DEVELOPMENT OF PROBLEM-BASED LEARNING INSTRUCTIONAL MODEL TO ENHANCE CRITICAL THINKING ABILITY OF UNDERGRADUATE STUDENTS

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Thesis Title Development of Problem-Based Learning Instructional Model to Enhance Critical Thinking Ability of Undergraduate Students

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ABSTRACT

The objectives of this research were to 1) examine the factors affecting critical thinking ability of undergraduate students, 2) develop problem-based learning instructional model to enhance critical thinking ability of undergraduate students and 3) study the results of problem-based learning instructional model to enhance critical thinking ability of undergraduate students. Three phases were conducted to answer research objectives 1, 2, and 3. The population of Phase 1 was 150 students who enrolled in College Students' Career Guidance course in semester 2 academic year 2023, and 3 lecturers who taught College Students' Career Guidance course from Guangxi University of Finance and Economics, Baise University and Guangxi Minzu University. Three experts were purposively obtained to confirm the conformity of the problem-based learning instructional model in Phase 2, and the sample groups in Phase 3 were 50 students who enrolled in College Students' Career Guidance course in semester 1 academic year 2024. The research instruments were 1) a set of questionnaire for students and the interview for lecturers 2) a set of conformity assessment form for confirming instructional model 3) lesson plans using problem-based learning instructional model and 4) scoring rubric form for critical thinking ability. Data were statistically analyzed by percentage, mean, standard deviation.

The research results were as follows:

1. There were 2 factors affecting critical thinking ability of undergraduate students included internal factors and external factors from the students and the lecturers. The internal factors involved psychology or physiology, attitude, knowledge

or skills. As for external factors referred to method of teaching, teaching materials, and teaching environment.

2. Problem-based learning instructional model to enhance critical thinking ability of undergraduate students was 100% as assessed by 3 experts conformed to utility, feasibility, propriety, and accuracy standards. The model developed by 5 components: 1) Principle and rationale, study the course and students' critical thinking ability and take the result from objective 1 to do model, 2) Objectives, take from objective 2 in research, 3) Contents, take from the structure of course to experiment, 4) Method of teaching & materials, take from the steps to teach by problem-based learning instructional model and 5) Evaluation, by scoring rubric form to undergraduate students' critical thinking ability.

3. After the experiment, it was found that 18% of 50 students were at excellent, 74% of 50 students were at good level in critical thinking ability and another 8% were at a medium level. The result is consistent with the research hypothesis that 80% upwards of the participants would have critical thinking ability at a good level after learning through problem-based learning instructional model.

Keywords: Problem-Based Learning Instructional Model, Critical Thinking Ability, Undergraduate Students

Acknowledgment

Time is like a hasty traveler, always rushing to faraway places without stopping. In the blink of an eye, my doctoral study career is coming to an end. Looking back on these three years of study, I see joy, tears, regret, disappointment, but more gratitude and reluctance.

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Everything in the past is a prologue. Looking back to the past, there is no rain or shine. Take the road ahead, think about it, and cherish it!

Chen Qifeng

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Introduction

Rationale

College Students' Career Guidance course for college students is a course designed to help students master the basic knowledge and skills of job search. In the school's curriculum system, College Student Career Guidance course is a public basic compulsory course for all students. The starting point of the course design is to help students reasonably position their career goals, write professional resumes and cover letters, effectively prepare for and respond to interviews, improve students' critical thinking ability, which lays a good foundation for future career development. In learning process, teachers give full play to the students' subjective position, give students time to explore the career world, master job search skills, and improve their practical problem-solving abilities (Guangxi University of Finance and Economics, 2024).

Critical thinking is one of the necessary abilities for talents in the twenty-first century. In today's era of rapid information development, the practice of simply copying past experiences without innovation is far from being able to adapt to the fast-changing social development (Zhan, 2021; Aycicek, 2021). Students who study College Students' Career Guidance course in Guangxi University of Finance and Economics are required to have 6 abilities in Critical Thinking (CT) ability as follows: 1) Perception ability, 2) Analytical ability, 3) Reasoning ability, 4) Evaluation ability, 5) Problem-solving ability, 6) Reflective ability. So the researcher would like to develop of problem-based learning instructional model to enhance critical thinking ability of undergraduate students.

Problem-based learning (PBL) instructional model is student-centred learning that encourages them to actively participate in discussion activity and to solve the given problems (Gallow, 2001). This teaching model can give full play to the leading role of students in the learning process, focusing on the cultivation of students' practical ability to understand problems, analyze and solve problems and the mastery of skills, and changing the passive acceptance of the students' learning mode. PBL is an effective method to stimulate students' thinking ability (Tiwari et al.,

2006) and utilize real-life problems as its context for students to think critically and solve problems as well as attain knowledge and essential concepts from the material (Lin & Lee, 2013). PBL is conducive to the cultivation of students' ability of unity and cooperation and solving real problems. After acquiring a problem, students have to collect information, analyze and research, discuss and cooperate in groups, and make creative use of acquired knowledge and skills to finally form a solution (Masek & Yamin, 2011), which is conducive to the development of students' unity and cooperation and practical problem solving ability. The purpose of PBL is to stimulate students' critical thinking, improve professional competence, enhance problem-solving ability, promote cooperation and decision-making skills in a new situation, and attain a skill that encourages lifelong learning, self-evaluation, and adaptation (Cheaney & Ingebritsen, 2005).

In addition, students are required to be able to build their own knowledge (student-centered). One way that can be done to improve critical thinking ability and learning competencies of students are to start a lesson with a problem or question (Synder & Synder, 2008). Learning starts with problems can through the application of the model of Problem Based Learning (PBL). In the PBL model, problems are presented at the beginning of learning and serve as a stimulus for learning activities (Chin & Chia, 2006). The PBL method can improve the learning competence of students, both cognitive and affective and psychomotor competencies. This learning model is able to make students actively involved in learning, so that learning becomes meaningful and can improve the learning competencies of students (Yew & Goh, 2016).

PBL model is a learning method that can be provided by teachers to develop students' critical thinking ability, because PBL provides an opportunity to develop all components or indicators of critical thinking (Bailin, 2002). So, the ability of students taught by experimental PBL method in terms of interpretation, analysis, evaluation and inference is better than students taught without experimental PBL method.

Critical thinking ability should be developed through the student's direct experiential problem-solving process. If students are used to using critical thinking ability to solve problems, then their critical thinking ability will be continued development (Aswan et al., 2018). This is consistent with Masek and Yamin (2011), who argued that problem-based learning models contain steps that support the

development of problem-based learning students' critical thinking ability. Some researches revealed that PBL model is that promotes students to solve real problems, enables students to compile their own knowledge, be independent, have confidence, and hone their higher-order thinking ability. PBL is known as a student-centered learning model, so this model provides room for improving students' critical thinking ability because through the PBL model, students conduct self-investigation and solve situational problems under the guidance of teachers (Savery, 2015).

In the learning process, PBL is not only a model, but also the basis for developing learning media (Jefriadi et al., 2018). According to the opinions of Sari et al. (2018), PBL model is thought to improve student learning because it foils collaboration and exchange of ideas in the learning process, thus making it easier for students to understand the material. Observations while learning PBL model show that students find ideas and ways to solve existing problems. PBL model is believed to improve student learning outcomes because PBL model can train students to work together and exchange ideas in the learning process so that students will find it easier to understand a material. The results of observations when learning PBL model took place showed that students found ideas and ways to solve existing problems. In accordance with the opinion of Degama and Sumarmin (2019), the use of PBL model can improve student learning abilities.

The use of problem-based learning (PBL) models provides students with the opportunity to develop critical thinking ability related to observation, presentation, analysis, and reasoning skills. Mayang et al. (2021) explain that in a PBL environment, students are actively engaged in learning, building knowledge and applying it to skills. Other ideas supporting the findings of this study include Matthew(2011), who found that PBL model affects students' cognitive, emotional, and psychomotor learning outcomes to enhance critical thinking ability.

As the rationale shown above, the author realizes the importance of studying “Development of Problem-Based Learning Instructional Model to Enhance Critical Thinking Ability of Undergraduate Students”.

Research Questions

1. What are the factors affecting critical thinking ability of undergraduate students?

2. Is problem-based learning instructional model to enhance critical thinking ability of undergraduate students appropriate for further implementation and how?

3. What are the results of implementing problem-based learning instructional model to enhance critical thinking ability of undergraduate students?

Research Objectives

1. To examine the factors affecting critical thinking ability of undergraduate students.

2. To develop problem-based learning instructional model to enhance critical thinking ability of undergraduate students.

3. To study the results of problem-based learning instructional model to enhance critical thinking ability of undergraduate students.

Research Hypotheses

After implementing problem-based learning instructional model, undergraduate students' critical thinking ability will be overall improved at 80% (Good Level).

Scope of the Research

Population

The total of 150 students from 3 classes of students with different levels of learning achievements, who enrolled in College Students' Career Guidance course at Guangxi University of Finance and Economics in semester 1 academic year, 2024. Those sections involve the following.

50 students in class A

50 students in class B

50 students in class C

The Sample Group

The 50 students who enrolled in College Students' Career Guidance course from class section B are obtained by cluster random sampling.

The Variables

Independent Variables

Problem-based learning instructional model

Dependent Variables

Undergraduate students' critical thinking ability

Contents

According to critical thinking ability of undergraduate students in this study, the researcher chooses Unit 3 for the experiment.

Time

The duration of the research in the semester 1 academic year, 2024 (From February to July and experiment in classroom in March)

Advantages

For students: They can improve ability to explore problems independently, enhance their enthusiasm and interest in learning have attention to the training of students' basic professional skills and help to stimulate students' critical thinking ability of innovation and cooperation.

For lecturers: The development instructional model of problem-based learning has the following meaning of three aspects. Firstly, it helps teachers break through the traditional teaching mode and adopt student-centered and problem-based teaching methods to meet the needs of social development. Secondly, it helps lecturers to change the traditional stylized mode and pay attention to cultivate students' professional ability, problem-solving ability and critical thinking ability. Thirdly, it improves lecturers' scientific evaluation ability, promote teachers to change the teaching methods and achieve teachers' professional development.

For university: The instructional model of problem-based learning should be developed to help schools deepen education and teaching reform, improve teaching quality, and cultivate applied talents with profound professional foundation, high-level practical skills and outstanding innovation ability.

