 3: Comprehensive ability
Standard 1: Physical phenomena explanation
Standard 2: Physical theory elaboration
Standard 3: Application of physical laws

Score Range	Meaning
13 - 15	Excellent
10 -12	Good
7 - 9	Moderate
4 - 6	Improved
Less than 4	Fail

Table 4.21 Statistical table of the cumulative percentage improvement of students' comprehensive ability by 3 standards

Mark	Frequency	Percentage	Effective percentage	Cumulative percentage
15	22	44.00	44.00	44.00
14	8	16.00	16.00	60.00
13	5	10.00	10.00	70.00
12	3	6.00	6.00	76.00
11	2	4.00	4.00	80.00
10	4	8.00	8.00	88.00
9	1	2.00	2.00	90.00
8	1	2.00	2.00	92.00
7	1	2.00	2.00	94.00
6	2	4.00	4.00	98.00
5	1	2.00	2.00	100.00
Total	50	100.00	100.0	100.00

According to the data in Table 4.20 and Table 4.21, the majority of students (88.00%) have excellent comprehension. 35 students (70.00%) achieved an excellent level, nine students (18.00%) achieved a good level and three students (6.00%) achieved an intermediate level. Only three students (6.00% of the total) reached the passing level, and none were rated as having poor comprehensive ability.

Overall, the majority of students (88.00%) achieved significant improvement in comprehensive ability after adopting the flipped classroom model, as shown in Table 4.20. This result is consistent with the study's hypothesis that more than 80% of the whole students will improve in comprehensive ability after implementing the flipped classroom instructional model. Therefore, it can be drawn that the application of flipped classroom instructional model in undergraduate physics course has obvious effects on improving students' understanding.

Imaginative ability

As can be seen from the ability level distribution table shown in Figure 4.7, most students scored between 12 and 15, and only 3 students scored less than 7, showing a normal distribution in terms of high scores.

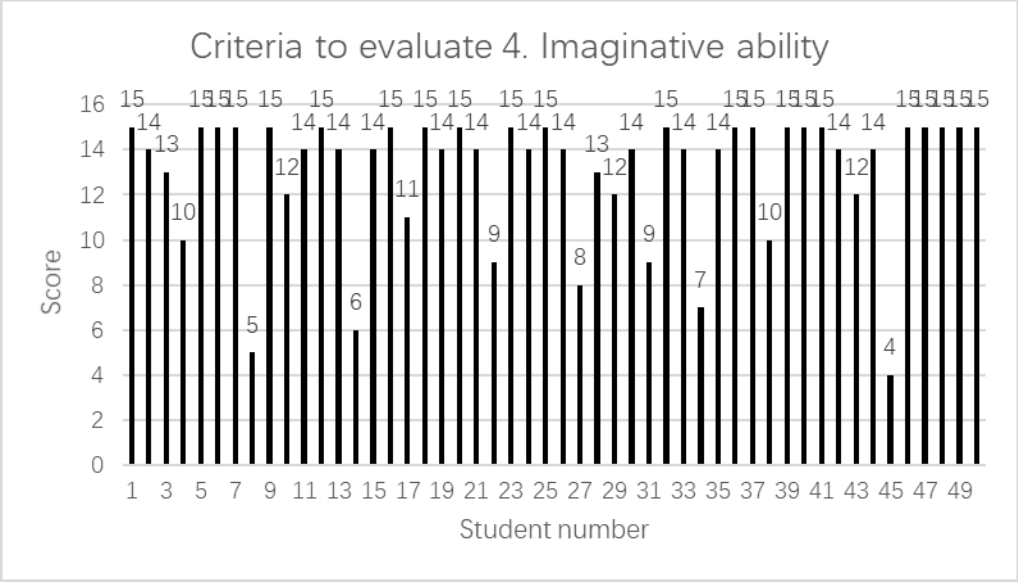

Figure 4.7 The figure of the relative score of students' imaginative ability standardsimproved by flipped classroom instructional model

Table 4.22 Statistical table of 3 standard development levels of students' imaginative ability

Development level	Frequency	Percentage
Excellent	37	74.00
Good	6	12.00
Moderate	4	8.00
Improved	3	6.00
Fail	0	0

The criteria from item 4: Imaginative ability

Standard 1: The building of physical models

Standard 2: Thinking about physical patterns

Standard 3: New theories are derived from physical models

Score Range	Meaning
13 - 15	Excellent
10 -12	Good
7 - 9	Moderate
4 - 6	Improved
Less than 4	Fail

Table 4.23 Statistical table of the cumulative percentage improvement of students' imaginative ability by 3 standards

Mark	Frequency	Percentage	Effective percentage	Cumulative percentage
15	22	44.00	44.00	44.00
14	13	26.00	26.00	70.00
13	2	4.00	4.00	74.00
12	3	6.00	6.00	80.00
11	1	2.00	2.00	82.00
10	2	4.00	4.00	86.00
9	2	4.00	4.00	90.00
8	1	2.00	2.00	92.00
7	1	2.00	2.00	94.00
6	1	2.00	2.00	96.00
5	1	2.00	2.00	98.00
4	1	2.00	2.00	100.00
Total	**50**	**100.00**	**100.00**	

According to the data in Table 4.22 ang Table 4.23 the majority of students (86.00%) have excellent imagination. Of these, 37 students (74.00%) achieved an excellent level, six students (12.00%) achieved a good level and four students (8.00%) achieved an intermediate level. Only three students (6.00% of the total) achieved the passing level, and none were rated as having poor imagination.

In general, it can be seen from Table 4.22 that the majority of students (86.00%) achieved significant improvement of imaginative ability after applying the flipped classroom instructional model. This result is consistent with the research hypothesis that the implementation of flipped classroom instructional model will improve the imagination of more than 80% of students. Therefore, it can be concluded that the application of flipped classroom instructional model in undergraduate physics has obvious effects on enhancing students' imagination.

By developing flipped classroom teaching model in college physics course teaching practice, there are four main steps: The first is to study the factors that improve students' physics innovation ability; the second is to evaluate the teaching implementation steps through expert interview method, that is, IOC score; the third is to carry out teaching practice; the fourth is to evaluate the teaching effect, and explore whether flipped classroom teaching can improve undergraduate students' physics innovation ability. The practical steps of improving undergraduates' physical innovation ability through the flipped classroom teaching mode are shown in Figure 4.8.

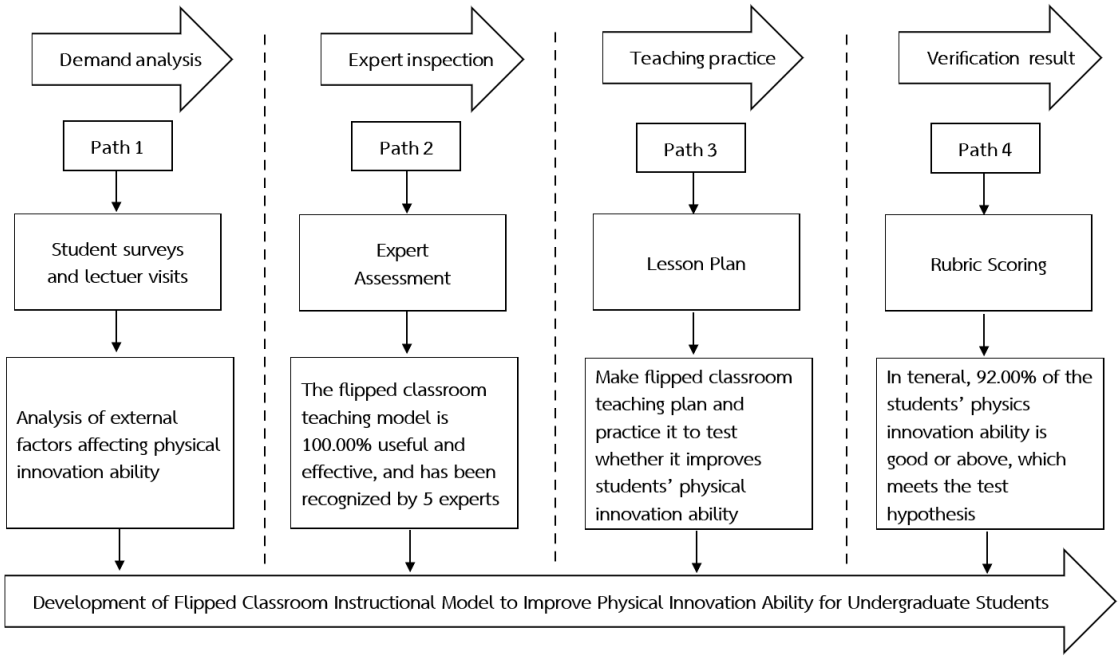

Figure 4.8 Effect diagram of mutual promotion and development between flipped classroom instructional model and students' physical innovative ability after implementation (Zhang, 2018)

Chapter 5
Conclusion Discussions and Recommendations

Through the analysis and presentation of the data results in Chapter 4, the purpose of this study of "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students" is achieved, and the following conclusions and discussions can be drawn. In addition, according to the research results, it is suggested to take some methods to further implement the flipped classroom instructional model and comprehensively improve the physical innovative ability of undergraduate students.

Research Objectives

1. To study the factors affecting physical innovative ability for undergraduate students.

2. To develop flipped classroom instructional model to improve physical innovative ability for undergraduate students.

3. To examine the results of implementing flipped classroom instructional model to improve physical innovative ability for undergraduate students.

Conclusion

1. There were 2 factors to improve physical innovative ability for undergraduate students: one was internal factors, including practical and psychological; the second was external factors, including teaching materials, teaching methods, and teaching evaluation.

2. Flipped classroom instructional model consisted of 5 parts: Principles and rational, Objectives, Contents, Teaching methods and materials, and Evaluation. The model had been evaluated programmatically (Utility standards, Feasibility standards, Appropriateness standards, and Accuracy standards) were 100% confirmed by 5 experts, and could be further implemented.

3. The results of implementing flipped classroom instructional model to improve physical innovative ability for undergraduate students it was found that 92.00% of 50 students was at a Good level (80% Good level). Therefore, it could be inferred that the flipped classroom instructional model was successful in improving students' physical innovation ability.

Discussions

1. There were 2 factors to improve physical innovative ability for undergraduate students: one was internal factors, including practical and psychological; the second was external factors, including teaching materials, teaching methods, and teaching evaluation according to teaching experiment.

The internal factors that affect physics innovation ability were generally at a high level (μ=4.22), indicating that students had high awareness of self-cognition and improving physics innovation ability. This showed that students are generally aware of their innovation ability in physics learning. Students rated physics courses with good teaching mode as the highest average (μ=4.45), further underscoring the importance of good teaching mode in stimulating students' ability to innovate in physics. The research also showed that students rated highly how their teachers helped them improve their physical creativity. The overall level of external factors affecting physical innovative ability is the model rate (μ=4.23), which is slightly lower than the overall level of internal factors affecting physical innovative ability. This indicates that while the external environment does have some influence on students' ability to innovate physics, it is not as crucial as internal factors. Among the external factors, No. 15 has the highest average score (μ =4.39), which suggests that students highly value the availability of hardware facilities and teaching equipment in the learning environment. This emphasizes the importance of teaching equipment in improving students' physical innovative ability. The average value of No.6 is also very high (μ=4.30), which indicates that the students are satisfied with the teaching mode of the lecturer and the teaching effect of combining the teaching objective to improve the students' physics course learning and physical innovative ability. This further result highlights the central role of teachers and teaching model in nurturing students' innovative talent in physics.

Physics innovation ability refers to the ability to promote the development and progress of physics science through independent thinking, finding problems, and proposing solutions in the process of physics learning, research, and practice. To enhance the ability of physical innovation, we need to start from some aspects, including knowledge accumulation, open thinking, problem-solving ability, experimental skills, independent learning ability, creativity and imagination, critical thinking, teamwork, and leadership.

Through in-depth investigation of students and interviews with scholars, it can be found that the improvement of students' physics innovation ability is mainly affected by the following core factors: knowledge accumulation, open mind, problem-solving ability, experimental skills, independent learning ability, imagination and creativity, critical thinking, cooperation, and leadership.

Through the investigation of students and interviews with scholars, it can be found that the improvement of students' physics innovation ability is mainly affected by the following external factors: good teaching atmosphere, practical teaching and experimental teaching, modern educational technology, diversified evaluation methods, teachers' guidance, and role example.

Overall, external factors play a crucial role in the improvement of physical innovative ability. In order to improve students' innovation ability, we need to start from the above aspects, constantly optimize the teaching environment and teaching methods, and nurture a new generation of students equipped with a spirit of innovation and practical skills.

2. Flipped classroom instructional model consisted of 5 parts: Principles and rational, Objectives, Contents, Teaching methods and materials, and Evaluation. The model had been evaluated programmatically (Utility standards, Feasibility standards, Appropriateness standards, and Accuracy standards) were 100% confirmed by 5 experts, and could be further implemented according to the confirmation from five experts regarding the five components of the flipped classroom teaching model, flipped classroom was determined to implement this teaching model in the University Physics Course. Through the confirmation results of 5 experts, the flipped classroom teaching model has been recognized and supported.

In terms of principles and rational. The practicability, feasibility, appropriateness and accuracy of the principles and basic principles of the model have been unanimously recognized by the five experts, which shows that the principles and basic principles of developing the flipped classroom model are stable and have a relatively solid theoretical foundation. This kind of teaching mode is conducive to enhancing undergraduate students' physics innovation ability and provides effective support in theory.

In terms of teaching objectives. Five experts have unanimously recognized the teaching objectives of this flipped classroom teaching model. The clear teaching aim

is the premise to achieve the teaching effects. The teaching goal of this model is distinct, which can improve students' physical innovative ability.

In terms of contents. According to the characteristics of flipped classroom teaching modes which were combined with the requirements of college physics syllabus, a reasonable selection of the fourth chapter which contains a total of 4 contents to carry out practical teaching, the material selection of the teaching contents which are scientific and appropriate, reflect the teaching practice and effect of the flipped classroom teaching mode in the teaching contents.

In terms of teaching methods and materials. Experts have acknowledged the recognition of the development of course contents and related teaching materials utilizing the flipped classroom teaching model. Well-designed teaching activities and practical physics learning experience have a good adaptability to flipped classroom teaching mode, and can effectively promote the improvement of students' physics innovation ability.

In terms of evaluation. As a critical part of teaching mode, teaching evaluation helps teachers to better understand students' learning status and adjust teaching methods and strategies accordingly. With the development of information technology, flipped classroom based on the network environment has been widely concerned. When flipped classroom teaching strategies are applied, teachers can establish clear evaluation methods and criteria to accurately measure student learning outcomes. In the design process, teachers should pay attention to personalized guidance for students, so that each student has different degrees of improvement, and make it more space for development. This can be done in a variety of ways, such as online testing, team discussions, or project outcomes. In these ways, students can be enabled to complete course tasks more effectively and gain progress, thus promoting their mastery of what they have learned. In addition, teachers need to think deeply about how to deal with students' behavior and their feedback in flipped classrooms to more effectively ignite students' enthusiasm and motivation for learning.

To sum up, the implementation of flipped classroom teaching mode in College Physics Course has been recognized and supported by the confirmation of 5 experts. This teaching mode has a solid theoretical foundation and practical application value, which can improve the physical innovative ability of undergraduate

students. In the process of implementation the flipped classroom, it is necessary to carefully design teaching activities, formulate clear teaching objectives, select appropriate teaching materials and methods, and formulate scientific evaluation standards and methods.

3. The results of implementing flipped classroom instructional model to improve physical innovative ability for undergraduate students it was found that 92.00% of 50 students was at a Good level (80% Good level). Therefore, it could be inferred that the flipped classroom instructional model was successful in improving students' physical innovation ability.

Through the implementation of the flipped classroom teaching model, it is observed that this model can significantly improve the physical innovative ability of undergraduate students. Based on this, the author puts forward the "student-centered" flipped classroom teaching model and designs the corresponding experiment, which is verified in practice. This teaching method focuses on stimulating students' subjective initiative and participation spirit, and provides them with a wider range of independent learning and thinking space, thus helping to cultivate their innovative thinking and practical operation ability.

Overall, 92.00% of the students had good physical innovative ability, 88.00% of the students were excellent and 4.00% of the students were good. This demonstrates that the implementation of the flipped classroom teaching model has resulted in enhanced physical innovation abilities of most students. Only three students (6.00%) reached the intermediate level, one student reached the pass level, and none were rated as poor in innovation. This suggests that the adoption of the flipped classroom teaching method has enhanced the Physical Innovative ability of undergraduate students, with no one being rated as poor, thus illustrating the widespread acceptance and success of this teaching approach.

Most of the students scored between 44 and 60 points, indicating that the students' Physical Innovative ability was generally improved, and the distribution was more balanced. Only 4 students scored below 31 points, which may mean that under the traditional teaching mode, their Physical Innovative ability may not be well cultivated and developed. The fact that high-scoring students fall within the normal distribution range suggests that the flipped classroom teaching method has a considerable impact on enhancing students' physical innovation abilities, and this

impact follows the normal distribution pattern.

Based on the presupposition of the research, the flipped classroom teaching method has an obvious effect on enhancing students' innovation ability in physics. As can be seen from the data, the hypothesis has been identified.

From the data shown in Table 4.12, it can be observed that the flipped classroom teaching method plays an important role in enhancing students' ability in physical innovation. In the teaching process, teachers make reasonable design and implementation of the teaching contents, so that students can better participate in learning, and effectively improve their independent learning ability, cooperative exploration spirit, and other comprehensive qualities. In summary, this paper uses data and graphics to reveal the progress of undergraduate students' Physical Innovative ability after the implementation of flipped classroom teaching mode. In the teaching process, teachers make reasonable design and implementation of the teaching contents, so that students can better participate in learning, and effectively improve their independent learning ability, cooperative exploration spirit, and other comprehensive qualities. This batch of data and graphs reveal that the use of the flipped classroom teaching method is of great significance in enhancing students' ability in physical innovation.

From the dimension of learning ability, 84.00% of students have excellent learning ability, of which 74.00% are excellent, 10.00% are good, and 10.00% are intermediate. Only 6.00% of the students achieved the passing level, and none were rated as academically poor. This means that after adopting the flipped classroom teaching strategy, the academic ability of most students has been enhanced.

From the perspective of analytical ability, 90.00% of the students have excellent analytical ability (74.00% are excellent, 16.00% are good), and 8.00% are medium. Only 2.00% of the students achieved the passing level, and none were rated as having poor analytical skills. This suggests that the flipped classroom teaching mode has resulted in improved analytical abilities for most students.

In terms of the dimension of comprehensive ability, 88.00% of the students are very good (70.00% are excellent, 18.00% is good), and 6.00% is medium. Only 6 percent of students achieved a passing grade. This means that most students' analytical skills have been improved after adopting the flipped classroom teaching strategy.

In terms of imaginative ability, 86.00% of the whole students were excellent (74.00% met the excellent standard, 12.00% met the good standard), and 8.00% met the medium standard. Only 6.00% of students achieved the passing level. This means that most students' imaginations were enhanced.

The scores of learning ability dimension, analytical ability dimension, comprehensive ability dimension, and imaginative ability dimension are normally distributed, indicating that the distribution of students' ability level is relatively balanced.

In the four dimensions, most of the students scored above the average, indicating that the flipped classroom teaching model has a significant effect on improving student ability of Physical Innovative ability.

According to the above data and analysis, it can be concluded that the flipped classroom teaching mode has a remarkable effect on improving students' comprehensive ability, learning ability, and analytical ability.

This batch of data further confirms that the flipped classroom teaching model has significant popularity and effectiveness in improving students' physical innovative ability in different dimensions. Overall, the data and graphs show that after the implementation of the flipped classroom teaching model, undergraduate students' learning ability, analytical ability, comprehensive ability, and imaginative ability are improved. The data displayed in the table indicates that the flipped classroom teaching model has a noteworthy impact on enhancing students' physical innovation abilities.

Recommendations

The results of this study result in two recommendations: applicability of the results and future research.

Applicability of the results

1. Preparation for flipped classroom instruction before class.

Firstly, teachers should clarify the teaching objectives and requirements under the flipped classroom teaching mode. it is necessary to clarify the specific content of the flip. Teachers should make clear the links between different courses, combine the existing resources of their schools to provide personalized teaching design for students, and ensure that every learning link can be satisfied. At the same

time, teachers have the responsibility to clarify the specific contents of flipped classroom teaching. In addition, it is also needed that teachers select the most suitable teaching contents for flipped classrooms according to the specific needs of students and the uniqueness of the subject. In the process of deciding the teaching contents, teachers must fully consider the students' cognitive habits and interest points.

Secondly, teacher choose video materials for teaching. Teaching videos are regarded as valuable materials for flipped classrooms, so teachers are responsible for producing high-quality teaching videos. In the process of making teaching videos, teachers must fully consider the visual and auditory experience of students, and strive to make it intuitive, vivid, and interesting. In addition, teachers also need to draw up teaching plans that match the actual needs according to the teaching theme and students' learning habits.

Thirdly, teacher assign the learning-related tasks. In preparation for the beginning of the course, teachers are responsible for disclosing their learning tasks to students and encouraging them to study independently. Teachers arrange learning activities. Learning tasks may include watching instructional videos, reading textbooks, and completing preview tasks. When learning tasks are formulated, teachers should take into account the learning needs of students and the uniqueness of the subject to ensure that the tasks match the actual situation.

Fourthly, teachers need to collect feedback from students. Students have the opportunity to provide feedback on their learning situation and difficulties to teachers by using online communication, questionnaire surveys, and interview. Teachers should promptly adapt their teaching strategies and methods based on students' feedback.

Fifthly, teachers prepare for classroom interaction. In the flipped teaching model, the interaction between classes becomes a crucial part. Therefore, in the pre-class preparation stage, teachers need to prepare some classroom interactive activities, such as group discussion, role-play, case analysis, etc. In addition, teachers should also design interactive ways that match the actual needs according to the teaching theme and students' learning habits.

Sixthly, teachers need to develop evaluation criteria that meet the flipped classroom. The evaluation criteria may encompass factors, such as attitude towards

learning, learning achievements and classroom performance. At the same time, teachers also need to formulate evaluation standards that meet the actual situation according to the teaching contents and students' learning characteristics.

Seventhly, teachers need to arrange teaching time. The time required for teaching can include video learning sessions, classroom interactive discussion sessions, and other interactive activities. In addition, teachers should also make a teaching time plan that matches the actual situation according to the student's learning status and the uniqueness of the subject.

Eighthly, teachers should adjust their teaching methods and strategies according to the opinions and evaluations given by students. In the process of teaching, teachers should pay attention to understanding students from different angles, stratify them reasonably, and put forward targeted teaching requirements for students at each level to improve the teaching effects. In addition, teachers also need to design teaching strategies and means that match the actual situation according to the teaching theme and students' learning habits. In teaching, teachers should aim at improving classroom efficiency, rationally use various teaching methods, and encourage students to learn efficiently. When teachers adjust their teaching methods, they must fully consider the actual needs and learning conditions of students.

2. The implementation of the flipped classroom teaching method in-class.

The first step is to do self-study before class. Teachers can provide pre-class guidance through webcasts or online course platforms. Self-directed learning before class is seen as a crucial step in implementing the flipped classroom model. By analyzing classroom activities, teachers guide students to complete corresponding learning tasks. Before class, students need to check the teaching video, master the relevant knowledge and skills, and complete the preview task. To ensure that classroom activities can be carried out effectively, teachers must also do a good job of after-school guidance to help students master the correct way of learning. To stimulate students' independent learning spirit, teachers have the responsibility to make high-quality teaching videos and publish corresponding learning tasks. At the same time, teachers also need to actively collect feedback from students so that they can adjust and optimize teaching strategies and methods in time.

The second step is the interaction in the classroom. The effective classroom teaching interaction can promote the information interaction and emotional resonance between teachers and students so that the teaching goal can be realized. In the flipped classroom model, students' classroom interaction becomes the core part of their learning process. Teachers are responsible for organizing a variety of classroom interactive activities, such as group discussions, role simulations, and case studies, to stimulate students' active thinking, interactive communication, and in-depth discussion. At the same time, it is the responsibility of teachers to provide timely feedback and guidance to students to assist them in solving problems they encounter and deepening their knowledge base.

The third step is to concern the internalization of knowledge. In the flipped classroom model, the internalization of knowledge becomes the key link in the learning process of students. Teachers need to design some consolidation exercises and deepen activities suitable for students according to their learning conditions and subject characteristics. For example, teachers can design challenging problems, cases, or projects for students to solve through independent thinking or working in groups to consolidate and deepen what they have learned.

The fourth step is the evaluation of feedback. Only by correctly and effectively carrying out evaluation activities in the teaching process, can students truly understand knowledge and improve their ability to use flipped classroom teaching mode. It is the responsibility of teachers to give timely feedback and assessments to students based on their learning performance and current situation. Teaching practice shows that feedback to students in various ways can effectively improve the teaching effect and promote the improvement of teaching quality. In addition, teachers should also encourage students to conduct self-assessments and mutual evaluations to help them have a deeper understanding of their learning status and shortcomings. The feedback contents of the evaluation may cover the attitude of learning, outcomes, and performance in the classroom.

The fifth step is about extra-curricular growth. Only by correctly and effectively carrying out evaluation activities in the teaching process, can students truly understand knowledge and improve their ability to use flipped classroom model. In order to adapt to students' learning characteristics and teaching contents, teachers should plan a series of extra-curricular activities that match students' needs.

For example, teachers can guide students to participate in some discipline competitions, research projects, and other activities, to expand students' knowledge and skills. In addition, teachers can guide students to use Internet resources for independent learning and personal growth.

3. The improvement of physical innovative ability.

Firstly, the ability to independent learning. When the flipped classroom teaching mode is adopted, students are required to watch the teaching videos by themselves, master the relevant knowledge points and skills, and complete the homework preview. In this stage, students mainly aim to consolidate what they have learned. This learning process requires students to have a certain degree of independent learning ability. To cultivate students' independent learning abilities, teachers can develop detailed learning plans, provide rich learning resources, and organize special learning groups.

Secondly, the ability of independent thinking. Under the flipped classroom teaching model, students need to think and solve various problems independently. Teachers can guide students to think and solve problems independently by designing some challenging problems, cases, or projects. In addition, teachers can organize various forms of activities to promote the development of students' independent thinking abilities, such as class discussion and group collaboration.

Thirdly, the ability of solving problems. In the flipped classroom, students have to solve some practical problems. Teachers can construct several specific problems or projects to guide students to apply their knowledge to solve practical problems they face. At the same time, teachers can also cultivate students' problem-solving abilities by organizing practical activities and experimental operations.

Fourthly, the ability of innovating and practicing. Teachers should focus on stimulating students' learning interest, and improve their independent exploration awareness, to achieve the purpose of improving students' innovation ability and practical ability. In the process of implementing the flipped classroom, students must possess a certain level of innovation and practical skills. In addition, students should also master the computer knowledge related to study, such as network technology, database applications, etc. Teachers can plan a series of innovative experiments, practical activities, or projects. In addition, teachers have the opportunity to organize various scientific and technological competitions to cultivate students' ability in innovation and practice.

Fifthly, the ability of cooperation between students. In this situation, students can not only improve their learning efficiency, but also enhance the sense of collective honor and better understand physics contents. In this flipped classroom environment, students need to collaborate and communicate in small groups. In addition, teachers should encourage students to participate in various competitions to enhance students' sense of competition and stimulate their interest in knowledge inquiry. Teachers can improve students' ability to teamwork by organizing various group activities and cooperative learning. In addition, teachers also can improve students' language skills by guiding students to participate in class discussions and sharing learning experiences.

Future research

The flipped classroom teaching mode has shown obvious superiority in enhancing sports innovation ability. In this situation, students can not only improve their learning efficiency, but also enhance the sense of collective honor and better understand the physics contents. At the same time, flipped classrooms also provide teachers with more teaching time, allowing them to carry out teaching activities more flexibly and effectively. In the future, flipped classroom teaching mode are expected to be further promoted and practiced in several key areas:

1. Combining new technologies: As science and technology continue to advance, flipped classroom teaching mode are likely to be integrated with more innovative technologies, such as virtual reality (VR), augmented reality (AR), and artificial intelligence (AI). This teaching mode is a new teaching idea. Students can have a more vivid and interesting learning experience, resulting in a deeper understanding and mastery of physics knowledge.

2. Personalized teaching methods: The flipped classroom teaching strategy can more effectively meet the needs of personalized teaching. Through the analysis of students' learning behaviors and interests, teachers can provide customized learning resources and teaching programs for each student to better meet students’ learning needs and improve their academic performance.

3. Online learning community: The combination of flipped classroom teaching methods and online learning communities can create a more open and interactive learning atmosphere. Students can communicate and discuss with other students and teachers to share their learning experiences and experiences, thereby better facilitating the dissemination and sharing of knowledge.

4. Evaluation and feedback mechanism: In the future, flipped classroom teaching mode may put more emphasis on establishing a system of evaluation and feedback. Based on this theory, a new teaching mode, an online micro-course, the teaching process, implementation steps, and application effects are expounded. Through real-time evaluation and feedback on students' learning process and results, teachers can have a deeper grasp of students' learning status and needs to timely adjust their teaching methods and strategies, and further improve the quality and results of teaching.

On the whole, the flipped classroom teaching method shows great possibility in enhancing physical innovative ability. In the future, it is likely to be further developed and applied in a combination of new technologies, personalized teaching, online learning communities, and assessment feedback mechanisms.

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Appendices

Appendix A

List of Specialists and Letters of Specialists Invitation for IOC Verification

- List of experts to validate research instruments
- List of experts to evaluate the format Instructional Model

List of experts to validate research instruments

1. Assistant Professor Dr. Prapai Sridama	Computer and Teachbnolog Program Bansomdejchaopraya Rajabhat University
2. Assistant Professor Dr.Saiphon Songsiengchai	English Program Bansomdejchaopraya Rajabhat University
3. Assistant Professor Dr.Sarayut Sethakajorn	Administration Program Bansomdejchaopraya Rajabhat University
4. Professor Dr. Yin Xiangbao	Department of Mathematics and Physics Hechi University
5. Professor Su An	Department of Mathematics and Physics Hechi University

List of experts to evaluate the format Instructional Model

1. Associate Professor Dr. Jittawisut Wimutipanya	Science Program Bansomdejchaopraya Rajabhat University
2. Assistant Professor Dr.Wanida Ploysangwal	English Program University of the Thai Chamber of Commerce
3. Dr. Panas Jansritong	Admistration Program Krirk University
4. Professor Dr. Wei Yucheng	Department of Mathematics and Physics Hechi University
5. Professor Pan Jihuan	Department of Mathematics and Physics Hechi University

Appendix B

Official Letter

Ref. No. MHESI 0643.14/๙๔๑

Graduate School
BansomdejchaoprayaRajabhat University
1061 Itsarapap 15 Itsarapap Rd.
Thonburi Bangkok 10600

29 August 2023

Subject Request for evaluation of instructional model

Dear Assistant Professor Dr.Wanida Ploysangwal

Attachment: Validation sheets

Regarding the thesis entitled "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students" of Mr. Zhong Youkun, a Ph.D. student majoring in Curriculum and Instruction Programme at BansomejchaoprayaRajabhat University code number 6473103110, Thailand under the supervision of Assistant Professor Dr.Nuttamon Punchatree as major advisor of Associate Professor Dr.Areewan Iamsa-ard and Associate Professor Dr.Suriya Phankosol, the instructional model will be developed in the said research. In view with this, the researcher would like your expertise to evaluate the appropriateness of such a developed instructional model. Knowing your experience in the field of Education, I would like to ask for your help in evaluating the said instructional model before its implementation.

I will be glad to hear your suggestions and comments for the improvement of the instructional model. Your positive response is highly appreciated.

Sincerely,

(Assistant Professor Dr.Kanakorn Sawangcharoen)
Dean of Graduate School
BansomejchaoprayaRajabhat University

Tel. (662) 4737000
Fax. (662) 4737000

Ref. No. MHESI 0643.14/970

Graduate School
BansomdejchaoprayaRajabhat University
1061 Itsarapap 15 Itsarapap Rd.
Thonburi Bangkok 10600

29 August 2023

Subject Request for evaluation of instructional model

Dear Associate Professor Jittawisut Wimutipanya

Attachment: Validation sheets

Regarding the thesis entitled "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students" of Mr. Zhong Youkun, a Ph.D. student majoring in Curriculum and Instruction Programme at BansomejchaoprayaRajabhat University code number 6473103110, Thailand under the supervision of Assistant Professor Dr.Nuttamon Punchatree as major advisor of Associate Professor Dr.Areewan Iamsa-ard and Associate Professor Dr.Suriya Phankosol, the instructional model will be developed in the said research. In view with this, the researcher would like your expertise to evaluate the appropriateness of such a developed instructional model. Knowing your experience in the field of Education, I would like to ask for your help in evaluating the said instructional model before its implementation.

I will be glad to hear your suggestions and comments for the improvement of the instructional model. Your positive response is highly appreciated.