Definitions of Terms

The factors affecting critical thinking ability of undergraduate students refers to the internal and external factors collected from students using questionnaire and interviews designed by the researcher. The internal factors involve psychology or physiology, attitude, and knowledge or skills. However, external factors involve teaching method, materials and environment. In addition, the factors will be obtained by structured interviews with the lecturers.

Development of problem-based learning instructional model refers to a new instructional framework which consists of the stable teaching activities and procedures. Such a developed instructional model is consisted of 5 components: 1) Principle & rationale, 2) Objectives, 3) Contents, 4) Methods of teaching & materials and 5) Evaluation. Meanwhile, the proposed instructional model is confirmed by three experts in 4 aspects: 1) Utility standards, 2) Feasibility standards, 3) Propriety standards and 4) Accuracy standards (Stufflebeam, 2012) as the 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.

Problem-Based Learning (PBL) refers to define as a teaching model under the guidance of teachers, student-centered, problem-based, group cooperation as the main activity form, and problem-solving as the goal, so as to cultivate students' analytical thinking ability and cooperative learning ability.(Silver, 2004; Dakabesi & Louise, 2019; Wahdaniyah, Agustini, & Tukiran, 2023; Barrows, 1996; Hmelo-Silver, 2004; Benjamin, 1999; Supianto et al., 2017; Liu, 2022; Li, 2021). The most common instruction is divided into 4 steps:

Step 1: Design problem-based learning tasks. Teachers design teaching questions and tasks according to the teaching objectives and characteristics of the course, and put forward some questions for students to discuss.

Step 2: Student self-directed learning. Based on the questions raised by the teacher and the teaching content, the students consult the materials and make an in-depth analysis of the problems.

Step 3: Group discussion and results presentation. Students discuss the problem cases in groups. Group members share their understanding of the problem, communicate with each other, summarize the research results, and form the answer to the problem. The results of each group can be communicated directly, or through PPT report, speech, report, video and other forms.

Step 4: Evaluation and revision. Students compare the pros and cons of the solutions to each other and score them. The teacher evaluates and grades the answers. These measures can further improve the target content and improve students' critical thinking ability.

Critical thinking ability refers to the ability of individual to observe, interpret, recognize, reason, evaluate, and reflect the questions by means of questioning, acknowledging and testing previously held assumptions, finally make decisions to solve the problems. Critical thinking ability in this study is summarized 6 dimensions: 1) Perception ability, 2) Analytical ability, 3) Reasoning ability, 4) Evaluation ability, 5) Problem-solving ability, 6) Reflective ability (Facione, 1990; Yang, Newby & Bill, 2005; Aswan, et al., 2018). We conclude as follow:

Perception ability refers to the ability of gathering the obtained information from various viewpoints thorough observation, identification of tendencies and patterns to identify the problems.

Standard 1: Collecting employment information

Standard 2: Screening employment information

Analytical ability refers to the ability to state a problem and identify a problem through testing observation and gathering information, and investigate to find out relevant facts.

Standard 1: Analyzing employment information

Standard 2: Determining employment information

Reasoning ability refers to the ability to make hypothesises, draw inferences, reach conclusions, arrive at solutions, and make decisions based on available evidence.

Standard 1: Using employment theories and methods to inference the needs of employers

Standard 2: Creating a resume and prepare for an interview based on employment skills

Evaluation ability refers to the ability to evaluate and resolve employment issues with resumes and interviews based on personal experience, available evidence and information gathered.

Standard 1: Finding your own value position for employers

Standard 2: Evaluating the outcome for resume and interview

Problem-solving ability refers to students' ability to analyze objective problems and propose the solutions of employment by using ideas, rules, certain procedures and methods based on traditional thinking or creative thinking.

Standard 1: Asking questions for the employer's needs

Standard 2: Putting forward a feasible solution for proposed problems

Reflective ability refers to the ability to think critically and inquiringly about what you have seen, heard and experienced, and to find new situations after solving problems, and to summarize and explore the new solutions.

Standard 1: Finding the weaknesses of the solution

Standard 2: Dealing with reflection and improvement

Undergraduate students refer to students who enrolled in College Students' Career Guidance course in semester 1 academic year 2024 at Guangxi University of Finance and Economics. The students will choose their own career after graduation.

Guangxi University of Finance and Economics is located in Nanning, capital of Guangxi Zhuang Autonomous Region. It is a construction institute of applied undergraduate universities project of the Ministry of Education of the People's Republic of China, a construction institute of universities project with Guangxi characteristics, a master training organization for accounting majors to "serve the special needs of the country", China-ASEAN financial and taxation talent training center, the first batch of demonstration universities in the country to deepen the reform of innovation and entrepreneurship education, and a university for first-class discipline construction in Guangxi.

Research Framework

This research is a study of “Development of Problem-based Learning Instructional Model to Enhance Critical Thinking Ability of Undergraduate Students”. The researcher studied the concept of critical thinking ability consisted of 6 dimensions: 1) Perception ability, 2) Analytical ability, 3) Reasoning ability, 4) Evaluation ability, 5) Problem-solving ability, 6) Reflective ability (Facione, 1990; Yang, Newby & Bill, 2005; Aswan, et al., 2018), analyzed the method of researcher, studied the concept of problem-based learning instructional model to do research framework 4 steps: Step 1: Design problem-based learning tasks; Step 2: Student self-directed learning; Step 3: Group discussion and results presentation; Step 4: Evaluation and revision. (Silver, 2004; Dakabesi & Louise, 2019; Wahdaniyah, Agustini, & Tukiran, 2023; Barrows, 1996; Hmelo-Silver, 2004; Benjamin, 1999; Supianto et al., 2017; Liu, 2022; Li, 2021). For development of problem-based learning instructional model, the researcher studied from Stufflebeam (2012) consisted of 1) Principle & Rationale, 2) Objective, 3) Content, 4) Method of teaching & materials and 5) Evaluation for research framework as shown in figure 1.1.

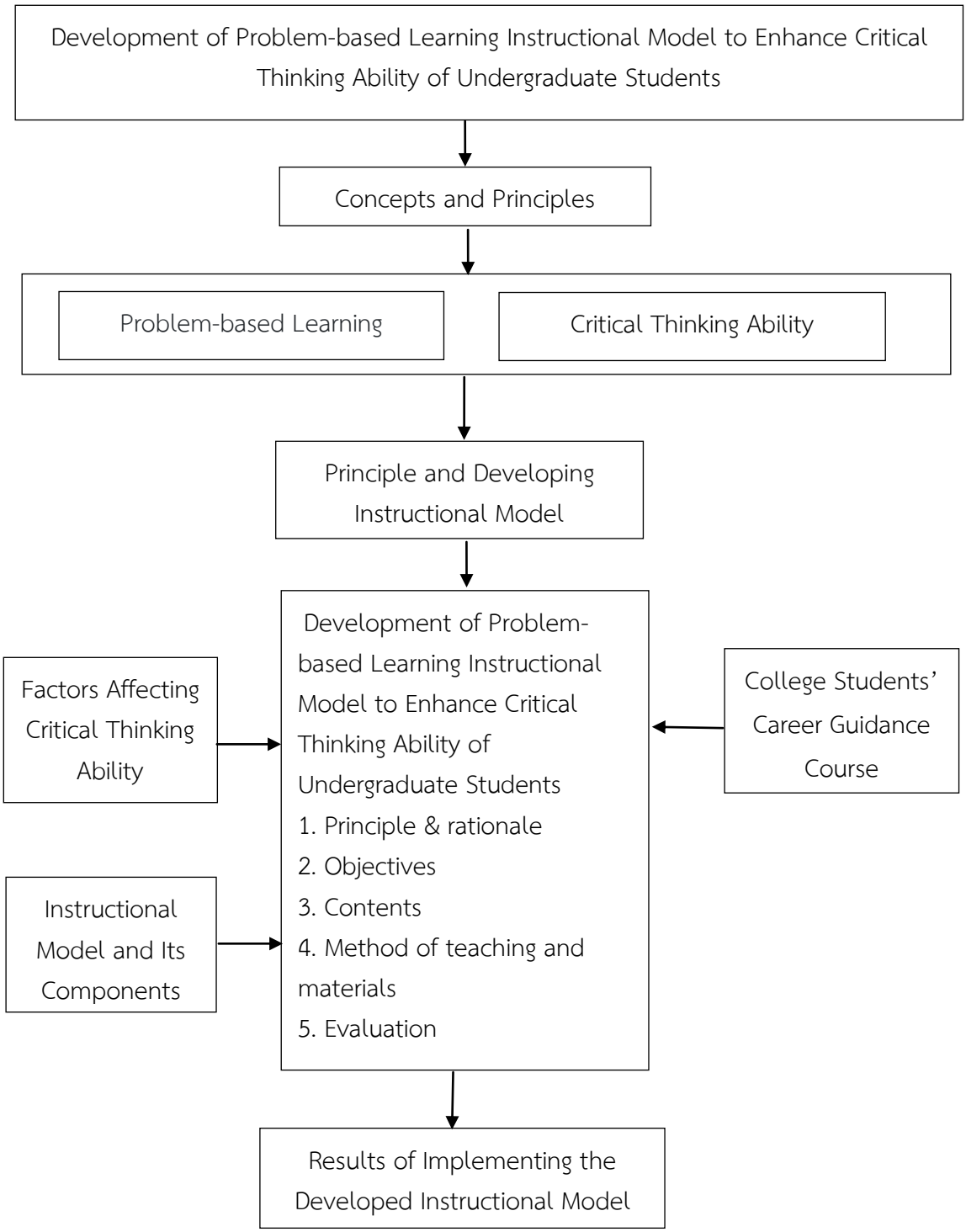

Figure 1.1 Research Framework

Chapter 2
Literature Review

In the study of “Development of Problem-Based Learning Instructional Model to Enhance Critical Thinking Ability of Undergraduate Students”, the researcher studied the documents concerning the following.

1. College Students’ Career Guidance Course
2. The Factors Affecting Critical Thinking Ability
3. Development of Instructional Model
4. Problem-Based Learning
5. Critical Thinking Ability
6. Related Research

The details are as follows.

College Students’ Career Guidance Course

Principle

The course of Career Guidance for College Students is a public basic compulsory course set up according to the document "Teaching Requirements for College Students' Career Development and Employment Guidance courses" issued by the General Office of the Ministry of Education in 2007 (Wang, 2008). The "more difficult employment season" has become the new normal for college students' employment, and college students who have not learned or practiced job-seeking skills have great difficulties in the wave of job-seeking. In the past five years, Chinese mainland has had an average of more than 10 million college graduates looking for jobs (Wang, 2023). The demand for job search skills is so urgent that colleges and universities have made career guidance an important part of their employment work. In the context of the current employment situation, students are better prepared for their careers through the study of this course, which enhances their ability of employment and career development.