Sincerely,

(Assistant Professor Dr.Kanakorn Sawangcharoen)
Dean of Graduate School
BansomejchaoprayaRajabhat University

Tel. (662) 4737000
Fax. (662) 4737000

Ref. No. MHESI 0643.14/๙๙๑

Graduate School
BansomdejchaoprayaRajabhat University
1061 Itsarapap 15 Itsarapap Rd.
Thonburi Bangkok 10600

๒๙ August 2023

Subject Request for evaluation of instructional model

Dear Dr.Panas Jansritong

Attachment: Validation sheets

Regarding the thesis entitled "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students" of Mr, Zhong Youkun, a Ph.D. student majoring in Curriculum and Instruction Programme at BansomejchaoprayaRajabhat University code number 6473103110, Thailand under the supervision of Assistant Professor Dr.Nuttamon Punchatree as major advisor of Associate Professor Dr.Areewan Iamsa-ard and Associate Professor Dr.Suriya Phankosol, the instructional model will be developed in the said research. In view with this, the researcher would like your expertise to evaluate the appropriateness of such a developed instructional model. Knowing your experience in the field of Education, I would like to ask for your help in evaluating the said instructional model before its implementation.

I will be glad to hear your suggestions and comments for the improvement of the instructional model. Your positive response is highly appreciated.

Sincerely,

(Assistant Professor Dr.Kanakorn Sawangcharoen)
Dean of Graduate School
BansomejchaoprayaRajabhat University

Tel. (662) 4737000
Fax. (662) 4737000

Ref. No. MHESI 0643.14/972

Graduate School
BansomdejchaoprayaRajabhat University
1061 Itsarapap 15 Itsarapap Rd.
Thonburi Bangkok 10600

29 August 2023

Subject Request for evaluation of instructional model

Dear Professor Dr. Wei Yucheng

Attachment: Validation sheets

Regarding the thesis entitled "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students" of Mr. Zhong Youkun, a Ph.D. student majoring in Curriculum and Instruction Programme at BansomejchaoprayaRajabhat University code number 6473103110, Thailand under the supervision of Assistant Professor Dr.Nuttamon Punchatree as major advisor of Associate Professor Dr.Areewan Iamsa-ard and Associate Professor Dr.Suriya Phankosol, the instructional model will be developed in the said research. In view with this, the researcher would like your expertise to evaluate the appropriateness of such a developed instructional model. Knowing your experience in the field of Education, I would like to ask for your help in evaluating the said instructional model before its implementation.

I will be glad to hear your suggestions and comments for the improvement of the instructional model. Your positive response is highly appreciated.

Sincerely,

(Assistant Professor Dr.Kanakorn Sawangcharoen)
Dean of Graduate School
BansomejchaoprayaRajabhat University

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Fax. (662) 4737000

Ref. No. MHESI 0643.14/ 993

Graduate School
BansomdejchaoprayaRajabhat University
1061 Itsarapap 15 Itsarapap Rd.
Thonburi Bangkok 10600

21 August 2023

Subject Request for evaluation of instructional model

Dear professor Pan Jihuan

Attachment: Validation sheets

Regarding the thesis entitled "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students" of Mr. Zhong Youkun, a Ph.D. student majoring in Curriculum and Instruction Programme at BansomejchaoprayaRajabhat University code number 6473103110, Thailand under the supervision of Assistant Professor Dr.Nuttamon Punchatree as major advisor of Associate Professor Dr.Areewan Iamsa-ard and Associate Professor Dr.Suriya Phankosol, the instructional model will be developed in the said research. In view with this, the researcher would like your expertise to evaluate the appropriateness of such a developed instructional model. Knowing your experience in the field of Education, I would like to ask for your help in evaluating the said instructional model before its implementation.

I will be glad to hear your suggestions and comments for the improvement of the instructional model. Your positive response is highly appreciated.

Sincerely,

(Assistant Professor Dr.Kanakorn Sawangcharoen)
Dean of Graduate School
BansomejchaoprayaRajabhat University

Tel. (662) 4737000
Fax. (662) 4737000

For hardcopy questionnaire
(กรณีส่งเป็นเอกสารชุดแบบ

Ref. No. MHESI 0643.14/๓๙๔

Graduate School
Bansomdejchaopraya Rajabhat University
1061 Itsarapap 15 Itsarapap Rd.
Thonburi Bangkok 10600

๒๙ August 2023

Subject Request for data collection

Dear President of Hechi University

Attachment questionnaire

Regarding the thesis entitled "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students" for Undergraduate Students in Hechi University of Mr. Zhong Youkun , a Ph.D. student majoring in Curriculum and Instruction Programme at Bansomejchaopraya Rajabhat University code number 6473103110 Thailand under the supervision of

Major Advisor : Assistant Professor Dr.Nuttamon Punchatree
Co-advisor : Associate Professor Dr. Areewan Iamsa-ard
Co-advisor : Associate Professor Dr.Suriya Phankosol

Researchers need to conduct a questionnaire survey on 50 students in Class B of physics course in Hechi College to collect factors that affect students' learning ability in college physics course.. Hence, I' m formally requesting your assistance in distributing the attached questionnaire to the informants as referred above and please send the completed ones back to the researcher via Gaoxin Park, No.42 Longjiang Road, Yizhou District, Hechi City, Guangxi.

The researcher plans to use this data for his thesis completion and further necessary publication as required by the Ph.D. course.

I am grateful for your consideration of my request. I pledge to adhere to any stipulations you deem fit. You may reach me at the phone number or email address provided below in case of any related questions. I look forward to your response.

Sincerely,

(Asst.Prof.Dr.Kanakorn Sawangcharoen)
Dean of Graduate School
Bansomejchaopraya Rajabhat University

Tel. +66 0204737000 Ext.

Fax. 66 0204737000

Ref. No. MHESI 0643.14/๑๗๕

Graduate School
Bansomdejchaopraya Rajabhat University
1061 Itsarapap 15 Itsarapap Rd.
Thonburi Bangkok 10600

๒๙ August 2023

Subject Request for permission to implement experiment

Dear President of Hechi University

Regarding the thesis entitled "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students" of Mr. Zhong Youkun, a Ph.D. student majoring in Curriculum and Instruction Programme at Bansomejchaopraya Rajabhat University code number 6473103110 Thailand under the supervision of

Major Advisor : Assistant Professor Dr.Nuttamon Punchatree
Co-advisor : Associate Professor Dr. Areewan Iamsa-ard
Co-advisor : Associate Professor Dr.Suriya Phankosol

The researchers need to conduct a questionnaire survey on 50 students in Class B of physics course in Hechi Gakuin University to collect factors that affect students' learning ability in college physics.I' m formally requesting your assistance in distributing the attached questionnaire to the informants as referred above and please send the completed ones back to the researcher No.42 Longjiang Road, Yizhou District, Hechi City, Guangxi.

The researcher plans to use this data for his thesis completion and further necessary publication as required by the Ph.D. course.

I am grateful for your consideration of my request. I pledge to adhere to any stipulations you deem fit. You may reach me at the phone number or email address provided below in case of any related questions. I look forward to your response.

Sincerely,

(Asst.Prof.Dr.Kanakorn Sawangcharoen)
Dean of Graduate School
Bansomejchaopraya Rajabhat University

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Ref. No. MHESI 0643.14/ 976

Graduate School
Bansomdejchaopraya Rajabhat University
1061 Itsarapap 15 Itsarapap Rd.
Thonburi Bangkok 10600

29 August 2023

Subject Request for research tool validation

Dear Assistant Professor Dr. Sarayut Sethakajorn

Attachment validation sheets

Regarding the thesis entitled "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students" of Mr. Zhong Youkun, a Ph.D. student majoring in Curriculum and Instruction Programme at Bansomejchaopraya Rajabhat University code number 6473103110, Thailand under the supervision of Assistant Professor Dr.Nuttamon Punchatree as major advisor of Associate Professor Dr.Areewan Iamsa-ard and Associate Professor Dr.Suriya Phankosol, questionnaire as instruments will be used in the said research. In view with this, the researcher would like your expertise to validate the attached questionnaires to qualify for conduction. Knowing your experience in the field of Education, I would like to ask for your help in validating the said instrument before administering it to the participants of the study.

The research objective, definitions of terms,questionnaire and the validation sheets are hereby attached. I will be glad to hear your suggestions and comments for the improvement of the instrument. Your positive response is highly appreciated.

Sincerely,

(Asst.Prof.Dr.Kanakorn Sawangcharoen)
Dean of Graduate School
Bansomejchaopraya Rajabhat University

Tel. +66 0204737000 Ext.
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Graduate School
Bansomdejchaopraya Rajabhat University
1061 Itsarapap 15 Itsarapap Rd.
Thonburi Bangkok 10600

29 August 2023

Subject Request for research tool validation

Dear Assistant Professor Dr.Prapai Sridama

Attachment validation sheets

Regarding the thesis entitled "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students" of Mr. Zhong Youkun, a Ph.D. student majoring in Curriculum and Instruction Programme at Bansomejchaopraya Rajabhat University code number 6473103110, Thailand under the supervision of Assistant Professor Dr.Nuttamon Punchatree as major advisor of Associate Professor Dr.Areewan Iamsa-ard and Associate Professor Dr.Suriya Phankosol, questionnaire as instruments will be used in the said research. In view with this, the researcher would like your expertise to validate the attached questionnaires to qualify for conduction. Knowing your experience in the field of Education, I would like to ask for your help in validating the said instrument before administering it to the participants of the study.

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Sincerely,

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Graduate School
Bansomdejchaopraya Rajabhat University
1061 Itsarapap 15 Itsarapap Rd.
Thonburi Bangkok 10600

๒๑ August 2023

Subject Request for research tool validation

Dear Assistant Professor Dr.Saiphon Songsiengchai

Attachment validation sheets

Regarding the thesis entitled "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students" of Mr. Zhong Youkun, a Ph.D. student majoring in Curriculum and Instruction Programme at Bansomejchaopraya Rajabhat University code number 6473103110, Thailand under the supervision of Assistant Professor Dr.Nuttamon Punchatree as major advisor of Associate Professor Dr.Areewan Iamsa-ard and Associate Professor Dr.Suriya Phankosol, questionnaire as instruments will be used in the said research. In view with this, the researcher would like your expertise to validate the attached questionnaires to qualify for conduction. Knowing your experience in the field of Education, I would like to ask for your help in validating the said instrument before administering it to the participants of the study.

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Ref. No. MHESI 0643.14/ ๑๙๑

Graduate School
Bansomdejchaopraya Rajabhat University
1061 Itsarapap 15 Itsarapap Rd.
Thonburi Bangkok 10600

29 August 2023

Subject Request for research tool validation

Dear Professor Dr. Yin Xiangbao

Attachment validation sheets

Regarding the thesis entitled "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students" of Mr. Zhong Youkun, a Ph.D. student majoring in Curriculum and Instruction Programme at Bansomejchaopraya Rajabhat University code number 6473103110, Thailand under the supervision of Assistant Professor Dr.Nuttamon Punchatree as major advisor of Associate Professor Dr.Areewan Iamsa-ard and Associate Professor Dr.Suriya Phankosol, questionnaire as instruments will be used in the said research. In view with this, the researcher would like your expertise to validate the attached questionnaires to qualify for conduction. Knowing your experience in the field of Education, I would like to ask for your help in validating the said instrument before administering it to the participants of the study.

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Dean of Graduate School
Bansomejchaopraya Rajabhat University

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Graduate School
Bansomdejchaopraya Rajabhat University
1061 Itsarapap 15 Itsarapap Rd.
Thonburi Bangkok 10600

29 August 2023

Subject Request for research tool validation

Dear professor Su An

Attachment validation sheets

Regarding the thesis entitled "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students" of Mr. Zhong Youkun, a Ph.D. student majoring in Curriculum and Instruction Programme at Bansomejchaopraya Rajabhat University code number 6473103110, Thailand under the supervision of Assistant Professor Dr.Nuttamon Punchatree as major advisor of Associate Professor Dr.Areewan Iamsa-ard and Associate Professor Dr.Suriya Phankosol, questionnaire as instruments will be used in the said research. In view with this, the researcher would like your expertise to validate the attached questionnaires to qualify for conduction. Knowing your experience in the field of Education, I would like to ask for your help in validating the said instrument before administering it to the participants of the study.

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Dean of Graduate School
Bansomejchaopraya Rajabhat University

Tel. +66 0204737000 Ext.
Fax. +66 0204737000

Ref. No. MHESI 0643.14/ 981

Graduate School
Bansomdejchaopraya Rajabhat University
1061 Itsarapap 15 Itsarapap Rd.
Thonburi Bangkok 10600

29 August 2023

Subject Request for research tool validation

Dear Assistant Professor Dr. Sarayut Sethakajorn

Attachment validation sheets

Regarding the thesis entitled "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students" of Mr. Zhong Youkun, a Ph.D. student majoring in Curriculum and Instruction Programme at Bansomejchaopraya Rajabhat University code number 6473103110, Thailand under the supervision of Assistant Professor Dr.Nuttamon Punchatree as major advisor of Associate Professor Dr.Areewan Iamsa-ard and Associate Professor Dr.Suriya Phankosol, questionnaire as instruments will be used in the said research. In view with this, the researcher would like your expertise to validate the attached questionnaires to qualify for conduction. Knowing your experience in the field of Education, I would like to ask for your help in validating the said instrument before administering it to the participants of the study.

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Ref. No. MHESI 0643.14/ ๙๘๒

Graduate School
Bansomdejchaopraya Rajabhat University
1061 Itsarapap 15 Itsarapap Rd.
Thonburi Bangkok 10600

๒๗ August 2023

Subject Request for research tool validation

Dear Assistant Professor Dr.Prapai Sridama

Attachment validation sheets

Regarding the thesis entitled "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students" of Mr. Zhong Youkun, a Ph.D. student majoring in Curriculum and Instruction Programme at Bansomejchaopraya Rajabhat University code number 6473103110, Thailand under the supervision of Assistant Professor Dr.Nuttamon Punchatree as major advisor of Associate Professor Dr.Areewan Iamsa-ard and Associate Professor Dr.Suriya Phankosol, questionnaire as instruments will be used in the said research. In view with this, the researcher would like your expertise to validate the attached questionnaires to qualify for conduction. Knowing your experience in the field of Education, I would like to ask for your help in validating the said instrument before administering it to the participants of the study.

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Bansomejchaopraya Rajabhat University

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Ref. No. MHESI 0643.14/983

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Bansomdejchaopraya Rajabhat University
1061 Itsarapap 15 Itsarapap Rd.
Thonburi Bangkok 10600

29 August 2023

Subject Request for research tool validation

Dear Assistant Professor Dr.Saiphon Songsiengchai

Attachment validation sheets

Regarding the thesis entitled "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students" of Mr. Zhong Youkun, a Ph.D. student majoring in Curriculum and Instruction Programme at Bansomejchaopraya Rajabhat University code number 6473103110, Thailand under the supervision of Assistant Professor Dr.Nuttamon Punchatree as major advisor of Associate Professor Dr.Areewan Iamsa-ard and Associate Professor Dr.Suriya Phankosol, questionnaire as instruments will be used in the said research. In view with this, the researcher would like your expertise to validate the attached questionnaires to qualify for conduction. Knowing your experience in the field of Education, I would like to ask for your help in validating the said instrument before administering it to the participants of the study.

The research objective, definitions of terms,questionnaire and the validation sheets are hereby attached. I will be glad to hear your suggestions and comments for the improvement of the instrument. Your positive response is highly appreciated.

Sincerely,

(Asst.Prof.Dr.Kanakorn Sawangcharoen)
Dean of Graduate School
Bansomejchaopraya Rajabhat University

Tel. +66 0204737000 Ext.
Fax. +66 0204737000

Ref. No. MHESI 0643.14/984

Graduate School
Bansomdejchaopraya Rajabhat University
1061 Itsarapap 15 Itsarapap Rd.
Thonburi Bangkok 10600

29 August 2023

Subject Request for research tool validation

Dear Professor Dr. Yin Xiangbao

Attachment validation sheets

Regarding the thesis entitled "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students" of Mr. Zhong Youkun, a Ph.D. student majoring in Curriculum and Instruction Programme at Bansomejchaopraya Rajabhat University code number 6473103110, Thailand under the supervision of Assistant Professor Dr.Nuttamon Punchatree as major advisor of Associate Professor Dr.Areewan Iamsa-ard and Associate Professor Dr.Suriya Phankosol, questionnaire as instruments will be used in the said research. In view with this, the researcher would like your expertise to validate the attached questionnaires to qualify for conduction. Knowing your experience in the field of Education, I would like to ask for your help in validating the said instrument before administering it to the participants of the study.