The purposes of the course

The objective of the College Students’ Career Guidance course is to encourage college students to rationally plan their future development, and strive to

consciously improve their employ ability and career management ability in the learning process. Students can understand the professional skills and their relationship with the target occupation and professional courses, how to evaluate and improve the personal qualities, and help them to improve their critical thinking ability. The specific purposes are as follows:

1. To enable students to clearly understand the importance of careers , the necessity and the systematic study of learning courses, and develop students an understanding of the current employment environment in China, and how to face such a situation and what measures to take.

2. To cultivate and improve the development of critical thinking ability and problem-solving skill, lay a good foundation for future career development, reasonably position their career goals, write professional resumes and cover letters, effectively prepare for and respond to interviews.

3. To give full play to the students' subjective position, give students time to explore the career world, master job search skills, and improve their critical thinking ability and problem-solving ability. (Guangxi University of Finance and Economics, 2024).

Curriculum Structure

The curriculum structure of College Students' Career Guidance course at Guangxi University of Finance and Economics has 3 units and 26 credit hours. This study uses units 3 of Guidance on the job search process as the content of the teaching experiment to critical thinking and problem-solving ability. The curriculum structure of College Students' Career Guidance course is shown in table 2.1.

Table 2.1 Chapters and Contents Used in the Present Study

Units	Chapters	Contents	Times 26 hrs.
Unit 1 Building Career Awareness	1.1 Recognizing careers	1.1.1 Connotation of Occupation 1.1.2 Classification of Occupations 1.1.3 Functions of Occupations	4 hrs.
	1.2 Recognizing careers' situation	1.2.1 Current state of the job market 1.2.2 Future employment trends	
Unit 2 Employment policy Interpretation and rights protection	2.1 Employment policy interpretation	2.1.1 National grass-roots employment policy 2.1.2 Enterprise employment and flexible employment policies 2.1.3 University student entrepreneurship and innovation policy	6 hrs.
	2.2 Employment rights protection	2.2.1 Laws and regulations on the protection of employment rights 2.2.2 Basic rights and protections of college students in employment 2.2.3 Methods and strategies for safeguarding rights	
Unit 3 Guidance on the job search process	3.1 Employment information collection and processing	3.1.1 Collecting information on employment 3.1.2 Processing employment information	16 hrs.
	3.2 Resume making	3.2.1 Analyzing the fit between your strengths and skills and the needs of the position 3.2.2 Determining job direction and perfecting resume	
	3.3 Guidance for job interviews	3.3.1 Developing interview strategies based on resume evaluations 3.3.2 Interview practice via role play and group work 3.3.3 Comments and reflections	

Unit 3 is chosen by the research for implementing the developed model in the present study.

The factors affecting critical thinking ability

The factors to enhance critical thinking ability for undergraduate students refers to the internal and external factors collected from students using questionnaire and interviews for lecturers designed by the researcher. The internal factors involve the psychology or physiology, attitude, and knowledge or skills while external factors consist of method of teaching, materials and environment. In addition, the factors will be obtained by collecting student questionnaires and structured interview with the lecturers.

The meaning of internal factors and external factors

Different scholars give different definitions to the meaning of internal factors and external factors.

Papanastasiou (2000) thought that internal factors are those related to the test material, while external factors refer to the environment.

Aspelin (2012) defined that internal factors is the influence of learners' psychological behavior, including motivation, interest, attitude, intelligence and so on. External factors are a combination of external environmental influences outside students.

Fitrianti & Nur (2018) believed that internal factors are the driving force that arises from a person to achieve. External causes are environmental factors that directly affect the learning result.

Hellas et al. (2018) thought students' learning process is influenced by internal and external factors. Internal factors include intelligence, self-concept, etc., while external factors include: family, social status, academic environment, etc.

Liu (2023) defined that internal factors are the factors that affect decision-making by personal characteristics such as IQ, personality and behavior. The external factors are that the growth environment includes domestic factors and educational factors.

Chamidy et al. (2023) defined that internal factors are the factors of some the characteristics and emotions that come from you personally, which influences your decision making, include health, intelligence, talents, interests, motivations, and

student learning methods. External factors are non-personal factors that influence your decision making, including lecturers, other students, facilities, courses, extracurricular activities, and achievements.

Physiological or psychological factors

Physiological factors generally refer to all biological factors that affect the structure and function of an individual's body. Physiological factors have an important impact on individual health, behavior, emotion and cognitive function. If a person is in poor health, it will distract attention and concentration from learning, thus affecting learning efficiency. Therefore, physical participation will affect students' learning results. Psychology explores the workings of the mind, delving into how humans learn, think, communicate, process emotions, and make decisions. These aspects form the foundation of individual behaviour, ultimately impacting investment decisions. The interplay between emotion and cognition, regardless of accuracy, shapes our choices. Psychological and emotional factors unavoidably influence learning attitude and learning outcome. These psychological factors profoundly shape attitudes and behaviour; a positive mood tends to foster optimism, whereas a negative mood can drive pessimism.(Kurogi, et al. 2023)

Attitude

In psychology, an attitude refers to a set of emotions, beliefs, and behaviors toward a particular object, person, thing, or event. Attitude is often the result of experience or upbringing. It can have a powerful influence over behavior and affect how people act in various situations. While attitudes are enduring, they can also change. The main components of attitude are cognitive, affective, and behavioral, which means they incorporate thoughts, feelings, & actions (Cherry, 2023).

Knowledge or skills

Knowledge is an awareness of facts, a familiarity with individuals and situations, or a practical skill. Knowledge of facts, also called propositional knowledge, is often characterized as true belief that is distinct from opinion or guesswork by virtue of justification (Bolisani & Bratianu, 2018). Knowledge is traditionally defined as true justified belief. In other words, knowledge is a state of mind, the person ascribed knowledge can provide good reasons for the content of his/hers belief and this belief is true. One may say that the concept of knowledge connects the subjective, the inter-subjective and the objective aspect of a state of

mind (Johansson, 2016). Knowledge is a familiarity, awareness, or understanding of someone or something, such as facts, information, descriptions, or skills, which is acquired through experience or education by perceiving, discovering, or learning. In other words, knowledge can refer to a theoretical or practical understanding of a subject. Skills refer to the ability of an individual to complete specific tasks acquired through learning, practice and practice. Skills are typically acquired through education, training, practice, and experience.

Teaching method

Teaching method is a set of principles and methods used by teachers to enable student learning. Some researchers considered that teaching methods are the broader techniques used to help students achieve learning outcomes, while activities are the different ways of implementing these methods. Teaching methods vary in their approach, some are more student-centered(such as Problem-based Learning, Role Plays and Simulations, Interactive Lecture, Case-based Learning) while others are more instructor centered (Lecture, Directed Discussion, Guided Instruction, Just-in-Time Teaching). Choosing the appropriate teaching method brings instruction to life while encouraging students to actively engage with content and develop their knowledge and skills.

Teaching materials

Teaching materials refers to the range of resources and lesson materials that teachers can use to teach. Teaching materials means any materials created at the School or created on behalf of the School that are primarily intended to be used or accessed by students at any level, for the purposes of any course of study those students are following including course guides, handouts (including annotated scores and manuscripts), instruction manuals and assessment and examination questions. Teaching materials enable teachers to offer more interactive, interesting and engaging learning activities.

Learning environment

Learning environment refers to the diverse physical locations, contexts, and cultures in which students learn. Educators may also argue that learning environments have both a direct and indirect influence on student learning, including their engagement in what is being taught, their motivation to learn, and their sense of well-being, belonging, and personal safety. A good learning environment plays an

important role in improving the learning effect and stimulating the interest in learning. Quiet learning space, comfortable seats and tables, and clean learning environment are conducive to students' learning.

Synthesizing the above literature, we think that internal factors include psychological behavior, intelligence, emotion, interest, attitude, habit, knowledge, skills, experience for learner. External factors include lecturers, the influence of others, facilities, courses, teaching method, teaching materials, extracurricular activities and achievements.

Development of instructional model

Definition of Instructional Model

Education scholars at China and other countries have never stopped the discussion of instructional model.

American educators Bruce Joyce and Martha Weil (1972) put forward the teaching model as a formal concept in 1972. Therefore, their research was considered to be the most influential research abroad. They put forward that the teaching model is a plan or model to form the curriculum, select the textbooks, and guide the teaching activities in the classroom and other environments. A teaching model is a learning environment. This environment has many uses, from how to arrange subjects, courses, units, and topics to designing instructional materials such as textbooks, workbooks, multimedia programs, and computer-aided learning programs.

He (1997) defined instructional model as a relatively stable structural pattern of the teaching activity process carried out in a certain environment, under the guidance of specific educational concepts, teaching theories, and learning theories.

Joyce et al. (2014) considered the teaching model as a plan used to create an environment in teaching and learning, which is a teaching guide for teachers to assist students in gaining knowledge, ideas, skills, values, ways of thinking and expressing easily and effectively.

According to Tumthong (2016), an instructional model referred to the practical model for teaching and learning with a specific purpose, which has a process of systematical design and development. Besides, the design and development of an instructional model should include the process of basic

information study, defining principles, setting guidelines, evaluation and improvement. This type of instructional model includes Piaget's cognitive development model (Luo et al., 2023), Ausubel's meaningful speech reception model (Monus, 2022).

From the analyses above, it can be concluded that instructional model refers to the basic structure and process of various teaching activities established in practice teaching under the guidance of certain teaching ideas and educational theories, which is designed and organized to achieve specific teaching goals and stably manifests in a simplified form. Teaching mode is the "bridge" and "intermediary" between teaching practice and teaching theory. It is not immutable, but will be affected by specific teaching theory and educational concept.

Components of Instructional Model

There are scholars to define the components of instructional model as follows:

Faryadi (2007) contended that instructional model generally includes should include the following components: 1) analyze learners, 2) standards and objectives, 3) select strategies, technology, media and materials, 4) utilize technology, media and materials, 5) require learner participation, and 6) evaluate and revise.

Chen (2014) contended that instructional model generally includes five components: 1) theoretical foundation, 2) teaching objectives, 3) implementation condition, 4) operational procedure, 5) teaching evaluation.

Theoretical foundation. There is always a certain educational theory behind each instructional model, and the ideas contained in it will penetrate into every factor and every step of instructional model.