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Dean of Graduate School
Bansomejchaopraya Rajabhat University

Tel. +66 0204737000 Ext.
Fax. +66 0204737000

Ref. No. MHESI 0643.14/ ๑๙๕

Graduate School
Bansomdejchaopraya Rajabhat University
1061 Itsarapap 15 Itsarapap Rd.
Thonburi Bangkok 10600

29 August 2023

Subject Request for research tool validation

Dear professor Su An

Attachment validation sheets

Regarding the thesis entitled "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students" of Mr. Zhong Youkun, a Ph.D. student majoring in Curriculum and Instruction Programme at Bansomejchaopraya Rajabhat University code number 6473103110, Thailand under the supervision of Assistant Professor Dr.Nuttamon Punchatree as major advisor of Associate Professor Dr.Areewan Iamsa-ard and Associate Professor Dr.Suriya Phankosol, questionnaire as instruments will be used in the said research. In view with this, the researcher would like your expertise to validate the attached questionnaires to qualify for conduction. Knowing your experience in the field of Education, I would like to ask for your help in validating the said instrument before administering it to the participants of the study.

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Dean of Graduate School
Bansomejchaopraya Rajabhat University

Tel. +66 0204737000 Ext.
Fax. +66 0204737000

Ref. No. MHESI 0643.14/ 986

Graduate School
Bansomdejchaopraya Rajabhat University
1061 Itsarapap 15 Itsarapap Rd.
Thonburi Bangkok 10600

29 August 2023

Subject Request for permission to implement experiment

Dear President of Hechi University

Regarding the thesis entitled "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students" of Mr. Zhong Youkun, a Ph.D. student majoring in Curriculum and Instruction Programme at Bansomejchaopraya Rajabhat University code number 6473103110 Thailand under the supervision of

Major Advisor : Assistant Professor Dr.Nuttamon Punchatree

Co-advisor : Associate Professor Dr. Areewan Iamsa-ard

Co-advisor : Associate Professor Dr.Suriya Phankosol

The researchers need to conduct a questionnaire survey on 50 students in Class B of physics course in Hechi Gakuin University to collect factors that affect students' learning ability in college physics.I' m formally requesting your assistance in distributing the attached questionnaire to the informants as referred above and please send the completed ones back to the researcher No.42 Longjiang Road, Yizhou District, Hechi City, Guangxi.

The researcher plans to use this data for his thesis completion and further necessary publication as required by the Ph.D. course.

I am grateful for your consideration of my request. I pledge to adhere to any stipulations you deem fit. You may reach me at the phone number or email address provided below in case of any related questions. I look forward to your response.

Sincerely,

(Asst.Prof.Dr.Kanakorn Sawangcharoen)
Dean of Graduate School
Bansomejchaopraya Rajabhat University

Tel. +66 0204737000 Ext.

Fax. +66 0204737000

For hardcopy questionnaire
(กรณีส่งเป็นเอกสารชุดแบบ

Ref. No. MHESI 0643.14/ ๙๙๑

Graduate School
Bansomdejchaopraya Rajabhat University
1061 Itsarapap 15 Itsarapap Rd.
Thonburi Bangkok 10600

๒๑ August 2023

Subject Request for data collection

Dear President of Hechi University

Attachment questionnaire

Regarding the thesis entitled "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students" for Undergraduate Students in Hechi University of Mr. Zhong Youkun , a Ph.D. student majoring in Curriculum and Instruction Programme at Bansomejchaopraya Rajabhat University code number 6473103110 Thailand under the supervision of

Major Advisor : Assistant Professor Dr.Nuttamon Punchatree
Co-advisor : Associate Professor Dr. Areewan Iamsa-ard
Co-advisor : Associate Professor Dr.Suriya Phankosol

Researchers need to conduct a questionnaire survey on 50 students in Class B of physics course in Hechi College to collect factors that affect students' learning ability in college physics course.. Hence, I' m formally requesting your assistance in distributing the attached questionnaire to the informants as referred above and please send the completed ones back to the researcher via Gaoxin Park, No.42 Longjiang Road, Yizhou District, Hechi City, Guangxi.

The researcher plans to use this data for his thesis completion and further necessary publication as required by the Ph.D. course.

I am grateful for your consideration of my request. I pledge to adhere to any stipulations you deem fit. You may reach me at the phone number or email address provided below in case of any related questions. I look forward to your response.

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Dean of Graduate School
Bansomejchaopraya Rajabhat University

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Ref. No. MHESI 0643.14/ ๙๘๘

Graduate School
BansomdejchaoprayaRajabhat University
1061 Itsarapap 15 Itsarapap Rd.
Thonburi Bangkok 10600

๒๙ August 2023

Subject Request for evaluation of instructional model

Dear professor Pan Jihuan

Attachment: Validation sheets

Regarding the thesis entitled "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students" of Mr. Zhong Youkun, a Ph.D. student majoring in Curriculum and Instruction Programme at BansomejchaoprayaRajabhat University code number 6473103110, Thailand under the supervision of Assistant Professor Dr.Nuttamon Punchatree as major advisor of Associate Professor Dr.Areewan Iamsa-ard and Associate Professor Dr.Suriya Phankosol, the instructional model will be developed in the said research. In view with this, the researcher would like your expertise to evaluate the appropriateness of such a developed instructional model. Knowing your experience in the field of Education, I would like to ask for your help in evaluating the said instructional model before its implementation.

I will be glad to hear your suggestions and comments for the improvement of the instructional model. Your positive response is highly appreciated.

Sincerely,

(Assistant Professor Dr.Kanakorn Sawangcharoen)
Dean of Graduate School
BansomejchaoprayaRajabhat University

Tel. (662) 4737000
Fax. (662) 4737000

Ref. No. MHESI 0643.14/989

Graduate School
BansomdejchaoprayaRajabhat University
1061 Itsarapap 15 Itsarapap Rd.
Thonburi Bangkok 10600

19 August 2023

Subject Request for evaluation of instructional model

Dear Professor Dr. Wei Yucheng

Attachment: Validation sheets

Regarding the thesis entitled "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students" of Mr. Zhong Youkun, a Ph.D. student majoring in Curriculum and Instruction Programme at BansomejchaoprayaRajabhat University code number 6473103110, Thailand under the supervision of Assistant Professor Dr.Nuttamon Punchatree as major advisor of Associate Professor Dr.Areewan Iamsa-ard and Associate Professor Dr.Suriya Phankosol, the instructional model will be developed in the said research. In view with this, the researcher would like your expertise to evaluate the appropriateness of such a developed instructional model. Knowing your experience in the field of Education, I would like to ask for your help in evaluating the said instructional model before its implementation.

I will be glad to hear your suggestions and comments for the improvement of the instructional model. Your positive response is highly appreciated.

Sincerely,

(Assistant Professor Dr.Kanakorn Sawangcharoen)
Dean of Graduate School
BansomejchaoprayaRajabhat University

Tel. (662) 4737000
Fax. (662) 4737000

Ref. No. MHESI 0643.14/990

Graduate School
BansomdejchaoprayaRajabhat University
1061 Itsarapap 15 Itsarapap Rd.
Thonburi Bangkok 10600

29 August 2023

Subject Request for evaluation of instructional model

Dear Dr.Panas Jansritong

Attachment: Validation sheets

Regarding the thesis entitled "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students" of Mr, Zhong Youkun, a Ph.D. student majoring in Curriculum and Instruction Programme at BansomejchaoprayaRajabhat University code number 6473103110, Thailand under the supervision of Assistant Professor Dr.Nuttamon Punchatree as major advisor of Associate Professor Dr.Areewan Iamsa-ard and Associate Professor Dr.Suriya Phankosol, the instructional model will be developed in the said research. In view with this, the researcher would like your expertise to evaluate the appropriateness of such a developed instructional model. Knowing your experience in the field of Education, I would like to ask for your help in evaluating the said instructional model before its implementation.

I will be glad to hear your suggestions and comments for the improvement of the instructional model. Your positive response is highly appreciated.

Sincerely,

(Assistant Professor Dr.Kanakorn Sawangcharoen)
Dean of Graduate School
BansomejchaoprayaRajabhat University

Tel. (662) 4737000
Fax. (662) 4737000

Ref. No. MHESI 0643.14/ 991

Graduate School
BansomdejchaoprayaRajabhat University
1061 Itsarapap 15 Itsarapap Rd.
Thonburi Bangkok 10600

29 August 2023

Subject Request for evaluation of instructional model

Dear Associate Professor Jittawisut Wimutipanya

Attachment: Validation sheets

Regarding the thesis entitled "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students" of Mr. Zhong Youkun, a Ph.D. student majoring in Curriculum and Instruction Programme at BansomejchaoprayaRajabhat University code number 6473103110, Thailand under the supervision of Assistant Professor Dr.Nuttamon Punchatree as major advisor of Associate Professor Dr.Areewan Iamsa-ard and Associate Professor Dr.Suriya Phankosol, the instructional model will be developed in the said research. In view with this, the researcher would like your expertise to evaluate the appropriateness of such a developed instructional model. Knowing your experience in the field of Education, I would like to ask for your help in evaluating the said instructional model before its implementation.

I will be glad to hear your suggestions and comments for the improvement of the instructional model. Your positive response is highly appreciated.

Sincerely,

(Assistant Professor Dr.Kanakorn Sawangcharoen)
Dean of Graduate School
BansomejchaoprayaRajabhat University

Tel. (662) 4737000
Fax. (662) 4737000

Ref. No. MHESI 0643.14/ 992

Graduate School
BansomdejchaoprayaRajabhat University
1061 Itsarapap 15 Itsarapap Rd.
Thonburi Bangkok 10600

29 August 2023

Subject Request for evaluation of instructional model

Dear Assistant Professor Dr.Wanida Ploysangwal

Attachment: Validation sheets

Regarding the thesis entitled "Development of Flipped Classroom Instructional Model to Improve Physical Innovative Ability for Undergraduate Students" of Mr. Zhong Youkun, a Ph.D. student majoring in Curriculum and Instruction Programme at BansomejchaoprayaRajabhat University code number 6473103110, Thailand under the supervision of Assistant Professor Dr.Nuttamon Punchatree as major advisor of Associate Professor Dr.Areewan Iamsa-ard and Associate Professor Dr.Suriya Phankosol, the instructional model will be developed in the said research. In view with this, the researcher would like your expertise to evaluate the appropriateness of such a developed instructional model. Knowing your experience in the field of Education, I would like to ask for your help in evaluating the said instructional model before its implementation.

I will be glad to hear your suggestions and comments for the improvement of the instructional model. Your positive response is highly appreciated.

Sincerely,

(Assistant Professor Dr.Kanakorn Sawangcharoen)
Dean of Graduate School
BansomejchaoprayaRajabhat University

Tel. (662) 4737000
Fax. (662) 4737000

Appendix C

Research Instrument

- Questionnaire for Students (Objective 1)
- Interview for Teachers (Objective 1)
- Questionnaire for Experts (Objective 2)
- Lesson Plan (Objective 3)
- Scoring Rubric Form (Objective 3)

Questionnaire for Students (Objective 1)

Directions:

These questionnaires are the instruments for collecting data in 1st phase of the research entitled “Development of Flipped Classroom Instructional Model to Improve Physical Innovative ability for Undergraduate Students”,conducted by Zhong Youkun, a Ph.D. student in Curriculum and Instruction Program at Bansomdejchaopraya Rajabhat University under the supervision of

1. Assistant Professor Dr. Nuttamon Punchatree
2. Associate Professor Dr.Areewan Iamsa-ard
3. Associate Professor Dr. Suriya Phankosol

This questionnaire is divided into 3 sections i.e.

Section 1 Common data of the respondent

Section 2 Information on factors affecting the Physical Innovative ability of undergraduate students.

The questionnaire type is the closed-ended questions that can only be answered by selecting from provided number to summated rating scale, 5 scales.

The important issues of the items consist of two groups of the factors: Internal factors (respondents) and External factors (teachers, circumstances, etc.)

Section 3 Further suggestions

Data obtained from this questionnaire are only used for the purpose of conducting aforementioned research and remain confidential. Individual or personal data presentation will be avoided.

Answer the questionnaire:

Section 1 Common data of the respondent

Directions: Please put ✔into the ☐ according to your own personal data

1. Gender is ☐ Male ☐ Female

2.From 3 colleges in Hechi university.

☐ A. Major Journalism from Mathematics and Physics School

☐ B. Major Mathematics from Chemistry and Biology School

☐ C. Major Tourism management from Big Data School

3. Age

☐ A. below 18 yrs. ☐ B. 18-20 yrs.

☐ C. 21-23 yrs. ☐ D. over 23 yrs.

Section 2 Questionnaire survey on influencing factors of Physical Innovative ability of undergraduate students.

Directions: Please fill in the attitude level field with the factors that affect physical innovation according to the following criteria. You can only choose one answer for each question. Please put ✔into the ☐.

5 means you STRONGLY AGREE with the item.
4 means you QUITE AGREE with the item.
3 means you remain NEUTRAL.
2 means you QUITE DISAGREE with the item
1 means you STRONGLY DISAGREE with the item

Questions	Answers				
	5	4	3	2	1
Internal factors (respondents)					
1. Students know that Physics course is an important compulsory course for students					
2. Students feel that Physics course is the great significance to personal's Physical Innovative ability.					
3. Students believe that the good technique in teaching to improve Physical Innovative ability in Physics course.					
4. Students believe that materials and learning resources to improve Physical Innovative ability in Physics course.					
5. Students are industrious in their learning (Assignments, Projects, Participation, etc.) with the highest potential themselves.					
6. Students feel that homework projects to give full play to own strengths in Physics course.					
7. Students feel that Physics course is the great significance to personal growth and development in future.					
8. Students feel that the assignments assigned by the lecturers and the feedback can help students better apply what they have learned.					
9. Students can master Physical Innovative ability by Flipped Classroom Instructional process in Physics course.					
10. Students are satisfied with the friendly cooperation and interaction between students and teachers or peers in the Physics course.					
11. Students feel that homework or project work assigned by lecturers and students can help students better apply the knowledge they have learned.					
12. Students feel that the evaluation project work assigned by lecturers and students can help students better apply the knowledge they have learned.					
13. Students have new ideas based on their responses to learning about Physical Innovative ability in Physics course.					

(Continued)

Questions	Answers				
	5	4	3	2	1
14. Students learn through Flipped Classroom Instructional to enhance their Physical Innovative ability.					
15. Students can develop their sense of accomplishment and pride through different activities in Physics course.					
External factor (students) teachers, environments, faculty facilities, materials and so on.					
16. The lecturer uses modern teaching methods Physics course (such as mobile phones, computers, APP platforms effectively, demonstrations, exploration, etc.) to stimulate students' interest in Physical Innovative ability.					
17. The lecturer combines traditional classroom evaluation methods with various modern intelligent online evaluation systems.					
18. The lecturer can guide students to realize that the learning of Physics course and Physical Innovative ability has a positive impact on their future development.					
19. The lecturer pays more attention to students' ability to apply Physical Innovative ability and its impact in Physics course.					
20. The lecturer chooses appropriate teaching methods according to the characteristics of Physics course and the tasks and goals of Physical Innovative ability.					
21. The lecturer combines the teaching method he teaches objectives, the knowledge and Flipped Classroom Instructional Model in Physics course to enhance undergraduate students’ Physical Innovative ability.					
22. The lecturer can stimulate students' interest and meet the contemporary needs of students, such as the Physics competition.					
23. The lecturer chooses suitable materials and emerging network resources.					
24. The textbook fully considers the content and objectives of Physics courses and Physical Innovative ability training.					

(Continued)

Questions	Answers				
	5	4	3	2	1
25. The materials can fully support students' learning in Physics courses and Physical Innovative ability training.					
26. The materials can fully support students' learning in Physics courses and Physical Innovative ability training.					
27. The materials and environment can enhance undergraduate students' Physical Innovative ability.					
28. The availability of learning spaces and the project based learning can affect students interest in Physics courses.					
29. Provides a teaching mode with a stable high-speed network anytime, anywhere on campus as a teaching guarantee, and supports project based Flipped Classroom Instructional Model to enhance undergraduate students' Physical Innovative ability.					
30. The environments is clean and bright, with desks and chairs, blackboards, podiums, computers, projectors, large screens, loudspeakers and other multimedia facilities to facilitate the teaching process.					

Section 3 Suggestions

.....

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.....

.....

Thank you for your kind cooperation for completing the questionnaire!

Researcher

Mr. Zhong Youkun

Interview for Teachers (Objective 1)

Directions:

This interview is a part of research entitled “Development of Situational Instructional Model to Improve English Writing Ability of Junior High School Students”.

Research Objectives:

To develop Flipped Classroom Instructional model to enhance Physical Innovative ability of undergraduate students. It is conducted by Zhong Youkun, a Ph.D. student in Curriculum and Instruction Programme at Bansomdejchaopraya Rajabhat University under the supervision of

1. Assistant Professor Dr. Nuttamon Punchatree
2. Associate Professor Dr.Areewan Iamsa-ard
3. Associate Professor Dr. Suriya Phankosol

The following open questions are the instrument for collecting data in 1st phase of the research, concerning about factors to affect problem-solving skills.

Please write down your own opinion for each questions. Data obtained from this questionnaire are only used for the purpose of conducting aforementioned research and remain confidential. Individual or personal data presentation will be avoided.

Section 1 These questions are the instrument for collecting data in 1st phase of the reach.

1. Gender is ☐ Male ☐ Female

2. The lecturers who are teaching Physics course from 3 colleges in Hechi university

☐ A. Lecturer from Literature and media School

☐ B. Lecturer from Mathematics and Science School

☐ C. Lecturer from Lecturer from Tourism management School

3. Experience teaching

☐ A. below 3 yrs. ☐ B. 3-6 yrs.

☐ C.7- 9 yrs. ☐ D. over 9 yrs.

4. Age

☐ A.below 25 yrs . ☐ C. 36-50 yrs.

☐ B. 25-35 yrs. ☐ D. over 50 yrs.

Section 2 An interview on the factors affecting undergraduate students' Physical Innovative ability.

Directions: The type of question is open-ended questions, you can answer according to your actual situation. Your answers will only be used in this research and will not be disclosed individually.

1. Why do you accept or select to teach this subject? (Example, prefer to teach, be expert in the content, be requested, or other reasons.)

2. How do you prepare to teach this subject? (Preparing contents, materials, teaching location,

3. For the first time in your teaching, how do you prepare subject orientation to educate students about the teaching system, measuring, and assessment?

4. Do you always implement teaching according to your teaching plan? Do you think your teaching plan can effectively enhance students' Physical Innovative ability? Do you often think about how to improve teaching?

5. How do you give the opportunity for students to participate in the teaching? (Please clarify the methodology.)

6. How many methodologies for students' measurement and assessment, and do you think your measurement and assessment course can reflect students' learning effect and knowledge level?

7. What Learning Tasks do you carry out to improve students' learning enthusiasm?

8. Do you provide the time for students after their regular class? If yes, how do you help students solve their difficulties?

9. Which aspects of your teaching need to be improved, or which aspects do you want the school to support you?

10. Previously, what problems do you meet in your teaching, and how do you find the solution?

Section 3 Comment and recommendation for improving the better instruction.

.....

Thank you for your kind cooperation for completing the questions.

Researcher Mr. Zhong Youkun

Questionnaire for Experts (Objective 2)

Quality evaluation table for improving undergraduate students' physics innovation ability based on flipped classroom teaching model.

Dear assessors,

The present study is conducted by Zhong Youkun Ph.D. student in Curriculum and Instruction Programme at Bansomdejchaopraya Rajabhat University, Thailand, under the supervision of the following advisors.

1. Assistant Professor Dr. Nuttamon Punchatree
2. Associate Professor Dr. Areewan Iamsa-ard
3. Associate Professor Dr. Suriya Phankosol

The attached open questions are the instrument for collecting data in phase 2 of the research, the objective of which is to confirm instructional.

Please write down your own opinion for each question. Data obtained from this questionnaire are only used for the purpose of conducting aforementioned research and remain confidential. Individual or personal data presentation will be avoided.

These questions involve 3 parts as follows.

Part 1: Assessor’s information

Part 2: Assessment of the quality of instructional model on 5-point rating scale basis in 4 aspects 1) Utility Standard 2) Feasibility Standard 3) Propriety Standard and 4) Accuracy Standard.

Part 3: Suggestion

The researcher certifies that all information obtained from this questionnaire will be used for academic purposes and to generate maximum benefit meeting objectives.

Thank you very much for dedicating your valuable time and providing useful information to this research for the benefit of further research and development.

Ph.D. student Name Zhong Youkun Curriculum and Instruction Program
Bansomdejchaopraya Rajabhat University

Lesson Plan (Objective 3)

Lesson Plan 1: Using flipped classroom teaching mode to teach Newton's laws of motion to improve students' learning ability （4 hour）

Objectives

Item1. Learning ability - to evaluate whether the flipped classroom teaching model has improved the learning ability of students innovation ability in physics.

Standard 1: Physics self-directed learning awareness

Standard 2: Physics study habits

Standard 3: Learning outcomes

Teaching:

The teaching based on the flipped classroom teaching mode refers to the comprehensive teaching mode which is divided into 5 steps in class. This lesson plan takes Newton's laws of motion as the teaching content, implements teaching activities through flipped classroom teaching mode, and aims to improve students' learning ability in physics innovation ability.

Step 1: Resource design (0.5 hour)

This part is mainly to attract students to initially understand the teaching content of Newton's laws of motion, and do a good job of budget practice for flipped classrooms. The teaching resource design of this lesson mainly includes three aspects: first, small-scale online teaching video (micro-lesson) or lesson video; The second is the teaching background of Newton's law of motion, that is, the development history of Newton's law of motion; The third is to improve the flipped classroom teaching courseware based on improving students' learning ability. Teaching resources are provided for students to learn independently before teachers teach, providing conditions for flipped classroom teaching.

Micro-lesson video resources

① Newton's First Law micro-lesson video

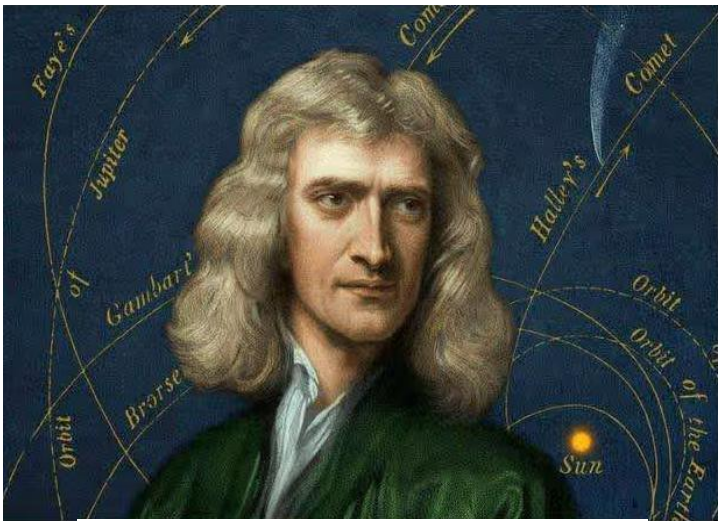
② Newton's Second Law micro-lesson video

③ Newton's Third Law micro-lesson video

④ Verification of Newton's Second Law experiment micro-lesson video

Project 1: background

Introduction to Newton



Picture1: Sir Isaac Newton

Sir Isaac Newton (1643-1727) was an English physicist, mathematician and astronomer. He graduated from Cambridge University and later became a professor there. He was the founder of Newton's laws of motion and the discoverer of the law of universal gravitation, which is the basis of classical mechanics, and laid the foundation for modern physics and mechanics. Because he established the basic system of classical mechanics, people often refer to classical mechanics as "Newtonian mechanics". In his later years, he devoted himself to writing works on the subject of theology. His works include Mathematical Principles of Natural Philosophy and Optics.

Newton was the founder of modern mechanics, the discoverer of gravity, analyzed the composition of white light, and discovered calculus in parallel with Leibniz. He was the greatest and most influential scientist who ever appeared in the history of mankind, as well as a physicist, mathematician, and philosopher.

In his monumental work, Mathematical Principles of Natural Philosophy, published on July 5, 1687, Newton mathematically elucidated the most fundamental laws of the universe - the law of universal gravitation and the three laws of motion. These four laws formed a unified system that was considered "the single greatest achievement in the history of human wisdom," thus establishing the scientific view of the physical world for the next three centuries and becoming the foundation of modern engineering. In mechanics, Newton clarified the principles of conservation of momentum and angular momentum. In optics, he invented the reflecting telescope and developed a theory of color based on the observation that a prism disperses white light into the visible spectrum. He also systematically formulated the law of cooling and studied the speed of sound. In mathematics, Newton shared with Leibniz the honor of developing calculus. He also proved the generalized binomial theorem, developed Newton's method for approximating the zeros of functions, and contributed to the study of power series.

Step 2: Assignment of tasks (0.5 hour)

This teaching session is mainly based on the flipped classroom model, where students are assigned relevant pre-study tasks before class to carry out project-based teaching in the classroom, actively guide students to participate in classroom discussions and other teaching activities, and embody the teaching status of taking students as the main body to improve students' learning ability. The main tasks include two aspects: one is to learn the teaching video through the relevant platform and raise the problems in the video that are uncertain and incomprehensible; the second is that the teacher arranges the relevant problems and guides the students to solve the problems with a positive mental attitude before the class, to make a good foundation for the flipped classroom teaching.

Task 1: Learn about Newton's life before class. Learn about Newton's life and contributions to scientific research, and learn about Newton's spirit of not being afraid of hard work and hard research.

Task 2: Study Newton's three laws of motion in advance.

Task 3: Questions for pre-study reflection

① what is the scope of application of Newton's laws of motion.

② what are inertial and non-inertial reference systems.

③ how to understand the instantaneous nature of Newton's laws of motion.

④ what is the difference between action and reaction forces, and equilibrium forces.

⑤ What should be noted about the application of Newton's laws of motion.

Project 2: Development of Newton's laws of motion

The creation and development of Newton's laws of motion

Newton's law of motion is a general term for Newton's first law of motion (i.e., the law of inertia), Newton's second law of motion, and Newton's third law of motion, summarized by Newton and published in Mathematical Principles of Natural Philosophy.

Newton's laws of motion were laid down and developed based on previous research. One is the theory of the motion of a falling body proposed by the Italian physicist Galileo, i.e., the idea that the distance of a free-falling body is proportional to the square of time. The second is the result of the ideal experiment on an inclined plane, i.e., the less resistance a moving object receives, the slower its speed of motion decreases and the longer it takes to move. The third is the idea of inertia, which was introduced by the French physicist Descartes. Fourth is the result of the Dutch physicist Huygens' study of inertial and collisional motion. These laws laid the

theoretical and experimental foundation for the establishment of.

Newton rigorously defined the basic concepts: the concepts of force, mass, inertia, velocity, acceleration, and so on. He attached importance to experimental research in scientific research and was good at summarizing and forming Newton's laws of motion:

The first law: any object is not subject to external forces or the role of the equilibrium force, always body mass at rest or uniform linear motion, until there is an external force acting on it to force it to change this state.

Second Law: The acceleration of an object is directly proportional to the combined external force on the object and inversely proportional to the mass of the object, and the direction of acceleration is the same as the direction of the combined external force.

The third law: the force and reaction between two objects, in the same line, equal in size and opposite in direction.

Newton's Laws of Motion apply to macroscopic objects moving at low speeds, not to objects moving at high speeds or to microscopic particles.

Step 3: Classroom discussion. （2 hours）

After the pre-class preview in the first two sessions, students have a certain understanding of Newton's Laws of Motion. In this session, classroom flipped teaching started to be implemented. Through the activities of teaching objectives display, group problem discussion, and classroom intelligent quiz, students can deepen their understanding of Newton's Laws of Motion and be able to skillfully utilize the Laws in solving practical problems to improve students' learning ability.

（1）Scan the code to sign in

Log in to the Rain Classroom teaching platform and have students sign in with their WeChat cell phones on this platform.

（2）Demonstrate instructional objectives

①Understand the content and substance of Newton's laws of motion.

② Identify the scope and conditions under which Newton's laws of motion apply.

③To master the application of Newton's laws of motion should pay attention to the following problems: first, Newton's laws of motion only hold in the inertial system of reference; second, will use the calculus method to deal with the simple mechanical problems under the action of variable forces.

（3）Breakout groups

Divide the class into five study groups, and recommend a group leader by the group, respectively, to organize the members of the group to carry out the discussion of the problem. Finally, the leader of the group on behalf of the group reported the results of the discussion to the class, the teacher commented on the results of the discussion and summarized them, forming a systematic knowledge system, thereby improving the learning ability of all students.

The discussion questions for each group are listed below:

Group 1: What is the scope of application of Newton's laws of motion.

Group 2: What are inertial and non-inertial reference systems.

Group 3:How to understand the instantaneous nature of Newton's laws of motion.

Group 4:What is the difference between action and reaction forces, and equilibrium forces.

Group 5: What should be noted about the application of Newton's laws of motion.

（4）Random selection for questions

After the leader of each group reported the results of the discussion of the group, the teacher to summarize and summarized the knowledge points, and the results of the discussion of the affirmative or otherwise, for the existence of doubtful issues, to further carry out the discussion of the question of randomly selected people.

（5）Implementation of courseware-assisted instruction

Teachers go through a step of checking the achievement of the teaching objectives and combining the problems discussed by the students with the teaching PPT courseware to organize the knowledge points in order to form a complete knowledge system of Newton's Laws of Motion.

Project 3: Analysis of important and difficult points

Scope of application of Newton's laws of motion

Scope of application: Newton's laws of motion apply to the low-speed motion of macroscopic objects, i.e., the motion of objects with speeds much less than the speed of light.

Conditions of application: Newton's laws of motion are only valid in an inertial reference system. The ground and the reference system that moves with uniform velocity relative to the ground can be regarded as an inertial reference system.

Newton's first law of motion reveals the essential property of the existence of

an object, i.e., inertia, which indicates that an object has the property of remaining at rest or maintaining uniform linear motion. Inertia exists in any object, and the inertia of an object is measured by its mass; the larger the mass, the larger the inertia, and the smaller the mass, the smaller the inertia. Newton's second law of motion reveals the intrinsic connection between motion and force. Force is what causes an object to accelerate, and there must be acceleration of an object that is subjected to force. Newton's third law of motion reveals that the forces acting between objects are action and reaction forces, which are forces acting on two objects with the same nature, equal in size, opposite in direction, and the lines of action of the forces are in the same straight line. o undo the operation again. Search and replace, search is to search according to the word or character in the text, and replace is to replace the word or character in the text.

Step 4: In-depth practice. (0.5 hour)

In this teaching session, two aspects of teaching practice will be carried out to improve students' learning ability through teaching practice. The first is to use the Rain Classroom teaching platform to push short-answer questions to students for practice. The second is to narrate thematic practice questions to reinforce the application of Newton's Laws of Motion in two types of problems.

Push short-answer questions to students for practice using the Rainy Classroom teaching platform. Each question takes one minute to answer, and the platform automatically displays the answer status of each option after students have finished answering.

（1）A car is moving in a straight line on a highway with the same pavement conditions. The following discussion of speed, inertia, mass and distance traveled by the car is correct (　)

（A）The greater the speed of the car, the greater its inertia

（B）The greater the mass, the greater its inertia

（C）The greater the speed of the car, the longer the distance it will skid after braking

（D）The greater the speed of the car, the longer it skids after braking, so the greater the inertia

（2）According to Newton's laws of motion, the following options are correct (　)

（A）A person can only land in his original position in a stationary carriage after jumping straight upward and high in the air.

（B）The person in a straight line along the uniform speed of the carriage, straight upward after jumping high, will land in the back of the jump point

（C）The person in a straight line accelerating along the carriage, straight upward after jumping high, will land in the back of the jumping point

（D）A person in a car decelerating in a straight line will land behind the starting point after jumping straight up and high.

Project 4: Application of Newton's Laws of Motion

Application of Newton's Laws of Motion

Steps to solve the problem:

（1）According to the question, determine the object of study;

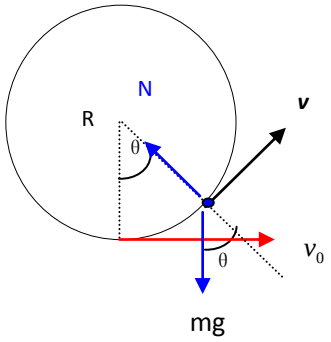
（2）analyze the forces on the object subjected to the force;

（3）Consider the process of object motion, establish a coordinate system, the equation. Because $\boldsymbol{F}=m\boldsymbol{a}$ is a vector, the specific application, to be written as a coordinate component equation, such as

$$\begin{cases} F_x = ma_x \\ F_y = ma_y \end{cases} \qquad \begin{cases} F_\tau = m\dfrac{dv}{dt} = mR\alpha \\ F_n = m\dfrac{v^2}{R} = mR\omega^2 \end{cases}$$

If the equation is not enough, use the acceler ation synthesis method to make auxiliary equations.

Example: The mass point in a vertical circle on the inner edge of the movement, the mass point in the lowest point A with an initial speed of v_0 thrown along the circumference, P for the location of the mass point at t time, v_0 why value, the mass point can be along the entire circle, known when, $t=0, v=v_0$.