Teaching objectives. It refers to the expected learning results of students in teaching activities, which indicates the standard or state to be achieved in teaching activities. Teachers should design and implement teaching activities around teaching objectives, and ensure the realization of teaching objectives through evaluation and feedback.

Implementation condition. In order to achieve a certain goal, the instructional model must have relevant conditions to achieve the goal. For example, the conditions to make the teaching goal become reality include teachers, students, means, teaching content, teaching methods, teaching tools and so on.

Operational procedure. Each instructional mode has its own operating steps and the tasks to be completed in each corresponding step. It specifies the tasks to be completed by the teacher in each activity.

Teaching evaluation. It Includes the evaluation method and evaluation criteria. Each instructional model has its own specific evaluation method and evaluation standard because of its different goals and specific implementation procedures and conditions.

Zhao (2018) contended that instructional model includes three components: 1) teaching objectives, 2) teaching and Learning activities, 3) feedback or assessment.

From the information above, the instructional model employed in the present study involve 5 components in line with the theories above i.e., principle and rationale, objectives, contents, methods of teaching & materials and evaluation.

Confirmatory Model

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 and 4) Accuracy standards. (Stufflebeam, 2012)

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.

Problem-Based Learning

Background

Problem-Based Learning (PBL) was originally founded in 1969 by Prof. Barrows, a neurologist at McMaster University in Canada, who first utilized PBL in his research on the reasoning ability of medical students (Barrow, et.al, 1977). This model was soon widely recognized and respected in the field of medical education, which really

opened a new era in the development of the "problem-centered" teaching model. After the 1980s, the PBL model was widely used in medical schools in North America, and until the late 1990s, medical schools in Europe also carried out attempts and explorations of the PBL model. Later, the PBL model was gradually applied to related fields. Linda(2004), in her book Problem-Based Learning - Making Learning Easier and More Interesting, defined concepts, constructed the model, theoretical foundations, instructional implementation, and instructional evaluation. The book provided a comprehensive and systematic description of the application of the problem-based learning model in classroom teaching, especially that the application of the problem-based learning model should be based on the teaching design of authentic situations, and the importance of the problem is also highlighted.

In the 1990s, the problem-based learning (PBL) model was gradually introduced to China, and many experts and scholars in China conducted systematic and in-depth research on this teaching model. 1986, the former Xi'an University of Medical Sciences and Shanghai University of Medical Sciences were the first to successfully introduce this model into teaching. After that, based on the advanced thinking of the problem-based learning model in western medical universities, the model had been gradually implemented in China, also in medical education related fields, such as Jinan University and Hunan Medical University, and since 2005, the model had been experimentally used in various disciplines in the field of education.

The definition of problem-based learning

There are scholars to define problem-based learning as follows:

Barrows (1986), Savery & Duffy (1995) contended that problem-based learning is defined as a learner-centered instructional approach that aims to help learners acquire problem-solving, reasoning, and meta-cognitive skills as well as domain-specific knowledge, by using an authentic, complex, and ill-structured problem as the starting point of, and stimulus for, learning in a collaborative learning environment.

Finkle & Torp (1995) stated that problem-based learning is a curriculum development and instructional system that simultaneously develops both problem solving strategies and disciplinary knowledge bases and skills by placing students in the active role of problem solvers confronted with an ill-structured problem that mirrors real-world problems.

Liu (2001) contended that problem-based learning refers to encouraging students to learn around a real and concrete problem, taking this as the learning background, enabling students to master the necessary thinking skills and strategies, carry out knowledge construction.

Zhang (2021) contended that problem-based learning refers to placing students in the context of an authentic problem, conducting daily learning in the form of group cooperation, and analyzing, distinguishing and evaluating in the process of exploring problems, so that students can not only understand knowledge, knowledge transfer and knowledge application, but also achieve the formation of critical thinking tendency and the purpose of thinking training, and form innovative talents.

From the above definitions, researchers agree with the proposition of problem-based learning: The teachers set up real, complex, and poorly structured problems, It is student-centered and help students gain domain-specific knowledge and problem-solving, reasoning, and evaluation skills in the process of problem exploration.

Theory

Constructivist theory

Representatives of constructivist theory of learning, represented by Piaget and Bruner, believe that the world is characterized by problems, and knowledge is not static, but dynamic and spiral development. It requires that, with the help of teachers, students must take the initiative to make connections between old and new knowledge, reorganize, optimize and synthesize new knowledge, and then incorporate it into the existing knowledge system, i.e., to incorporate the new knowledge into the individual's original knowledge system and build bridges, so as to make the student's knowledge system more complete. The core content of constructivist theory is student-centered, focusing on the generation of learning problems. Thus, a good question is the basis for students to engage in learning, and proactivity serves as a bridge for students to construct knowledge structures. The focus is still on the students' own thinking qualities. The design of the question is done by the teacher's role, and a good question is also a good start for students to develop their individual critical thinking.

Students in the problem-solving process, with the help of supplementary learning materials, analyze the problem, clarify the key to the problem, identify the problem breakthroughs, targeted access to information, exchange of ideas with peers, and ultimately determine the answer to the problem until the formation of conclusions, to construct a knowledge system. In this process, teachers only need to create a relevant teaching situation for students or provide some supporting materials or materials and information that can help students to connect with the existing knowledge system to accelerate the speed of students to construct knowledge. At the same time, teachers are also required to maximize the use of classroom time in guiding students to cooperate and communicate within the classroom to promote independent learning to achieve the construction and internalization of knowledge. (He, 1997)

Constructivist theory also proposes four major elements in the teaching and learning process, which are: context, cooperation, conversation and meaning construction. These four elements are also reflected in the PBL model, which advocates that learners analyze and discuss problems through cooperation in authentic problem situations, and then gradually acquire new knowledge and construct connections between old and new knowledge (Hu &Huang, 2007). In addition, constructivists focus on the interaction between teachers and students, and more importantly, the interaction between students and students. Therefore, constructivist theory provides an effective theoretical support for the PBL model. The PBL model focuses on the design of problems, on cooperative group discussions, and on self-constructed knowledge systems all based on the guiding principles of constructivist theory.

Humanistic theory

Humanistic theory is "people-oriented" as the guide to the theory of educational thought, which arose in the United States in the twentieth century, emphasizing the subjective position of students in education. Humanistic theory emphasizes that learners are conscious, capable people, learners have the desire to learn and master knowledge, often encounter this or that problem in knowledge and learning, at this time the teacher needs to point out, guide them, teach them the necessary experience and methods (Liu, 2001). Taking humanistic theory as the guiding ideology means that teaching should not be teacher-centered, and the task

of education should not be about teachers instilling knowledge into students, but focusing on placing students in the student's main position, taking the curriculum that is suitable for and needed by students' development as the content of education, and motivating every student to actively participate in the classroom under the mobilization of the teacher as the leading teacher.

Researchers in humanistic theory advocate a combination of self-directed and collaborative learning, where the learner does not exist as a single individual, but as a whole in relation to the surrounding environment. Therefore, humanistic theory emphasizes the influence of social groups on individual growth, which is also known as collaborative learning. From a narrow perspective, the external environment to which students are most exposed is the classroom community, in which they are both independent individuals and subject to the combined influence of the classroom community and teachers. In the context of a harmonious environment, individuals and their peers communicate with each other, cooperate and learn, and make progress together, and individuals and teachers teach each other.

Therefore, according to the theory of humanism, in the teaching process, teachers, as the guide and facilitator of students' learning, should deeply explore students' potential, so that each student can become a complete self to realize their own value. Students, as the main body of learning, should be proactive and work together, and the PBL model and the cultivation of critical thinking have absorbed the nutrition of this theory, focusing on the status of the main body of the students and tapping the potential of the students.

Problem teaching theory

The theory of problem-based learning was first proposed by the Soviet educator Makhmutov. The psychological basis of this theory comes from the former Soviet Union's "problematic thinking" theory. According to Makhmutov's explanation, when a person is faced with a difficult situation (a problematic situation), the existing knowledge structure and experience cannot solve the current situation, in order to solve the problematic situation, it is necessary to formulate a new solution to the problem. The process of solving this problematic situation is called "problematic thinking". Its epistemology is also derived from the psychological "problematic thinking". Since human beings are both emotional and rational, individuals will use both emotional and rational thinking to think about problems when problematic

thinking occurs. Perceptual thinking is characterized by individual subjectivity and intuition, while rational thinking is the process of logical reasoning and argumentation, which is characterized by indirectness and verbalization. In the process of problem solving, only the use of perceptual thinking cannot solve the problem scenarios, need to be assisted by the facts of rational judgment, the two kinds of thinking used together.

Therefore, the problem teaching is by the problem as a guide, learners use perceptual and rational thinking to obtain knowledge of a teaching mode, this theory and PBL teaching mode have common points, but also for the PBL teaching to lay a theoretical foundation.

Table 2.2 Key points of three problem-based learning theories

Constructivist theory	Humanistic theory	Problem teaching theory
1. Student-centered, focusing on the generation of learning problems 2. Four major elements in the teaching and learning process: context, cooperation, conversation and meaning construction	1. People-oriented 2. Teachers deeply explore students' potential as the guide and facilitator of students' learning	1. Problem-centered 2. problematic thinking
3. Interaction between teachers and students, and between students and students	3. Students are proactive and work together as the main body of learning	3. perceptual and rational thinking to obtain knowledge of a teaching mode

Methods of Teaching Problem-Based Learning (PBL)

There were academic educators have the step methods of teaching Problem-Based Learning (PBL) as follows:

Silver (2004), Dakabesi & Louise (2019) and Wahdaniyah, Agustini, & Tukiran (2023) summarized methods of teaching PBL into 4 steps:

Step 1: **Teachers ask questions**. Teachers design teaching cases according to the teaching objectives and characteristics of the course, and put forward 3-5 questions for students to discuss.

Step 2: **Student self-directed learning**. Based on the questions raised by the teacher and the teaching content, the students consult the materials and make an in-depth analysis of the problems.

Step 3: **Group discussion and results presentation**. Students discuss the problem cases in groups. Group members share their understanding of the problem, communicate with each other, summarize the research results, and form the answer to the problem. The results of each group can be communicated directly, or through PPT report, speech, report, video and other forms.

Step 4: **Evaluation and revision.** The students themselves and teachers evaluate and grade the answers to further improve the task content.

Barrows (1996) developed a PBL model that consists of 5 steps.

Step 1: **Set a new task**, students can introduce each other and set the mood, PBL role introduction.

Step 2: **Organize a new group**, students can set the problem, recognize the problem, describe the product or operation, assign tasks, refine the problem , formulate possible outcomes, refine and assign issues, identify resources and develop work steps and time frame.