Picture: Diagram of the circular motion of an object

Taking the Earth as the frame of reference and taking the tangential normal coordinates, we get

$$-mg\sin\theta = m\frac{dv}{dt}$$

$$N - mg\cos\theta = \frac{mv^2}{R}$$

With θ as the variable, the first equation becomes

$$-mg\sin\theta = m\frac{dv}{ds}\frac{ds}{dt} = mv\frac{dv}{ds}$$

Q $ds = Rd\theta$

$\therefore$ $vdv = -g\sin\theta ds = -Rg\sin\theta d\theta$

Integrating both sides gives

$$\frac{1}{2}v^2 = Rg\cos\theta + c$$

Q $t = 0, \quad \theta = 0、v = v_0$

$\therefore$ $c = \frac{1}{2}v_0^2 - Rg$

$\therefore$ $v^2 = v_0^2 - 2Rg(1-\cos\theta)$

$$N = m[\frac{v_0^2}{R} - g(2-3\cos\theta)]$$

When $\theta = \pi$ if $N \geq 0$ Then the mass can move along the whole circle. So v_0 minimum should satisfy

$$\frac{v_0^2}{R} - g(2-3\cos\pi) = 0$$

Get $v_0 = \sqrt{5Rg}$

That is $v_0 \geq \sqrt{5Rg}$, A point of mass can move along the entire circumference.

Step 5: Summarize and improve. (0.5 hour)

In the last part of the flipped classroom, on the one hand, it is summarizing and improving. It is mainly for the teacher to summarize the teaching of this chapter and make a comprehensive summary of the process of generating Newton's Laws of Motion, the formulation of the three laws, the scope of application of motion, and the steps of solving Newton's Laws of Motion, to improve the learning ability dimension of the students' Physical Innovative ability. At the same time, cutting-edge knowledge of physics related to the teaching content is introduced for students to carry out self-learning activities after class to further improve their learning ability. On the other hand, there is teaching evaluation. Including students' pre-course preparation, participation in the flipped classroom, random question answering, etc., the evaluation information is exported on the platform as the main basis of the teaching process, and is also included in the usual grades.

Evaluation 1:Group Task work for students

This task is to be completed in class, in small groups to complete the following tasks: Create a PPT to introduce the achievements of the great physicist

Newton, for the teacher to grade, in order to judge the student's learning ability to achieve.

Item1. Learning ability - to evaluate whether the flipped classroom teaching model has improved the learning ability of students innovation ability in physics.

The criteria from item 1 : **Learning ability**

Standard 1: Physics self-directed learning awareness	
Standard 2: Physics study habits	
Standard 3: Learning outcomes	
Score Range	**Meaning**
13 - 15	Excellent
10 -12	Good
7 - 9	Moderate
4 - 6	Improved
Less than 4	Fail

Materials:

1) Teaching materials

2) College physics course books

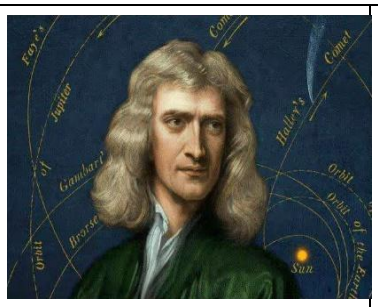
Learning Resources

1) Newton's three Laws of motion learning video

2) Related academic papers

University physics course PPT picture

Slide 01



Slide 02

Slide 03

一、牛顿第一定律

牛顿第一定律：任何物体将保持其原来静止或匀速直线运动状态直到有外力迫使它改变这种运动状态为止。物体的这种运动状态通常称为惯性运动，而物体保持原有运动状态的特性称为**惯性**。任何物体在任何状态下都具有惯性，**惯性是物体的固有属性**。牛顿第一定律又称为**惯性定律**。

一所受合外力为零的质点并不是在任何参考系中都能保持加速度为零的静止或匀速直线运动状态。

Slide 04

一、牛顿第一定律

惯性定律只能在某些特殊参考系中成立。通常把所受合外力为零的质点相对于它静止或作匀速直线运动的参考系称为**惯性参考系**，简称惯性系。

地球：公转加速度 $a\approx=5.9\times10^{-3}\,\mathrm{m\cdot s^{-2}}$

自转加速度 $a\approx=3.4\times10^{-2}\,\mathrm{m\cdot s^{-2}}$

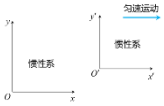
一个参考系是否是惯性系，取决于实验的精度要求。

通常，太阳参考系是一个精确度很好的惯性系；地球或静止在地面上的任一物体也是近似程度很好惯性系。

Slide 05

一、牛顿第一定律

凡相对于某惯性系静止或作匀速直线运动的其他参考系都是惯性系。



非惯性系：相对于已知惯性系作**加速**运动的参考系。

Slide 06

二、牛顿第二定律

牛顿第二定律：物体受到外力作用时，它所获得的加速度 $\vec{a}$ 的大小与合外力的大小成正比，与物体的质量成反比；加速度 $\vec{a}$ 的方向与合外力 $\vec{F}$ 的方向相同。

牛顿第二定律的数学形式

$$\vec{F}=k m\vec{a}$$

在国际单位制(SI)中 $k=1$

质量就是物体**惯性大小的量度**。牛顿第二定律中的质量也常被称为**惯性质量**。

万有引力定律的数学形式

$$\vec{F}=-G\frac{m_1m_2}{r^2}\vec{r}$$

G：引力常量；m_1、m_2：引力质量

Slide 07

三、牛顿第三定律

牛顿第三定律：当物体 A 以力 $\vec{F}_1$ 作用在物体 B 上时，物体 B 也必定同时以力 $\vec{F}_2$ 作用在物体 A 上，$\vec{F}_1$ 和 $\vec{F}_2$ 大小相等，方向相反，且力的作用线在同一直线上。

$$\vec{F}_1=-\vec{F}_2$$

Slide 08

三、牛顿第三定律

作用力与反作用力总是成对出现，且作用力与反作用力之间的关系是一一对应的。

作用力与反作用力是分别作用在两个物体上，因此绝对不是一对平衡力。

作用力与反作用力一定是属于同一性质的力。

Slide 09

四、牛顿定律的应用

牛顿第二定律 $\vec{F}=m\vec{a}=m\frac{\mathrm{d}^2\vec{r}}{\mathrm{d}t^2}$ 是矢量式。在具体运算时，一般先要选定合适的坐标系，然后将牛顿第二定律写成该坐标系的分量式。例如，在直角坐标系中它的分量式为

$$\begin{cases}F_x=ma_x=m\dfrac{\mathrm{d}v_x}{\mathrm{d}t}=m\dfrac{\mathrm{d}^2x}{\mathrm{d}t^2}\\ F_y=ma_y=m\dfrac{\mathrm{d}v_y}{\mathrm{d}t}=m\dfrac{\mathrm{d}^2y}{\mathrm{d}t^2}\\ F_z=ma_z=m\dfrac{\mathrm{d}v_z}{\mathrm{d}t}=m\dfrac{\mathrm{d}^2z}{\mathrm{d}t^2}\end{cases}$$

Slide 10

四、牛顿定律的应用

在研究曲线运动时，也可用自然坐标系中的法向分量和切向分量式

$$\begin{cases}F_t=ma_t=m\dfrac{\mathrm{d}v}{\mathrm{d}t}\\ F_n=ma_n=m\dfrac{v^2}{\rho}\end{cases}$$

注意：

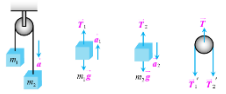
牛顿定律只适用于质点模型，只在惯性系中成立。可以证明，牛顿定律、动量定理和动量守恒定律、动能定理、功能原理和机械能守恒定律、角动量定理和角动量守恒定律等都只在惯性系中成立，并且牛顿定律只能在低速（不考虑相对论效应时）、宏观（不考虑量子效应时）的情况下适用。

Slide 11

4.1 例 题

例 题

一细绳跨过一轴承光滑的定滑轮，绳的两端分别悬有质量为 m_1 和 m_2 的物体($m_1<m_2$)，如图所示。设滑轮和绳的质量可忽略不计，绳不能伸长，试求物体的加速度以及悬挂滑轮的绳中张力。



Slide 12

4.1 例 题

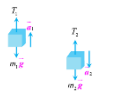
解 分别以 m_1、m_2 及滑轮为研究对象，其隔离体受力如上图所示。

对 m_1，它在绳子拉力 T_1 及重力 m_1g 的作用下以加速度 a_1 向上运动，取向上为正向，则有

$$T_1-m_1g=m_1a_1 \quad ①$$

对 m_2，它在绳子拉力 T_2 及重力 m_2g 的作用下以加速度 a_2 向下运动，取向下为正向，则有

$$m_2g-T_2=m_2a_2 \quad ②$$



由于定滑轮轴承光滑，滑轮和绳的质量可以略去，所以绳上各部分的张力都相等，又因为绳不能伸长，所以 m_1、m_2 的加速度大小相等，即有

$$T_1=T_2=T, \qquad a_1=a_2=a$$

Slide 13

4.1 例 题

解①和②两式，得

$$a=\frac{m_2-m_1}{m_1+m_2}g \qquad T=\frac{2m_1m_2}{m_1+m_2}g$$

由牛顿第三定律知：$T_1'=T_1=T$，$T_2'=T_2=T$，又考虑到定滑轮质量不计，所以有

$$T'=2T=\frac{4m_1m_2}{m_1+m_2}g$$

容易证明

$$T'<(m_1+m_2)g$$

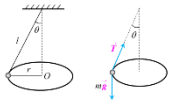
Slide 14

4.1 例 题

例 题

如图所示的圆锥摆，摆长为 l 的细绳一端固定在天花板上，另一端悬挂质量为 m 的小球，小球经推动后，在水平面内绕通过圆心 O 的竖直轴作角速率为 ω 的匀速率圆周运动。问绳和竖直方向所成的角度 θ 为多少？空气阻力不计。

解 小球受重力和绳的拉力的作用如图所示。



根据牛顿第二定律有

$$\vec{T}+m\vec{g}=m\vec{a} \quad ①$$

Slide 15

Clip Video

1. Newton's First Law micro-lesson video
2. Newton's Second Law micro-lesson video
3. Newton's Third Law micro-lesson video
4. Verification of Newton's Second Law experiment micro-lesson video

Evaluation 2:Task work for students (Individual)

This task is required to be completed after class and submitted to the teacher for grading:Students create a PPT to introduce the achievements of the great physicist Newton, for the teacher to grade, in order to judge the student's learning ability to achieve.

Item1. Learning ability - to evaluate whether the flipped classroom teaching model has improved the learning ability of students innovation ability in physics.

The criteria from item 1 : **Learning ability**

Standard 1: Physics self-directed learning awareness	
Standard 2: Physics study habits	
Standard 3: Learning outcomes	
Score Range	**Meaning**
13 - 15	Excellent
10 -12	Good
7 - 9	Moderate
4 - 6	Improved
Less than 4	Fail

Scoring Rubric Form (Objective 3)

Research Title: Development of Flipped Classroom Instructional Model to Improve Physical Innovative ability for Undergraduate Students

Research Objectives 3: Examining the Effectiveness of Flipped Classroom Teaching Models in Improving Undergraduate Physics Innovation Skills

Directions: Please assess the validity of the attached lesson plans regarding the given issues by putting ✓ in the box according to the following criteria.

+1 if you think the Item CORRESPONDS with the item of assessment
0 if you are NOT SURE the Item corresponds with the item of assessment
-1 if you think the Item DOES NOT correspond with the item of assessment

Scoring Criteria Sheet

Item	Score				
	5	4	3	2	1
	Perform all or nearly all of the following tasks well	Do almost all of the following tasks well	Complete most of the following tasks	Inability to complete most or many of the following tasks	Cannot complete any of the following tasks
1 Learning ability					
Standard 1: Physics self-directed learning awareness	Physical independent learning consciousness is very strong	Strong consciousness of independent learning of physics	The consciousness of independent learning in physics is general	The consciousness of independent learning of physics is weak	The consciousness of independent learning of physics is very weak
Standard 2: Physics study habits	Have a good physics preview, lectures, review habits	Physics preview, lectures, review habit is good	Physics preview, lectures, review habits are general	Poor habits of physics preview, listening to lectures and reviewing	Basically no physical preview, lectures, review habits
Standard 3: Learning outcomes	In physics knowledge, methods and other aspects of the harvest	In physics knowledge, methods and other aspects of high harvest	In physics knowledge, methods and other aspects of the general gain	Low gain in physical knowledge and methods	There is no gain in physical knowledge, methods, etc
2. Analytical ability					
Standard 1: Descriptions of physical phenomena	Objective and complete description of physical phenomena	The description of physical phenomena is more objective and complete	Basically objective and complete description of physical phenomena	The description of physical phenomena is not objective or complete	Completely unable to describe physical phenomena objectively and completely
Standard 2: Instructing physics experiments	Carry out physics experiment guidance comprehensively	The guidance of physics experiment is more comprehensive. Basically	it can guide the physical experiment	Poor guidance for conducting physical experiments	Can not guide the conduct of physics experiments
Standard 3: Preview physical results based on physical phenomena and experiments	It is very accurate to predict physical results based on physical phenomena and physical experiments	It is more accurate to predict physical results based on physical phenomena and physical experiments	The root predicts physical results based on physical phenomena and physical experiments	Poor prediction of physical results based on physical phenomena and physical experiments	Physical results cannot **score** be predicted from physical phenomena and physical experiments

(Continued)

Item	score				
	5	4	3	2	1
	Perform all or nearly all of the following tasks well	Do almost all of the following tasks well	Complete most of the following tasks	Inability to complete most or many of the following tasks	Cannot complete any of the following tasks
3. Comprehensive ability					
Standard 1: Physical phenomena explanation	Has a complete understandin g of physical phenomena	Have a complete understanding of physical phenomena	A complete understanding of physical phenomena	Poor understanding of physical phenomena	Unable to understand physical phenomena
Standard 2: Physical theory elaboration	The explanation of physical theory is very accurate	The physical theory is more accurate	Physical theory explains the general	Poor explanation of physical theory	Physical theory cannot be elaborated
Standard 3: Application of physical laws	The application of physical theorems is very comprehensi ve and concrete	The application of physical theorems is more comprehensive and specific	The application of physical laws is at an average level	Poor application of physical laws	The application of the laws of physics cannot be carried out
4. Imaginative ability					
Standard 1: The building of physical models	It can build perfect physical models based on physical processes	It can establish a better physical model according to the physical process	Can build physical models based on physical processes	Physical models based on physical processes are poor	It is not possible to build physical models based on physical processes
Standard 2: Thinking about physical patterns	The thinking on physical models is very sound	The thinking of physical model is more perfect	Consider the physical model in general	Poor thinking on physical models	Unable to think about physical models
Standard 3: New theories are derived from physical models	It is very accurate to deduce new physical theories from physical models	It is more accurate to deduce the new physical theory according to the physical model	New physical theories can be derived from physical models	It is not accurate enough to derive new physical theories from physical models	New physical theories cannot be derived from physical models

No.	Items	Rating results			Remarks
		+1	0	-1	
Learning ability					
1	**Standard 1: Physics self-directed learning awareness.** Clear learning goals, keep curiosity about physics, and learn physics with a positive attitude.				
2	**Standard 2: Physics study habits.** Have a good physics class preview, diligent study and good habits of timely review.				
3	**Standard 3: Learning outcomes.** Solid knowledge of physics, active participation in teaching practice, with a rigorous disciplinary attitude.				
Analytical ability					
4	**Standard 1: Descriptions of physical phenomena.** Students' descriptions of physical phenomena are objective and accurate.				
5	**Standard 2: Instructing physics experiments.** It can carry out physical experiments effectively and mistake physical laws from experiments.				
6	**Standard 3: Preview physical results based on physical phenomena and experiments.** It has good prediction function and can predict physical results according to physical phenomena and physical experiments.				

(Continued)

No.	Items	Rating results			Remarks
		+1	0	-1	
Comprehensive ability					
7	**Standard 1: Physical phenomena explanation.** Objective and accurate interpretation of physical phenomena.				
8	**Standard 2: Physical theory elaboration.** Can fully explain the physical theory in the appropriate language, and the physical point of view is correct.				
9	**Standard 3: Application of physical laws.** On the basis of correct understanding of physical theory, can flexibly use physical laws.				
Imaginative ability					
10	**Standard 1: The building of physical models.** Physical models can be built appropriately according to physical processes.				
11	**Standard 2: Thinking about physical patterns.** In combination with the actual situation, it can put forward constructive thinking on the established physical model.				
12	**Standard 3: New theories are derived from physical models.** New physical theories can be derived from physical models by means of translation or analogy.				