Step 3: **New round of problem solving**, students can discussion of resources used , comments on those resources and re-rating of questions

Step 4: **Presentation of results**, students can demonstrate their understanding through different formats, tools

Step 5: **Reflection**, students can summarize knowledge and self-evaluation, group evaluation.

Silver (2004) further refined the teaching process of PBL by viewing the whole teaching process as a cyclical process. He summarizes this cyclical process into seven steps, which are: 1) problem scenario, 2) screening facts, 3) problem assumptions, 4) identifying gaps in knowledge, 5) applying knowledge, 6) generalizing, and 7) evaluating.

Benjamin (1999) constructed the PBL teaching process according to his own understanding, and he also identified the process as 8 steps, which are: 1) identifying

the problem, 2) analyzing the problem, 3) generating hypotheses, 4) confirming what is known, 5) establishing the required information, 6) identifying resources, 7) gathering new information, and 8) connecting old and new knowledge.

Schmidt (2000) also proposed a "seven-step" model, which are: 1) describing the problem, 2) defining the problem, 3) analyzing the problem (brainstorming), 4) analyzing the problem (discussing), 5) determining the learning objectives and content, 6) independent learning, and 7) sharing the results. Subsequently, the step of "group work" was added on top of this to make the overall process more complete.

Supianto et al. (2017) proposed a six-process PBL model containing: 1) discovering problems, 2) posing problems, 3) analyzing problems, 4) exploring problems, 5) solving problems, and 6) posing new problems by focusing on problems.

Liu (2022) divided the process of problem-based learning mode into five steps in combination with the characteristics of problem-based learning mode and critical thinking ability: 1) students put forward questions, 2) design plans according to their own views, 3) search data, 4) discuss and communicate, and 5) reflect on the evaluation of results.

Li (2021) divided the PBL teaching process into three steps: 1) preparation before class (asking questions, 2) organizing groups, and communicating in groups) implementation during class (activity report) and 3) reflection after class (activity report). In each part, teacher activities and student activities were designed.

The researcher summarized method of teaching PBL from Silver (2004), Dakabesi & Louise (2019) and Wahdaniyah, Agustini, & Tukiran (2023), Barrows (1996), Hmelo-Silver (2004), Benjamin (1999), Supianto et al. (2017), Liu (2022) and Li (2021), there were 4 steps as follows:

Step 1: **Design problem-based learning tasks**. Teachers design teaching questions and tasks according to the teaching objectives and characteristics of the course, and put forward some questions for students to discuss.

Step 2: **Student self-directed learning.** Based on the questions raised by the teacher and the teaching content, the students consult the materials and make an in-depth analysis of the problems.

Step 3: **Group discussion and results presentation.** Students discuss the problem cases in groups. Group members share their understanding of the problem, communicate with each other, summarize the research results, and form the answer to the problem. The results of each group can be communicated directly, or through PPT report, speech, report, video and other forms.

Step 4: **Evaluation and revision**. Students compare the pros and cons of the solutions to each other and score them. The teacher evaluates and grades the answers. These measures can further improve the target content and improve students' critical thinking ability.

Roles of teachers and students

Roles of teachers

Compared with the traditional teaching mode, for problem-based learning, teachers are only the in part of knowledge, but also the promoters, guides and collaborators of students' development.

Teachers are facilitators of student development. In problem-based learning, the teacher, as a facilitator, does not directly inform the students of the results of knowledge, but rather presents the thought processes and strategies of the experts by appropriately questioning the various real problems encountered by the students in solving practical problems (Degama, 2019). When students observe, experiment or discuss independently, teachers should actively look and listen, truly feel what students do and think, keep abreast of various situations, consider how to guide students next, give students psychological support, and cultivate students' self-discipline (Cheaney & Ingebritsen, 2005).

Teachers are the guides of students' autonomous learning. In problem-based learning, when guiding students to solve problems, teachers should be able to point out the direction and actively create an atmosphere supporting open inquiry learning. At the same time, teachers should always follow the principle of autonomy and exploration, positioning all their educational behaviors to support and help students learn independently and solve problems by themselves. Before students may encounter problems, make forward-looking predictions, do a good job in advance control, to avoid students detours; When students are confused or encounter problems that are difficult to solve, appropriate guidance and guidance are given so that students can get rid of confusion and make choices.

Teachers are partners in student learning. In problem-based learning, teachers are faced with the task of guiding students to "solve problems", and the content of teachers' guidance should cover science, technology, culture and other fields extensively. Moreover, teachers are faced with several groups, and it is difficult for an individual to complete all the guidance work for each group of students alone. If teachers are to work closely with more teachers in a larger space and in a more equal way, they must build connections with other colleagues, even parents and members of the community. Teachers pay attention to other related subjects from only the trend of this subject; from completing teaching tasks independently, to cooperating with other teachers to complete the guidance of students. While teaching students to cooperate, teachers must first learn to cooperate themselves. The collaborator role of the teacher is not only between educators, but also outside the school to collaborate with relevant members of society (e.g. parents, experts, community members). Teachers and students should be a kind of mutual cooperation and mutual promotion of learning and research community.

Roles of students

In problem-based learning, not only has the role of the teacher changed greatly, but the role of the student has also taken on different meanings. Students are not only learners, but also collaborators and researchers.

Students are collaborators. In problem-based learning, students learn by solving practical problems. Due to the complexity of some problems, students need to work in small groups, in which students share professional knowledge and jointly deal with various difficulties encountered in the process of problem solving. This is not only conducive to improving students' learning initiative and self-control, but also can promote the development of good interpersonal relations among students, promote the development of students' psychological quality and improve their social skills (Jefriadi et al., 2018).

The student's researcher role. Students' research is not equivalent to scientific research in the strict sense. Although there are similarities between the two, students' research activities are more reflected in the interest and process of inquiry, which involves various activities such as raising questions, guessing results, making plans, observing, experimenting, making, collecting evidence, explaining, expressing and communicating, which is again similar to scientific research. In problem-based

learning, when students can see things from multiple perspectives, problem situations can attract and sustain students' interest and enable them to actively seek solutions to problems. During this period, students are committed problem solvers: they identify the crux of the problem, look for good ways to solve the problem, and strive to explore and understand the practical significance of the problem.

Strengths and weaknesses of problem-based learning

Strengths of problem-based learning

First, it is beneficial to develop students' critical thinking ability. In the process of problem-based learning model, research, reasoning and reflection on the problem are carried out through coordination among group members until the problem is solved. In the process of group cooperative learning, when faced with the problems to be solved, the discussion among the group members can stimulate the critical thinking inspiration of the members to some extent. In the process of problem solving, students learn to cooperate and negotiate, and cultivate their awareness of active participation and critical thinking.

Second, it is beneficial to cultivate students' independent learning ability. Problem-based learning focuses on student-centered learning. Students take the initiative to participate in the whole process from the proposal of problems, the formulation of plans, the implementation of plans, to the evaluation and modification of results, providing a good environment for the cultivation of students' independent learning ability.

Thirdly, it is beneficial to cultivate students' practical operation ability. Problem-based learning is learning based on real situations. It requires students to create problems that are closely related to their current and future work and life. When students see the connection between these learning materials and their actual work and life, their enthusiasm will be quickly mobilized, and they will do their best to grasp the relevant information and apply what they have learned to solve problems, so as to improve their practical operation ability.

Weaknesses of Problem-Based Learning

First, the learning community is narrow. PBL in the classroom environment, the learning group is mainly limited to students in the classroom, so the thinking of each member of the group is relatively homogenous, and the overall thinking level

of the learning group is difficult to reach a higher level, which determines the design of the final problem solution to the innovation level is not high.

Second, it takes more time. In the case of students' weak basic knowledge, students need to spend a lot of spare time to prepare materials, which will lead to the increase of learning burden, otherwise, it is difficult to achieve the expected teaching objectives.

Critical Thinking Ability

Background

Critical thinking has been recognized as one of the most important thinking ability and one of the most important indicators of student learning quality. In order to develop successful critical thinkers, critical thinking must be incorporated into the curriculum content and teaching approaches. Although the importance of critical thinking ability in learning process is agreed upon, there is great disagreement and controversy about how critical thinking is defined (Galinsky, 2010; Changwong et al., 2018).

The definition of critical thinking ability

The structure of critical thinking is also the focus of domestic and foreign scholars for many years, and the research results are gradually transitioning from a single structure to a complex structure. In terms of structure, the scholars first paid attention to the skill level of critical thinking, so they focus on the composition of critical thinking ability. The following are several representative research results.

Dewey put forward a new concept-reflective thinking, advocating bold questioning and cautious assertion. Dewey’s method was analyzed and discussed systematically in the field of education (Kuhn, 1999). Dewey defended that critical thinking as a process that begins with a problem and ends with a solution and self-interpretation. Bean (2011) elaborated on this point by stating that such a problem should ‘evoke students’ natural curiosity and stimulate both learning and critical thought.

Facione (1990) defended that made a clear distinction between critical thinking and higher-order thinking. One of the reasons why the concept of critical thinking lacks a unified definition in academia is that it belongs to two different fields, namely philosophy and psychology. Philosophers tend to focus on the nature of

critical thinking and its consequences. Psychologists, on the other hand, focus more on cognitive processes, the elements of thought, and the manipulation of problem solving. In addition, cognitive and developmental psychologists base their research largely on evidence; The research of philosophical field is based on logical reasoning. In recent years, educators have put more emphasis on blending philosophical and psychological perspectives in order to develop a more inclusive theory that can guide teaching.

Paul (1992) considered critical thinking as a weapon against prejudice, unfounded assumptions, and irrational habits. A more detailed definition is as follows: "Critical thinking is a unique, purposeful mode of thinking in which people measure systematically and habitually their thinking against a set of intellectual criteria, control the construction of thinking, use criteria to guide the construction of thinking, and use goals and criteria to evaluate the effectiveness of thinking."In contrast to philosophical perspectives, cognitive and developmental psychologists tend to associate critical thinking with problem solving, either as the same term or as part of problem solving.

Further, Paul & Elder (2006) expanded on this point of view by defining critical thinking as ‘the art of analyzing and evaluating thinking with a view to improve it’. These definitions indicated that critical thinking is the ability to apply cognitive ability, such as analyzing, applying, and evaluating when thinking.

Moreover, Pithers & Soden (2000) stated that critical thinking involves being able to identify questions worth pursuing, being able to pursue one’s questions through self-directed search and interrogation of knowledge, a sense that knowledge is contestable and being able to present evidence to support one’s arguments.