Criteria to evaluate **Learning ability**

Score Range	Grade
13 - 15	Excellent
10 -12	Good
7 - 9	Moderate
4 - 6	Improved
Less than 4	Fail

Criteria to evaluate **Analytical ability**

Score Range	Meaning
13 - 15	Excellent
10 -12	Good
7 - 9	Moderate
4 - 6	Improved
Less than 4	Fail

Criteria to evaluate **Comprehensive ability**

Score Range	Meaning
13 - 15	Excellent
10 -12	Good
7 - 9	Moderate
4 - 6	Improved
Less than 4	Fail

Criteria to evaluate **Imaginative ability**

Score Range	Meaning
13 - 15	Excellent
10 -12	Good
7 - 9	Moderate
4 - 6	Improved
Less than 4	Fail

Criteria to evaluate Creativity overall

Score Range	Meaning
49 - 60	Excellent
37 - 48	Good
25 - 36	Moderate
13- 24	Improved
Less than 13	Fail

Suggestions

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Appendix D

The Results of the Quality Analysis of Research Instruments

- IOC Questionnaire for Students
- IOC Interview for Teachers
- IOC Handout
- IOC for confirm the quality of Instructional Model
- IOC for Validity of the Instructional Model
- IOC Lesson Plan
- IOC Valid of Rubric

Assessment form for Validity of Factor Analysis Questionnaire

Research Title: Development of Flipped Classroom Instructional Model to Improve Physical Innovative ability for Undergraduate Students

Research Objectives: To examine the factors affecting Physical Innovative Ability of undergraduate students.

Directions: Please assess the congruence between factors and questions by putting☐ in the box according to the following criteria.

+ 1 if you think the question CAN measure the factor given

0 if you are NOT SURE the question can measure the factor given

- 1 if you think the question CANNOT measure the factor given

Item	Contents	Specialists' rating					Total	Mean	Results
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5			
Part 1	**Common data of the respondent**								
No.1	Gender ☐ A. Male ☐ B. Female	+1	+1	+1	+1	+1	5	1.00	Valid
No.2	From 3 colleges in Hechi university. ☐ A. Major Journalism from Mathematics and Physics School ☐ B. Major Mathematics from Chemistry and Biology School ☐ C. Major Tourism management from Big Data School	+1	+1	+1	+1	+1	5	1.00	Valid
No.3	Age ☐ A. below 18 yrs. ☐ B. 18-20 yrs. ☐ C. 21-23 yrs. ☐ D. over 23 yrs.	+1	+1	+1	+1	+1	5	1.00	Valid
Part 2	**Internal factors (respondents)**								
No.1	Students know that Physics course is an important compulsory course for students	+1	+1	+1	+1	+1	5	1.00	Valid
No.2	Students feel that Physics course is the great significance to personal's Physical Innovative ability .	+1	+1	+1	+1	+1	5	1.00	Valid

(Continued)

Item	Contents	Specialists' rating					Total	Mean	Results
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5			
No.3	Students believe that the good technique in teaching to improve Physical Innovative ability in Physics course.	+1	+1	+1	+1	+1	5	1.00	Valid
No.4	Students believe that materials and learning resources to improve Physical Innovative ability in Physics course.	+1	+1	+1	+1	+1	5	1.00	Valid
No.5	Students are industrious in their learning (Assignments, Projects, Participation, etc.) with the highest potential themselves.	+1	+1	+1	+1	+1	5	1.00	Valid
No.6	Students feel that homework projects to give full play to own strengths in Physics course.	+1	+1	+1	+1	+1	5	1.00	Valid
No.7	Students feel that Physics course is the great significance to personal growth and development in future.	+1	+1	+1	+1	+1	5	1.00	Valid
No.8	Students feel that the assignments assigned by the lecturers and the feedback can help students better apply what they have learned.	+1	+1	+1	+1	+1	5	1.00	Valid

(Continued)

Item	Contents	Specialists' rating					Total	Mean	Results
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5			
No.9	Students can master Physical Innovative ability by Flipped Classroom Instructional process in Physics course.	+1	+1	+1	+1	+1	5	1.00	Valid
No.10	Students are satisfied with the friendly cooperation and interaction between students and teachers or peers in the Physics course.	+1	+1	+1	+1	+1	5	1.00	Valid
No.11	Students feel that homework or project work assigned by lecturers and students can help students better apply the knowledge they have learned.	+1	+1	+1	+1	+1	5	1.00	Valid
No.12	Students feel that the evaluation project work assigned by lecturers and students can help students better apply the knowledge they have learned.	+1	+1	+1	+1	+1	5	1.00	Valid
No.13	Students have new ideas based on their responses to learning about Physical Innovative ability in Physics course.	+1	+1	+1	+1	+1	5	1.00	Valid
No.14	Students learn through Flipped Classroom Instructional to enhance their Physical Innovative ability.	+1	+1	+1	+1	+1	5	1.00	Valid

(Continued)

Item	Contents	Specialists' rating					Total	Mean	Results
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5			
No.15	Students can develop their sense of accomplishment and pride through different activities in Physics course.	+1	+1	+1	+1	+1	5	1.00	Valid
	External factors (lecturers, materialand circumstance)								
No.16	The lecturer uses modern teaching methods Physics course (such as mobile phones, computers, APP platforms effectively, demonstrations, exploration, etc.) to stimulate students' interest in Physical Innovative ability.	+1	+1	+1	+1	+1	5	1.00	Valid
No.17	The lecturer combines traditional classroom evaluation methods with various modern intelligent online evaluation systems.	+1	+1	+1	+1	+1	5	1.00	Valid
No.18	The lecturer can guide students to realize that the learning of Physics course and Physical Innovative ability has a positive impact on their future development.	+1	+1	+1	+1	+1	5	1.00	Valid
No.19	The lecturer pays more attention to students' ability to apply Physical Innovative ability and its impact in Physics course.	+1	+1	+1	+1	+1	5	1.00	Valid

(Continued)

Item	Contents	Specialists' rating					Total	Mean	Results
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5			
No.20	The lecturer chooses appropriate teaching methods according to the characteristics of Physics course and the tasks and goals of Physical Innovative ability.	+1	+1	+1	+1	+1	5	1.00	Valid
No.21	The lecturer combines the teaching method he teaches objectives, the knowledge and Flipped Classroom Instructional Model in Physics course to enhance undergraduate students'Physical Innovative ability.	+1	+1	+1	+1	+1	5	1.00	Valid
No.22	The lecturer can stimulate students' interest and meet the contemporary needs of students, such as the Physics competition.	+1	+1	+1	+1	+1	5	1.00	Valid
No.23	The lecturer chooses suitable materials and emerging network resources.	+1	+1	+1	+1	+1	5	1.00	Valid
No 24	The textbook fully considers the content and objectives of Physics courses and Physical Innovative ability training.	+1	+1	+1	+1	+1	5	1.00	Valid
No.25	The materials can fully support students' learning in Physics courses and Physical Innovative ability training.	+1	+1	+1	+1	+1	5	1.00	Valid

(Continued)

Item	Contents	Specialists' rating					Total	Mean	Results
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5			
No.26	The materials can fully support students' learning in Physics courses and Physical Innovative ability training.	+1	+1	+1	+1	+1	5	1.00	Valid
No.27	The materials and environment can enhance undergraduate students'Physical Innovative ability.	+1	+1	+1	+1	+1	5	1.00	Valid
No.28	The availability of learning spaces and the project based learning can affect students interest in Physics courses.	+1	+1	+1	+1	+1	5	1.00	Valid
No.29	Provides a teaching mode with a stable high-speed network anytime, anywhere on campus as a teaching guarantee, and supports project based Flipped Classroom Instructional Model to enhance undergraduate students'Physical Innovative ability.	+1	+1	+1	+1	+1	5	1.00	Valid
No.30	The environments is clean and bright, with desks and chairs, blackboards, podiums, computers, projectors, large screens, loudspeakers and other multimedia facilities to facilitate the teaching process.	+1	+1	+1	+1	+1	5	1.00	Valid

Suggestions.....

Assessment form for Validity of Factor Analysis of Interview paper

Research Title: Development of Flipped Classroom Instructional Model to Improve Physical Innovative ability for Undergraduate Students

Research Objectives: To develop Flipped Classroom Instructional model to enhance Physical Innovative ability of undergraduate students.

Directions: Please assess the congruence between factors and questions by putting □ in the box according to the following criteria.

+ 1 if you think the question CAN measure the questions given.
0 if you are NOT SURE the question can measure the questions given.
- 1 if you think the question CANNOT measure the f questions given

Item	Contents	Specialists' rating					Total	Mean	Results
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5			
Part 1	**Common data of the respondent**								
No. 1	Gender ☐ A Male ☐ B Female	+1	+1	+1	+1	+1	5	1.00	Valid
No. 2	The lecturers who are teaching Physics course from 3 colleges in Hechi university ☐ A. Lecturer from Literature and media School ☐ B. Lecturer from Mathematics and Science School ☐ C. Lecturer from Lecturer from Tourism management School	+1	+1	+1	+1	+1	5	1.00	Valid
No. 3	Experience teaching ☐ A. below 3 yrs. ☐ B. 3-6 yrs. ☐ C.7- 9 yrs . ☐ D. over 9 yrs.	+1	+1	+1	+1	+1	5	1.00	Valid
No. 4	Age ☐ A. below 25 yrs . ☐ C. 36-50 yrs. ☐ B. 25-35 yrs. ☐ D. over 50 yrs.	+1	+1	+1	+1	+1	5	1.00	Valid
Part 2	**Questions**								
No. 1	Why do you accept or select to teach this subject? (Example, prefer to teach, be expert in the content, be requested, or other reasons.)	+1	+1	+1	+1	+1	5	1.00	Valid

(Continued)

Item	Contents	Specialists' rating					Total	Mean	Results
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5			
No.2	How do you prepare to teach this subject? (Preparing contents, materials, teaching location,	+1	+1	+1	+1	+1	5	1.00	Valid
No.3	For the first time in your teaching, how do you prepare subject orientation to educate students about the teaching system, measuring, and assessment?	+1	+1	+1	+1	+1	5	1.00	Valid
No.4	Do you always implement teaching according to your teaching plan? Do you think your teaching plan can effectively enhance students' Physical Innovative ability? Do you often think about how to improve teaching?	+1	+1	+1	+1	+1	5	1.00	Valid
No.5	How do you give the opportunity for students to participate in the teaching? (Please clarify the methodology.)	+1	+1	+1	+1	+1	5	1.00	Valid
No.6	How many methodologies for students' measurement and assessment, and do you think your measurement and assessment course can reflect students' learning effect and knowledge level?	+1	+1	+1	+1	+1	5	1.00	Valid

(Continued)

Item	Contents	Specialists' rating					Total	Mean	Results
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5			
No.7	What Learning Tasks do you carry out to improve students' learning enthusiasm?	+1	+1	+1	+1	+1	5	1.00	Valid
No.8	Do you provide the time for students after their regular class? If yes, how do you help students solve their difficulties?	+1	+1	+1	+1	+1	5	1.00	Valid
No.9	Which aspects of your teaching need to be improved, or which aspects do you want the school to support you?	+1	+1	+1	+1	+1	5	1.00	Valid
No.10	Previously, what problems do you meet in your teaching, and how do you find the solution?	+1	+1	+1	+1	+1	5	1.00	Valid

Suggestions..... .....

Evaluation Result of IOC for Handout

No.	Questions	Experts' rating					Total	Mean	Results
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5			
1	**Principle and Rationale:**								
	Utility Standard								
	1. The result of questionaire from students have the benefit for Principle and Rationale	+1	+1	+1	+1	+1	5	1.00	Valid
	2. The result of interview from teachers have the benefit for Principle and Rationale	+1	+1	+1	+1	+1	5	1.00	Valid
	Feasibility Standard								
	3. The result of questionaire from students have the possibility for Principle and Rationale	+1	+1	+1	+1	+1	5	1.00	Valid
	4. The result of interview from lecturers have the possibility for Principle and Rationale	+1	+1	+1	+1	+1	5	1.00	Valid
	Propriety Standard								
	5. The result of questionaire from students have the suitability for Principle and Rationale	+1	+1	+1	+1	+1	5	1.00	Valid
	6. The result of interview from lecturers have the suitability for Principle and Rationale	+1	+1	+1	+1	+1	5	1.00	Valid
	Accuracy Standard								
	7. The result of questionaire from students have the accuracy for Principle and Rationale	+1	+1	+1	+1	+1	5	1.00	Valid

(Continued)

	Questions	Experts' rating					Total	Mean	Results
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5			
	8. The result of interview from lecturers have the accuracy for Principle and Rationale	+1	+1	+1	+1	+1	5	1.00	Valid
2	**Objectives:**								
	Utility Standard								
	9. The objectives have benefit for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	Feasibility Standard								
	10. The objectives have possibility for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	Propriety Standard								
	11. The objectives have suitability for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	Accuracy Standard								
	12. The objectives have accuracy for students.	+1	+1	+1	+1	+1	5	1.00	Valid
3	**Contents:**								
	Utility Standard								
	13.The contents have benefit for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	Feasibility Standard								
	14. The contents have possibility for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	Propriety Standard								
	15. The contents have suitability for students.	+1	+1	+1	+1	+1	5	1.00	Valid

(Continued)

	Questions	Experts' rating					Total	Mean	Results
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5			
	Accuracy Standard								
	16. The contents have accuracy for students.	+1	+1	+1	+1	+1	5	1.00	Valid
4	**Methods of teaching & materials:**								
	Utility Standard								
	17. The methods of teaching & materials have benefit for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	Feasibility Standard								
	18. The methods of teaching & materials have possibility for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	Propriety Standard								
	19. The methods of teaching & materials have suitability for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	Accuracy Standard								
	20. The methods of teaching & materials have accuracy for students.	+1	+1	+1	+1	+1	5	1.00	Valid
5	**Evaluation:**								
	Utility Standard								
	21.The evaluation has benefit for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	Feasibility Standard								
	22. The evaluation has possibility for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	Propriety Standard								
	23. The evaluation has suitability for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	Accuracy Standard								
	24. The evaluation has accuracy for students.	+1	+1	+1	+1	+1	5	1.00	Valid

Assessment of confirm the quality of Flipped Classroom Instructional Model

Direction: Assessment of confirm the quality of instructional model

Please answer all questions by making ✓ in the answer box that corresponds to your opinion or the truth using the following criteria.

+1 if you think the issues CAN measure the appropriateness of the instructional model

0 if you are NOT SURE the issues can measure the appropriateness of the instructional model

-1 if you think the issues CANNOT measure the appropriateness of the instructional model

No.	Questions	Experts' rating					Total	Mean	Results
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5			
1	**Utility Standard** 1. The result of questionaire from students have the benefit for Principle and Rationale	+1	+1	+1	+1	+1	5	1.00	Valid
	2. The result of interview from lecturers have the benefit for Principle and Rationale	+1	+1	+1	+1	+1	5	1.00	Valid
	3. The objectives have benefit for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	4.The contents have benefit for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	5. The methods of teaching & materials have benefit for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	6.The evaluation has benefit for students.	+1	+1	+1	+1	+1	5	1.00	Valid
2	**Feasibility Standard** 1. The result of questionaire from students have the possibility for Principle and Rationale	+1	+1	+1	+1	+1	5	1.00	Valid
	2. The result of interview from lecturers have the possibility for Principle and Rationale	+1	+1	+1	+1	+1	5	1.00	Valid
	3. The objectives have possibility for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	4. The contents have possibility for students.	+1	+1	+1	+1	+1	5	1.00	Valid

(Continued)

No.	Questions	Experts' rating					Total	Mean	Results
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5			
	5. The methods of teaching & materials have possibility for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	6. The evaluation has possibility for students.	+1	+1	+1	+1	+1	5	1.00	Valid
3	**Propriety Standard** 1. The result of questionaire from students have the suitability for Principle and Rationale	+1	+1	+1	+1	+1	5	1.00	Valid
	2. The result of interview from lecturers have the suitability for Principle and Rationale	+1	+1	+1	+1	+1	5	1.00	Valid
	3. The objectives have suitability for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	4. The contents have suitability for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	5. The methods of teaching & materials have suitability for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	6. The evaluation has suitability for students.	+1	+1	+1	+1	+1	5	1.00	Valid
4	**Accuracy Standard** 1. The result of questionaire from students have the accuracy for Principle and Rationale	+1	+1	+1	+1	+1	5	1.00	Valid
	2. The result of interview from lecturers have the accuracy for Principle and Rationale	+1	+1	+1	+1	+1	5	1.00	Valid

(Continued)

No.	Questions	Experts' rating					Total	Mean	Results
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5			
	3. The objectives have accuracy for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	4. The contents have accuracy for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	5. The methods of teaching & materials have accuracy for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	6. The evaluation has accuracy for students.	+1	+1	+1	+1	+1	5	1.00	Valid

Suggestion

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Assessment form IOC for Validity of Instructional Model Questionnaire

Research Title: Development of Flipped Classroom Instructional Model to Improve Physical Innovative ability for Undergraduate Students

Research Objectives 2: Developing a flipped classroom teaching model to improve undergraduate physics innovation.

Directions: Please assess the congruence between components of flipped classroom teaching model by putting ✓ in the box according to the following criteria.

+1 if you think the issues CAN measure the appropriateness of the instructional model
0 if you are NOT SURE the issues can measure the appropriateness of the instructional model
-1 if you think the issues CANNOT measure the appropriateness of the instructional model

No.	Questions	Experts' rating					Total	Mean	Results
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5			
1	**Principle and Rationale:**								
	Utility Standard								
	1. The result of questionaire from students have the benefit for Principle and Rationale	+1	+1	+1	+1	+1	5	1.00	Valid
	2. The result of interview from lecturers have the benefit for Principle and Rationale	+1	+1	+1	+1	+1	5	1.00	Valid
	Feasibility Standard								
	3. The result of questionaire from students have the possibility for Principle and Rationale	+1	+1	+1	+1	+1	5	1.00	Valid
	4. The result of interview from lecturers have the possibility for Principle and Rationale	+1	+1	+1	+1	+1	5	1.00	Valid
	Propriety Standard								
	5. The result of questionaire from students have the suitability for Principle and Rationale	+1	+1	+1	+1	+1	5	1.00	Valid
	6. The result of interview from lecturers have the suitability for Principle and Rationale	+1	+1	+1	+1	+1	5	1.00	Valid
	Accuracy Standard								
	7. The result of questionaire from students have the accuracy for Principle and Rationale	+1	+1	+1	+1	+1	5	1.00	Valid
	8. The result of interview from lecturers have the accuracy for Principle and Rationale	+1	+1	+1	+1	+1	5	1.00	Valid

(Continued)

No.	Questions	Experts' rating					Total	Mean	Results
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5			
2	**Objectives:**								
	Utility Standard								
	9. The objectives have benefit for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	Feasibility Standard								
	10. The objectives have possibility for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	Propriety Standard								
	11. The objectives have suitability for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	Accuracy Standard								
	12. The objectives have accuracy for students.	+1	+1	+1	+1	+1	5	1.00	Valid
3	**Contents:**								
	Utility Standard								
	13.The contents have benefit for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	Feasibility Standard								
	14. The contents have possibility for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	Propriety Standard								
	15. The contents have suitability for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	Accuracy Standard								
	16. The contents have accuracy for students.	+1	+1	+1	+1	+1	5	1.00	Valid
4	**Methods of teaching & materials:** Flipped Classroom Instructional Model								

(Continued)

No.	Questions	Experts' rating					Total	Mean	Results
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5			
	Utility Standard								
	17. The methods of teaching & materials have benefit for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	Feasibility Standard								
	18. The methods of teaching & materials have possibility for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	Propriety Standard								
	19. The methods of teaching & materials have suitability for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	Accuracy Standard								
	20. The methods of teaching & materials have accuracy for students.	+1	+1	+1	+1	+1	5	1.00	Valid
5	**Evaluation:**								
	Utility Standard								
	21.The evaluation has benefit for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	Feasibility Standard								
	22. The evaluation has possibility for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	Propriety Standard								
	23. The evaluation has suitability for students.	+1	+1	+1	+1	+1	5	1.00	Valid
	Accuracy Standard								
	24. The evaluation has accuracy for students.	+1	+1	+1	+1	+1	5	1.00	Valid

Assessment form for Validity of Lesson Plan

Research Title: Development of Flipped Classroom Instructional Model to Improve Physical Innovative ability for Undergraduate Students

Research Objectives 3: Examining the Effectiveness of Flipped Classroom Teaching Models in Improving Undergraduate Physics Innovation Skills

Directions: Please assess the validity of the attached lesson plans regarding the given issues by putting ✓ in the box according to the following criteria.

+1 if you think the lesson plan CORRESPONDS with the item of assessment

0 if you are NOT SURE the lesson plan corresponds with the item of assessment

-1 if you think the lesson plan DOES NOT correspond with the item of assessment

No.	Items	Experts' rating					Total	Mean	Results
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5			
1	**Learning Objective** Complying with content of the course	+1	+1	+1	+1	+1	5	1.00	Valid
2	Covering knowledge, process, and attitude	+1	+1	+1	+1	+1	5	1.00	Valid
3	Being measurable in knowledge, process, and attitude	+1	+1	+1	+1	+1	5	1.00	Valid
4	**Contents** Complying with learning objective	+1	+1	+1	+1	+1	5	1.00	Valid
5	Being appropriate in terms of time management	+1	+1	+1	+1	+1	5	1.00	Valid
6	**Flipped Classroom Teaching Models** Complying with the designed instructional model	+1	+1	+1	+1	+1	5	1.00	Valid
7	Supporting students' learning	+1	+1	+1	+1	+1	5	1.00	Valid
8	Including various activities	+1	+1	+1	+1	+1	5	1.00	Valid
9	**Learning materials** Complying with the learning objectives	+1	+1	+1	+1	+1	5	1.00	Valid
10	Complying with the contents	+1	+1	+1	+1	+1	5	1.00	Valid
11	**Evaluation and Assessment** Complying with the learning objectives	+1	+1	+1	+1	+1	5	1.00	Valid
12	Including various methods and instruments	+1	+1	+1	+1	+1	5	1.00	Valid

Suggestions

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Undergraduate Physics Creativity Validity Assessment Form

Research Title: Development of Flipped Classroom Instructional Model to Improve Physical Innovative ability for Undergraduate Students

Research Objectives: 3. Examining the Effectiveness of Flipped Classroom Teaching Models in Improving Undergraduate Physics Innovation Skills

Assessor: Assistant Professor Dr. Sarayut Sethakajorn
Position : Administration Program
Workplace : Bansomdejchaopraya Rajabhat University

Directions: Please assess the validity of the attached lesson plans regarding the given issues by putting ✓ in the box according to the following criteria.

+1 if you think the Item CORRESPONDS with the item of assessment
0 if you are NOT SURE the Item corresponds with the item of assessment
-1 if you think the Item DOES NOT correspond with the item of assessment

Item	Score				
	5	4	3	2	1
	Perform all or nearly all of the following tasks well	Do almost all of the following tasks well	Complete most of the following tasks	Inability to complete most or many of the following tasks	Cannot complete any of the following tasks
1 Learning ability					
Standard 1: Physics self-directed learning awareness	Physical independent learning consciousness is very strong	Strong consciousness of independent learning of physics	The consciousness of independent learning in physics is general	The consciousness of independent learning of physics is weak	The consciousness of independent learning of physics is very weak
Standard 2: Physics study habits	Have a good physics preview, lectures, review habits	Physics preview, lectures, review habit is good	Physics preview, lectures, review habits are general	Poor habits of physics preview, listening to lectures and reviewing	Basically no physical preview, lectures, review habits
Standard 3: Learning outcomes	In physics knowledge, methods and other aspects of the harvest	In physics knowledge, methods and other aspects of high harvest	In physics knowledge, methods and other aspects of the general gain	Low gain in physical knowledge and methods	There is no gain in physical knowledge, methods, etc
2. Analytical ability					
Standard 1: Descriptions of physical phenomena	Objective and complete description of physical phenomena	The description of physical phenomena is more objective and complete	Basically objective and complete description of physical phenomena	The description of physical phenomena is not objective or complete	Completely unable to describe physical phenomena objectively and completely
Standard 2: Instructing physics experiments	Carry out physics experiment guidance comprehensivel y	The guidance of physics experiment is more comprehensive. Basically	it can guide the physical experiment	Poor guidance for conducting physical experiments	Can not guide the conduct of physics experiments
Standard 3: Preview physical results based on physical phenomena and experiments	It is very accurate to predict physical results based on physical phenomena and physical experiments	It is more accurate to predict physical results based on physical phenomena and physical experiments	The root predicts physical results based on physical phenomena and physical experiments	Poor prediction of physical results based on physical phenomena and physical experiments	Physical results cannot **score** be predicted from physical phenomena and physical experiments

(Continued)

Item	Score				
	5	4	3	2	1
	Perform all or nearly all of the following tasks well	Do almost all of the following tasks well	Complete most of the following tasks	Inability to complete most or many of the following tasks	Cannot complete any of the following tasks
3. Comprehensive ability					
Standard 1: Physical phenomena explanation	Has a complete understanding of physical phenomena	Have a complete understanding of physical phenomena	A complete understanding of physical phenomena	Poor understanding of physical phenomena	Unable to understand physical phenomena
Standard 2: Physical theory elaboration	The explanation of physical theory is very accurate	The physical theory is more accurate	Physical theory explains the general	Poor explanation of physical theory	Physical theory cannot be elaborated
Standard 3: Application of physical laws	The application of physical theorems is very comprehensive and concrete	The application of physical theorems is more comprehensive and specific	The application of physical laws is at an average level	Poor application of physical laws	The application of the laws of physics cannot be carried out
4. Imaginative ability					
Standard 1: The building of physical models	It can build perfect physical models based on physical processes	It can establish a better physical model according to the physical process	Can build physical models based on physical processes	Physical models based on physical processes are poor	It is not possible to build physical models based on physical processes
Standard 2: Thinking about physical patterns	The thinking on physical models is very sound	The thinking of physical model is more perfect	Consider the physical model in general	Poor thinking on physical models	Unable to think about physical models
Standard 3: New theories are derived from physical models	It is very accurate to deduce new physical theories from physical models	It is more accurate to deduce the new physical theory according to the physical model	New physical theories can be derived from physical models	It is not accurate enough to derive new physical theories from physical models	New physical theories cannot be derived from physical models

No.	Items	Experts' rating					Total	Mean	Results
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5			
Learning ability									
1	**Standard 1: Physics self-directed learning awareness.** Clear learning goals, keep curiosity about physics, and learn physics with a positive attitude.	+1	+1	+1	+1	+1	5	1.00	Valid
2	**Standard 2: Physics study habits.** Have a good physics class preview, diligent study and good habits of timely review.	+1	+1	+1	+1	+1	5	1.00	Valid
3	**Standard 3: Learning outcomes.** Solid knowledge of physics, active participation in teaching practice, with a rigorous disciplinary attitude.	+1	+1	+1	+1	+1	5	1.00	Valid
Analytical ability									
4	**Standard 1: Descriptions of physical phenomena.** Students' descriptions of physical phenomena are objective and accurate.	+1	+1	+1	+1	+1	5	1.00	Valid
5	**Standard 2: Instructing physics experiments.** It can carry out physical experiments effectively and mistake physical laws from experiments.	+1	+1	+1	+1	+1	5	1.00	Valid

(Continued)

No.	Items	Experts' rating					Total	Mean	Results
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5			
6	**Standard 3: Preview physical results based on physical phenomena and experiments.** It has good prediction function and can predict physical results according to physical phenomena and physical experiments.	+1	+1	+1	+1	+1	5	1.00	Valid
Comprehensive ability									
7	**Standard 1: Physical phenomena explanation.** Objective and accurate interpretation of physical phenomena.	+1	+1	+1	+1	+1	5	1.00	Valid
8	**Standard 2: Physical theory elaboration.** Can fully explain the physical theory in the appropriate language, and the physical point of view is correct.	+1	+1	+1	+1	+1	5	1.00	Valid
9	**Standard 3: Application of physical laws.** On the basis of correct understanding of physical theory, can flexibly use physical laws.	+1	+1	+1	+1	+1	5	1.00	Valid
Imaginative ability									

(Continued)

No.	Items	Experts' rating					Total	Mean	Results
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5			
10	**Standard 1: The building of physical models.** Physical models can be built appropriately according to physical processes.	+1	+1	+1	+1	+1	5	1.00	Valid
11	**Standard 2: Thinking about physical patterns.** In combination with the actual situation, it can put forward constructive thinking on the established physical model.	+1	+1	+1	+1	+1	5	1.00	Valid
12	**Standard 3: New theories are derived from physical models.** New physical theories can be derived from physical models by means of translation or analogy.	+1	+1	+1	+1	+1	5	1.00	Valid

Criteria to evaluate **Learning ability**

Score Range	Grade
13 - 15	Excellent
10 -12	Good
7 - 9	Moderate
4 - 6	Improved
Less than 4	Fail

Criteria to evaluate **Analytical ability**

Score Range	Meaning
13 - 15	Excellent
10 -12	Good
7 - 9	Moderate
4 - 6	Improved
Less than 4	Fail

Criteria to evaluate **Comprehensive ability**

Score Range	**Meaning**
13 - 15	Excellent
10 -12	Good
7 - 9	Moderate
4 - 6	Improved
Less than 4	Fail

Criteria to evaluate **Imaginative ability**

Score Range	**Meaning**
13 - 15	Excellent
10 -12	Good
7 - 9	Moderate
4 - 6	Improved
Less than 4	Fail

Criteria to evaluate Creativity overall

Score Range	**Meaning**
49 - 60	Excellent
37 - 48	Good
25 - 36	Moderate
13- 24	Improved
Less than 13	Fail

Suggestions..... ..

Appendix E

Certificate of English

BANSOMDEJCHAOPRAYA
RAJABHAT UNIVERSITY

This is to certify that

Mr. Zhong Youkun

Achieved BSRU English Proficiency Test (BSRU-TEP) level

C2

Given on 22nd August 2021

(Assistant Professor Dr Kulsirin Aphiratvoradej)
Director

English Language Proficiency Level Descriptors: Common European Framework of Reference for Languages (CEFR)

A1
- Can understand and use familiar everyday expressions and very basic phrases aimed at the satisfaction needs of a concrete type.
- Can introduce him/her and others and can ask and answer questions about personal details such as where he/she lives, people he/she knows and things he/she has.
- Can interact in a simple way provided the other person talks slowly and clearly and is prepared to help.

A2
- Can understand sentences and frequently used expressions related to areas of most immediate relevant (e.g. very basic personal and family information, shopping, local geography, employment).
- Can communicate in simple and routine tasks requiring a simple and direct exchange of information on familiar and routine matters.
- Can describe in simple terms aspects of his/her background, immediate environment and matters in care of immediate need.

B1
- Can understand the main points of clear standard input on familiar matters regularly encountered in school, leisure, etc.
- Can deal with most situations likely to arise while travelling in an area where the language is spoken.
- Can produce simple connected text on topics that are familiar or of personal interest.
- Can describe experiences and events, dreams, hopes and ambitions and briefly give reasons and explanations for opinions and plans.

B2
- Can understand the main ideas of complex text on both concrete and abstract topics, including technical discussions in his/her field of specialization.
- Can interact with a degree of fluency and spontaneity that makes regular interaction with native speaks quite possible without strain for either party.
- Can produce clear, detailed text on a wide range of subjects and explain a viewpoint on a topical issue giving the advantages and disadvantages of various options.

C1
- Can understand a wide range of demanding, longer texts, and recognise implicit meaning.
- Can express ideas fluently and spontaneously without much obvious searching for expressions.
- Can use language flexibly and effectively for social, academic and professional purposes.
- Can produce clear, well-structured, detailed text on complex subjects, showing controlled use of organizational patterns, connectors and cohesive devices.

C2
- Can understand with ease virtually everything heard or read.
- Can summarize information from different spoken and written sources, reconstructing arguments and accounts in a coherent presentation.
- Can express him/herself spontaneously, very fluently and precisely, differentiating finer shades of mean even in the most complex situations.

Source: Common European Framework of Reference for Languages: Learning, teaching, assessment (www.coe.int)

BSRU-TEP Criteria

CEFR Level	BSRU-TEP
A1	1 - 20
A2	21 - 40
B1	41 - 60
B2	61 - 80
C1	81 - 100
C2	101 - 120

No. .....

Office of International Affairs and
ASEAN Network

Appendix F

The Document for Acceptance Research

MHESI 8038.1/32

Mcu Ubonratchathani journal of Buddhist Studies (TCI.2)
Mahachulalongkornrajavidyalaya University, Ubon Ratchathani Campus

RESPONSE FOR PUBLICATION OF THE ARTICLE

15th September 2023

The Editorial Department of Mcu Ubonratchathani journal of Buddhist Studies (TCI.2) MCU, Ubon Ratchathani Campus has considered the article

Title	DEVELOPMENT OF FLIPPED CLASSROOM INSTRUCTIONAL MODEL TO IMPROVE PHYSICAL INNOVATIVE ABILITY FOR UNDERGRADUATE STUDENTS
Writer	Zhong Youkun, Nuttamon Punchatree, Areewan Iamsa-ard and Suriya Phankosol
Publication Approval	Mcu Ubonratchathani journal of Buddhist studies (ISSN : 2774-0463 (Online)) Mahachulalongkornrajavidyalaya University, Ubon Ratchathani Campus
Period of Publication	5th Year, Volume III (September-December, 2023)

Your article has been sent to 3 experts for peer review and found that its quality is at a "**Good**" level and academically useful.

Please be informed accordingly.

(Assoc.Prof. Dr.Phrakhruwutthidhampandit)
Editor of Mcu Ubonratchathani journal of Buddhist studies (TCI)
Mahachulalongkornrajavidyalaya University,
Ubon Ratchathani Campus

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