Bailin (2002) defended that critical thinking as thinking of a particular quality-essentially good thinking that meets specified criteria or standards of adequacy and accuracy.

Ennis (2011) defined critical thinking as "rational, reflective thinking in determining beliefs or actions." Later, Ennis further expanded this definition and divided temperament and ability into two dimensions for critical thinking, including 12 temperaments and 12 abilities respectively. People should not only master the abilities of critical thinking, but also possess the temperament of critical thinking.

The Delphi Project was completed and a study report was submitted (APA 1990). The report draws on the consensus of 46 experts in different fields on critical thinking and defines critical thinking as: "This judgment takes the form of interpretation, analysis, evaluation, inference, and a description of the arguments, concepts, methods, criteria, or contexts on which the judgment rests for some specific and definite purpose." The essence of critical thinking is truth seeking, open thinking, analytical and systematic ability, self-confidence and curiosity.

Some Chinese scholars also defined critical thinking from the perspective of philosophy. For example, Yang (2007) believed that: "Critical thinking ability includes the ability to understand, identify, analyze, synthesize, compare, judge and other aspects of information, but reasoning and demonstration ability is the most important." Critical thinking starts with reasoning and argumentation. Critical thinking is fundamentally a logical discipline."

Gu (2007) believed that critical thinking in a broad sense is the ability to develop and improve people's world view and apply it to all aspects of life with high quality. More specifically, critical thinking is the ability to make rational decisions about what to believe or do.

Component of Glaser's critical thinking ability

Deeply influenced by Dewey, Glaser regards scientific thinking as a kind of reflective thinking. The thinking skills he summarizes include the following aspects.

1) Identify problems

2) Solve problems in practical ways

3) Collect and collate relevant information

4) Identify unstated assumptions and values

5) Understand and use language clearly and accurately parse data

6) Evaluate evidence and ideas

7) Find logical relationships between propositions

8) Draw the necessary conclusions

9) Test the generalities or conclusions

Rebuild one's belief structure on the basis of a wider range of experiences make accurate judgments about specific things and features of everyday life.

Ennis' FRISCO

Early Ennis (2011) believed that critical thinking ability were the main components of critical thinking ability. Even though he included the tendency of critical thinking in his later theory, his research focus on critical thinking was still on the aspect of critical thinking ability. He proposed six kinds of skills, called FRISCO for short, with each letter representing the first letter of an English word for a skill. The six skills are list in table 2.3.

Table 2.3 Ennis' FRISCO model for six kinds of skills

Skills	Description and explanation
Focus	when facing any situation and dealing with any problem, identify the main ideas and problems
Reasons	To support a conclusion based on empirical evidence or logical analysis
Inference	The process of providing support for a conclusion based on empirical evidence or logical analysis, including drawing a conclusion from a given reason. In critical thinking, the main task of inference is to test whether a conclusion can be supported by the reasons given and whether the conclusion is indeed warranted
Situation	In the process of critical thinking, when considering the importance of an argument or issue, it must be done in the context of a wide range of issues
Clarity	Clarify the meaning of the terms used in an argument and how they are used, delineating the uniqueness of their meanings to avoid confusion
Overview	Look again at the first five steps of critical thinking to further examine the consistency between the components of the entire process

Although Glaser's critical thinking ability constitute and Ennis' theory includes critical thinking ability and critical thinking tendency, it can be seen from his FRISCO one-dimensional structure model that he still lays emphasis on critical thinking ability and pays insufficient attention to critical thinking tendency.

In the development of the study of critical thinking, scholars gradually realized that the skill of critical thinking is only a component of critical thinking, and the spirit, tendency or temperament of critical thinking also played a decisive role in a critical thinker.

After several rounds of discussion and research, Facione et al. (1990) came up with a report and proposed the Delphi two-dimensional critical thinking structure, including the cognitive level and the emotional level. The cognitive level can be broken down into 6 abilities: 1) interpretation, 2) analysis, 3) evaluation, 4) inference, 5) explanation, 6) self-regulation. In these abilities, analysis, evaluation and reasoning are the core skills, and each cognitive ability includes multiple sub-abilities.

Paul & Elder (2006) proposed a ternary structure model, namely, thought elements, criteria, and intelligence characteristics. At the center of the model are the Thinking 8 elements. They believe that thinking should have purpose, questions, information, basic concepts, hypotheses, specific perspectives, reasoning, revelation, and these eight elements form a circular chain of thinking. Each thought element should be measured or tested using 10 criteria.

Based on the Paul-Elder ternary structure model, Professor Lin proposed the intelligence theory of thought structure in 2005, which is known as the "Mitsubishi structure model" in psychology circles.

Wen (2009) proposed a hierarchical model based on two-dimensional model, three-dimensional model and three-edge model. She basically adopted the framework of the two-dimensional model, and integrated the criteria in the three-dimensional model and the recognition of the global role of self-regulation in the three-dimensional model into the theoretical framework of the hierarchical model.

Most of the scholars who study critical thinking in China agreed with the two-dimensional structure of "critical thinking ability" and "critical thinking quality". Liu (2021) believed that critical thinking is composed of "critical thinking ability" and "critical spirit". Among them, critical thinking must be based on general thinking skills (such as comparison, classification, analysis, synthesis, abstraction and generalization, etc.), while also having some specific critical thinking ability. The critical spirit is "the mental readiness, willingness, and tendency to judge consciously." The process of students' problem-solving ability has six stages, including understanding the problem,

describing the problem, showing the problem, solving the problem, reflecting on solution program, communication solution (Wu & Xie, 2013).

Table 2.4 Six dimensions and processes of critical thinking and problem-solving ability

Dimensions	Connotation	Process
Understand	The ability to use background knowledge to understand text, graphs, formulas, and specific situations, including the acquisition of explicit and implicit cues, the comparison of various information, and the perception of the problem situation.	Understanding the problem
Analyze	Analyze the variables and their relationships to each other, distinguish between direct and indirect variables, and retrieve and organize information that can be used to develop problem-solving hypotheses	Describing the problem
Reason	By putting forward hypotheses, it reasons about the different outcomes for different hypotheses	Showing the problem
Practice	Hands-on practice ability, that is, the ability to solve problems by putting the proposed hypothesis into practice through hands-on operation, which includes both symbolic form (doing problems) and practical form of problem solving.	Solving the problem
Reflect	Based on the problem-solving results, the understanding of problem situation, the proposed hypothesis, and the process of action are examined to identify possible problems and areas for improvement.	Reflecting the solution
Express	Including oral and written expression skills, that is, the ability to communicate with others about the understanding of the problem situation, the process of problem solving and the result of the ability to show others.	Communicating the solution

Looking back through above literature, critical thinking ability refers to the ability of individual to observe, interpret, recognize, reason, evaluate, and reflect the questions by means of questioning, acknowledging and testing previously held assumptions, finally make decisions to solve the problems (Wu & Xie, 2013). This paper summarizes the definition that critical thinking ability refers to the students can be able to have 6 ability: 1) Perception ability, 2) Analytical ability, 3) Reasoning ability, 4) Evaluation ability, 5) Problem-solving ability, 6) Reflective ability. We conclude as follow:

1) Perception ability: The ability of observation and identification, which see the obtained information from various viewpoints Thorough observation, identification of tendencies and patterns as in information mapping, identification of similarities and dissimilarities, etc.

2) Analytical ability includes statement, classification, comparison, interpretation and differentiation.

3) Reasoning ability includes questioning, hypothesis, inference, elaboration, demonstration and other ability.

4) Evaluation ability refers to the ability to evaluate the hypothesis, argumentation process, conclusions.

5) Problem-solving ability refers to students' ability to analyze objective problems and propose solutions by using ideas, rules, certain procedures and methods based on traditional thinking or creative thinking.

6) Reflective ability refers to the ability to think critically and inquiringly about what you have seen, heard and experienced, and to find new situations after solving problems, and to summarize and explore the future.

In view of these impacts, the abilities are consciously integrated with teaching tasks in the teaching process, so as to explore the cultivation methods.

We summarize the connection of contents, problem-based learning instructional model, critical thinking ability and Instruments or Activities by table 2.5.

Table 2.5 Summary for Content, Method, Problem-based learning, Critical thinking ability and Instruments/Activities

Unit/Content/Time	Methods	Problem-based learning instructional model				Critical thinking ability						Instruments / Activities
		S.1	S.2	S.3	S.4	D.1	D.2	D.3	D.4	D.5	D.6	
3.1 Employment information collection and processing (4hrs.) 3.1.1 Collecting information on employment (2 hrs.) 3.1.2 Processing employment information(2 hrs.)	PBL	T	T+L	T+L	T+L	√						Rubric scoring, Class observation, Group work
3.2 Resume Making(4hrs.) 3.2.1 Analyzing the fit between your strengths and skills and the needs of the position (2 hrs.)	PBL	T	T+L	T+L	T+L		√					Rubric scoring, Class observation, Group work
3.2.2 Determining job direction and perfecting resume (2 hrs.)	PBL	T	T+L	T+L	T+L			√				Rubric scoring, Class observation, Group work

Table 2.5 (Continued)

Unit/Content/Time	Methods	Problem-based learning instructional model				Critical thinking ability						Instruments / Activities
		S.1	S.2	S.3	S.4	D.1	D.2	D.3	D.4	D.5	D.6	
3.3 Guidance for job interviews(8hrs.) 3.3.1 Developing interview strategies based on resume evaluations (3 hrs.)	PBL	T	T+L	T+L	T+L				√			Rubric scoring, Class observation, Group work
3.3.2 Interview practice via role play and group work (3 hrs.)	PBL	T	T+L	T+L	T+L					√		Rubric scoring, Class observation, Group work
3.3.3 Comments and reflections for resume and interview (2 hrs.)	PBL	T	T+L	T+L	T+L						√	Rubric scoring, Class observation, Group work

S.1: Design problem-based learning tasks

S.2: curriculum analysis and content creation

S.3: Course task execution

S.4: Comprehensive performance comparison and evaluation

L.: Learner	T.: Teacher
D.1 Perception ability	D.2 Analytical ability
D.3 Reasoning ability	D.4 Evaluation ability
D.5 Problem-solving ability	D.6 Reflective ability

Related Research

The assessment tools for critical thinking ability

In the research of measurement tools of critical thinking ability, the construction of critical thinking is very complex, so there are many kinds of measurement methods. Common research tools are Watson-Glasser Assessment of Critical Thinking (Watson & Glaser, 1964), Critical Thinking Tests in the Social Sciences, Developmental Cognitive Ability Test, Observe and Evaluate the Test (Follman, et al., 1996), California Critical Thinking Ability Test (Facione, 1996), and California Critical Thinking Disposition Inventory (CCTDI), and so on. The research on the measuring tools of critical thinking in China is mainly about the translation or localization of foreign authority scales.

Luo & Yang (2001) translated and revised CCTST and CCTDI, which are highly recognized in the international community.

Peng et al. (2004) carried on the localization reform of CCTDI to make it more suitable for the research needs of China.

Huhn et al. (2013) sorted out and summarized the Watson-Glaser Critical Thinking appraisal (WGCTA; Watson & Glaser, 1964); the CCTST (Facione & Facione, 1994). They developed an instrument-the Psychological Critical Thinking inventory to assess students' critical thinking ability in studies.

Of the above seven measuring tools, except for the Cambridge Thinking Skills Assessment developed by the British, the rest were developed by the United States, and most of the measuring tools were first introduced during the 1980s and 1990s. Although Cambridge University's thinking ability measure was first developed in the early 2000s, its development began in the mid-1980s. It can be inferred that the

cultivation of thinking ability has become a concern of higher education in the United States and the United Kingdom as early as the 1980s. The object of measurement is generally college students and high school students. From the point of view of the test question type, the main form of the objective question is optional. From the perspective of measuring type, except CCTDI measuring personality tendency, others are measuring critical thinking ability.

In short, from the perspective of the current research status of critical thinking, the current academic circles have fully and deeply studied the definition and structure of critical thinking, and made specific explorations in the model structure, influencing factors and measurement methods of critical thinking. Although scholars have not reached a consensus on these aspects, many theoretical models and testing tools are relatively mature and have their own advantages.

The relationship between critical thinking and problem-based learning models.

The critical thinking ability are mainly summarized as the skills of interpretation, analysis, evaluation and reflection. Combined with the general process of problem-based learning model is asking questions, cooperating to analyze problems, discussing and communicating to solve problems, reflecting on the evaluation of results. This study aims to study the promotion of critical thinking ability in problem-based learning model. Therefore, for the internal relationship between the two, critical thinking ability are the core, and every link of problem-based learning model, from question raising to reflection on achievement evaluation, is carried out in a cycle. And each skill of critical thinking ability is embodied in each link of problem-based learning (Liu, 2016).

In problem-based learning mode, question raising is the primary goal of learning activities. In the process of question raising, students are required to be able to identify the theme, express information clearly and smoothly, identify existing problems, classify information accurately, and summarize their own views succinctly. In this process, it is the concrete embodiment of the basic skills of critical thinking ability (Akpur, 2020).

The independent learning link based on problem learning mode is the key factor to solve the problem. In the process of problem analysis, it is necessary to find out the causes and consequences of the problem, state and judge the

relationship with other points of view, and timely exclude information irrelevant to the topic in the process of independent learning. This reflects the analytical skills in critical thinking ability (Treffinger et al., 2006). To improve students' analytical skills is to improve their critical thinking ability.

Romanowski & Nasser (2012) stated that what is required to develop learning is authenticity, which means that learning should be adjusted to the characteristics of the learning itself. For example, on the environment course, the students have to interact with their surrounding environment. Yet, they are not. So, it causes the low ability of the students' critical thinking.

Asyari et al. (2016) depicted Lesson Study activity on an environment course which focused on the students' critical thinking activity through the integration of PBL and GI. The learning was conducted through Lesson Study and was based on the environment. The crucial value of the Lesson Study was the lecturers showed more attention to the students since they wanted to know the students' learning style and what made them learn.

In the group evaluation and exchange activities in the teaching process, the group members refute each other's opinions and defend their own opinions through debate. This reflects the evaluation skills in critical thinking ability. Evaluation requires could be able to evaluate arguments, question evidence, accurately and clearly express one's own opinions, and combine relevant evidence to support one's own opinions.

In the final evaluation and reflection section of teaching activities, students reflect on the problems and solutions by summarizing the process of problem solving. This proves that the self-reflection indicators of critical thinking ability require self-reflection, self-assessment, and self-correction.

Due to the complexity of critical thinking itself, each step in the process of problem learning mode is not only the embodiment of a single aspect of critical thinking, but also the application of comprehensive ability. For example, the question raising process based on problem learning mode not only reflects the interpretation skills among the basic skills that critical thinking can provide, but also the skills of analysis and evaluation. Therefore, each link of problem-based learning mode focuses on a certain skill of critical thinking, rather than a simple linear correspondence.

Chapter 3
Research Methodology

This research used mixed method of research. This research is divided into three phases.

Phase 1 was conducted to answer research **objective 1:** To examine the factors affecting critical thinking ability of undergraduate students.

Phase 2 was conducted to answer research **objective 2:** To develop problem-based learning instructional model to enhance critical thinking ability of undergraduate students.

Phase 3 was conducted to answer research **objective 3:** To study the results of problem-based learning instructional model to enhance critical thinking ability of undergraduate students.

The details are as follows.

Phase 1 was conducted to answer research objective 1: To examine the factors affecting critical thinking ability of undergraduate students.

Population

Group 1: The 150 students of College Students' Career Guidance course in Semester 2 academic year 2023 from 3 colleges in Guangxi Province. Those section involve the following:

1) 50 students from Guangxi University of Finance and Economics

2) 50 students from Baise University

3) 50 students from Guangxi Minzu University

Research instrument

The questionnaire for students

Designing instrument 1 (The questionnaire for students)

1. Study College Students' Career Guidance course and factors affecting critical thinking ability of undergraduate students.

2. Design a questionnaire on factors to enhance critical thinking ability for the students in Guangxi Province. There are 3 Parts:

Part 1 is about Common data of the respondent in overall. (N=150),

Part 2 are 6 items of internal factors and 6 items of external factors,

Part 3 is suggestion.

3. Present the draft of questionnaire to the advisors for checking correctness and completion.

4. Assess the validity of questionnaire on factors to enhance critical thinking ability for the students in Guangxi Province by 3 experts (List name from 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 related to the topics

The acceptable items must have the IOC values not less than 0.6. The IOC calculated from the validation measure 1.

5. Design Likert 5-point rating scale questionnaire on the following score rating criteria.

The acceptable items must have the IOC values not less than 0.6. The IOC calculated from the validation measures 1.00.

6. Design Likert 5-point rating scale questionnaire on the following score rating criteria.

Score rating criteria

5 means strongly agree (The highest)

4 means agree (High)

3 means neutral (Medium)

2 means disagree (Few)

1 means strongly disagree (The fewest)

The factors affecting critical thinking ability obtained from the students are interpreted using MEAN Level criteria proposed by Phongsri (2011).

4.51-5.00 means strongly agree (The highest)

3.51-4.50 means agree (High)

2.51-3.50 means neutral (Medium)

1.51-2.50 means disagree (Few)

1.00-1.50 means strongly disagree (The fewest)

Data Collection

1. Ask for permission for data collection from Guangxi University of Finance and Economics, Baise University, Guangxi Minzu University.

2. Data were collected through the Questionnaire star from 150 students affecting the critical thinking ability for undergraduate students in Guangxi Province.

Data Analysis

Descriptive Statistics i.e., Frequency, Mean (μ), Standard Deviation (σ)

Key Informants

Group 2: Three lecturers who are teaching College Students' Career Guidance course from 3 colleges in Guangxi Province.

1) 1 Lecture from Guangxi University of Finance and Economics

2) 1 Lecture from Baise University

3) 1 Lecture from Guangxi Minzu University

Research instrument

The interview form for the lecturers

Designing instrument 2

1. Study literature on problem-based learning instructional model, enhancing critical thinking ability, and factors affecting critical thinking ability of undergraduate students.

2. Design the draft of open-ended interview on factors affecting critical thinking ability. there are 3 Parts :

Part 1 is about Common data of the respondent in overall. (N=3) .

Part 2 are 5 questions for internal factors; 5 questions for internal factors.

Part 3 is suggestions.

3. Present the draft of open-ended interview to the advisors for checking correctness and completion.

4. Assess the validity of open-end interview on factors affecting critical thinking ability for the lecturers in Guangxi Province by three experts (List name from Appendix A) through Item-Objective Congruence (IOC) according to the criteria as 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 related to the topics

The acceptable items must have the IOC values not less than 0.6. The IOC calculated from the validation measures 1.00.

5. Do the open-end interview in three local College in Guangxi Province. The open-end interview type can only be answered by the lecturers.

Data Collection

1. Ask for permission for data collection from Guangxi University of Finance and Economics, Baise University, Guangxi Minzu University.

2. Collect data from designated lecturers via video calls, wechat voice and email using developed interviews.

Data Analysis

The analysis of data was quantitative analysis with content analysis by descriptive statistics.

Output Phase 1

Factors affecting are internal and external factors to enhance critical thinking ability for undergraduate students in Guanxi provice by table 3.1.

Table 3.1 Summary the process to do in Phase 1

Topics	Details
Research process	Analyzed the internal and external influencing factors from students and lecturers.
Research objective 1	To examine the factors affecting critical thinking ability of undergraduate students
Conduct research	Designing instrument 1 (The questionnaire for students) Designing instrument 2 (The interview for the lecturers) Assess the validity by 3 experts (List name from Appendix A)
Target group	1. The 150 students of College Students' Career Guidance course in the semester 2 academic year 2023 from 3 colleges in Guangxi Province. 2. The lecturers who are teaching College Students' Career Guidance course from 3 colleges in Guangxi Province.

Table 3.1 (Continued)

Topics	Details
Instrument	1. Questionnaire for students Part 1: Common data of the respondent in overall. (N=150) Part 2: About internal and External Factors. 6 items of internal factors 6 items of external factors Part 3: Suggestion 2. Interview for the lecturers. Part 1: Common data of the respondent in overall. (N=3) Part 2: 10 questions. 5 questions for internal factors; 5 questions for external factors; Part 3: Suggestions
Data analysis	Descriptive Statistics i.e, Frequency, Mean (μ) Standard Deviation (σ) for questionnaires. 2. Content analysis for interview.
Output	The result of the factors to enhance critical thinking ability of undergraduate students. The internal factors are consisted of psychology or physiology, attitude, and knowledge or skills. The external factors are consisted of teaching method, materials, and environment.

Phase 2 was conducted to answer research objective 2: To develop problem-based learning instructional model to enhance critical thinking ability of undergraduate students.

Research instrument

Conformity assessment form of problem-based learning instructional model in terms of accuracy standard, propriety standard, feasibility standard, and utility standard.

Designing instrument

1. Study related concepts, principles, process about developing instructional model, including results in terms of factors affecting critical thinking ability from research objective 1.

2. Design handout of problem-based learning instructional model, 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, is in 4 aspects standards: 1) Utility standards, 2) Feasibility standards, 3) Propriety standards and 4) Accuracy standards.

3. Design a questionnaire on confirming the appropriateness of the instructional model in terms of accuracy standards, propriety standards, feasibility standards, and utility standards.

4. Present the draft of open-ended interview to the advisors for checking correctness and completion.

5. Assess the validity of the questionnaire on confirming the appropriateness of the instructional model by 3 experts (List name from Appendix A) through Item-Objective Congruence (IOC) according to the criteria as shown below (Phongsri, 2011).

+1 = If your are sure the contents measure its objectives

0 = If your are not sure that the measurement contents related its objectives

-1 = If it is certain that the contents is measured and does not related the objectives

The acceptable items must have the IOC values not less than 0.6. The IOC calculated from the validation measures 1.00.

6. Design the conformity assessment form of problem-based learning instructional model.

Data Collection

1. Ask for permission of data collection

2. Collect appropriateness of the instructional model in terms of accuracy standard, propriety standard, feasibility standard, and utility standard from the 3 experts, including 2 Thai experts and 1 Chinese experts (List name in Appendix A) using the developed conformity assessment form of problem-based learning instructional model.

Data Analysis

Descriptive analysis i.e. frequency and percentage.

The acceptable items must not be less than 100%.

Output Phase 2

Problem-based learning instructional model the appropriateness of which is confirmed by experts for further implementation shown in table 3.2.

Table 3.2 Summary the process to do in Phase 2

Topics	Details
Research process	Develop problem-based learning instructional model in terms of accuracy standards, propriety standards, feasibility standards, and utility standards.
Research objective 2	To develop problem-based learning instructional model to enhance critical thinking ability of undergraduate students.
Research instrument	Designing instrument (the questionnaire for IOC). Designing instrument about the questionnaire on confirming the instructional. Assess the validity by 3 experts (List name in Appendix A).
Target group	3 experts through Item-Objective Congruence (IOC) according to the criteria.
Instrument	Questionnaires The handout for 3 experts through Item-Objective Congruence (IOC)
Data analysis	Descriptive analysis i.e. frequency and percentage. The acceptable items must not be less than 100%.
Output	The problem-based learning Instructional model the appropriateness of which is confirmed by experts for further implementation.

Phase 3 was conducted to answer research objective 3: To study the results of problem-based learning instructional model to enhance critical thinking ability of undergraduate students.

Population

The total of 150 Sophomore students from 3 classes of students with different levels of learning achievement who enroll in College Students' Career Guidance Course at Guangxi University of Finance and Economics in semester 1 academic year 2024. Those sections involve the following.

50 students in class A

50 students in class B

50 students in class C

The Sample Group

The 50 students who enrolled in College Students' Career Guidance Course from class section B are obtained by cluster random sampling.

Research Design

Table 3.3 Posttest Only Experimental Design

Group	X	T1
Sample Group	Problem-based learning instructional model	Critical thinking ability

X -- Problem-based learning instructional model

T1 -- Critical thinking ability

Research instruments

1. Lesson plans using problem-based learning instructional model

2. Rubric scoring form.

Designing instrument 1 (Lesson plans)

1. Study and design lesson plans with the following components: contents, objectives, methods of teaching, materials and 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 3 experts (List name from Appendix A) through Item-Objective Congruence (IOC) according to the criteria as 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 related to the topics

The acceptable items must have the IOC values not less than 0.6. 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)

Rubric scoring form

1. Study the rubric scoring criteria aligned with critical thinking ability.

2. Design 5-point range rubric scoring criteria. (From Appendix D).

3. Present 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 3 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 0.6. The IOC calculated from the validation measures 1.00.

Data Collection

1. Ask for permission of data collection from Guangxi University of Finance and Economics.

2. Collect students' performance of critical thinking ability by using rubric scoring before assessment by external raters.

Data Analysis

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

Table 3.4 Criteria to evaluate 1 Perception ability

Score	Grade
9-10	Excellent
7-8	Good
5-6	Medium
3-4	Pass
Less than 3	Poor

Table 3.5 Criteria to evaluate 2 Analytical ability

Score	Grade
9-10	Excellent
7-8	Good
5-6	Medium
3-4	Pass
Less than 3	Poor

Table 3.6 Criteria to evaluate 3 Reasoning ability

Score	Grade
9-10	Excellent
7-8	Good
5-6	Medium
3-4	Pass
Less than 3	Poor

Table 3.7 Criteria to evaluate 4 Evaluation ability

Score	Grade
9-10	Excellent
7-8	Good
5-6	Medium
3-4	Pass
Less than 3	Poor

Table 3.8 Criteria to evaluate 5 Problem-solving ability

Score	Grade
9-10	Excellent
7-8	Good
5-6	Medium
3-4	Pass
Less than 3	Poor

Table 3.9 Criteria to evaluate 6 Reflective ability

Score	Grade
9-10	Excellent
7-8	Good
5-6	Medium
3-4	Pass
Less than 3	Poor

Table 3.10 Criteria to evaluate critical thinking ability

Score	Grade
49-60	Excellent
37-48	Good
25-36	Medium
13-24	Pass
Less than 13	Poor

Output Phase 3

The results of implementing problem-based learning instructional model will enhance critical thinking ability of undergraduate students at a level good ≥80% according to rubric scoring criteria into their levels descriptor by table 3.11.

Table 3.11 Summary the process to do in Phase 3

Topics	Details
Research process	Conformity assessment form of lesson plans and rubric scoring in terms.
Research objective 3	To study the results of problem-based learning instructional model to enhance critical thinking ability of undergraduate students.
Conduct research	Design handouts and implement teaching in accordance with the principles and steps, goals and contents, teaching methods and evaluation of teaching based on problem-based learning instructional model

Table 3.11 (Continued)

Topics	Details
The sample group	1. The 50 students who enrolled in College Students' Career Guidance course from class section B are obtained by cluster sampling. 2. By 3 experts through Item-Objective Congruence (IOC) according to the criteria.
Instrument	Lesson plan for 3 experts through Item-Objective Congruence (IOC) Rubric score form for 3 experts through Item-Objective Congruence (IOC)
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. Descriptive analysis i.e. frequency and percentage. The critical thinking ability of undergraduate students at a level good ≥80%.
Output	The suitability of Lesson plan and rubric scoring will been confirmed by experts and can be used for teaching experiments.

Chapter 4
Results of Analysis

The purpose of this chapter is to present the results of the study. In the study of "Development of Problem-Based Learning Instructional Model to Enhance Critical Thinking Ability of Undergraduate Students", the researcher studied the documents concerning the following.

Objective 1: To examine the factors affecting critical thinking ability of undergraduate students.

Objective 2: To develop problem-based learning instructional model to enhance critical thinking ability of undergraduate students.

Objective 3: To study the results of problem-based learning instructional model to enhance critical thinking ability of undergraduate students.

The results of the data analysis will be represented with symbols and meanings, as follows:

N - The population

μ - Mean

σ - Standard Deviation

Data Analysis Results

Part 1: Analysis results serving objective 1: To examine the factors affecting critical thinking ability of undergraduate students.

The common data of the respondents is shown in table 4.1.

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

Data	Frequency	Percentage
Gender		
Male	48	32.00
Female	102	68.00
Total	**150**	**100.00**
Age		
A. below 18 yrs.	0	0.00
B. 18-19 yrs.	18	12.00
C. 20-21 yrs.	93	62.00
D. over 21 yrs.	39	26.00
Total	**150**	**100.00**

Table 4.1 shows the results of the common data on gender and age for the respondents overall. It was found the difference in the proportion of men and women, with 32% of wen and 68% of women. Since there are more liberal arts majors in the three universities, and the proportion of female students is naturally higher, the sample is consistent with the actual gender of the schools. The age distribution of students is highest in the 20-21 year old age group at 62%, the age of students is over 21 years old at 26%, while the age of students is between 18-19 years old at only 12%.

Table 4.2 The result of questionnaire from students in overview (N=150)

Factors	μ	σ	Level	Ranking
Internal factors (Psychology or physiology, Attitude, Knowledge or skills)				
1. Students realize the importance of the College Students' Career Guidance course and firmly believe that critical thinking ability are of great help to future career choice and personal development.	4.31	.795	high	6

Table 4.2 (Continued)

Factors	μ	σ	Level	Ranking
2. Students believe that good personality, stable mood and friendly way of getting along will contribute to collecting, identifying and processing career information, which improves their critical thinking ability.	4.47	.766	high	1
3. Students believe that it is very important for students to have a good learning attitude towards College Students' Career Guidance course. They consider that thinking positively in class and summing up meticulously after class for students in the course could help students to collect, identify and deal with career information and improve job-hunting skills, which will enhance critical thinking ability.	4.39	.723	high	2
4. Students believe that students can combine their personal interests, majors and values to effectively plan their future careers and enhance their job search competitiveness through College Students' Career Guidance course. Because when you participate in the interview, you can better show your own advantages, and conduct in-depth analysis of professional problems or phenomena.	4.32	.754	high	4
5. The significance of the prior knowledge is to help students build a bridge between new knowledge and that they have already in College Students' Career Guidance course. After learning theoretical knowledge, students acquire vocational knowledge through various online platforms and digital resources, which helps to improve students' vocational cognitive ability.	4.21	.756	high	11

Table 4.2 (Continued)

Factors	μ	σ	Level	Ranking
6.Students believe that taking notes and participating in discussions in class can better understand and master new knowledge.	4.19	.766	high	12
Total Average of Internal factors	**4.32**	**.655**	**high**	
External factors(Method of teaching, Materials, Environment)				
7.Students believe that teachers adopt a variety of teaching methods such as case analysis, scenario simulation, role playing and group discussion in College Students' Career Guidance course, which can stimulate students' learning interest and promote the development of students' critical thinking ability.	4.29	.710	high	8
8.Students believe that teachers take the ability as the orientation, take the problem as the driving force, pay attention to the creation of situations, and guide students to think independently in College Students' Career Guidance course, which is conducive to improving their critical thinking ability.	4.31	.695	high	5
9.Students believe that teachers use rich digital teaching resources, such as digital education platforms, online teaching videos, to achieve diversified learning in College Students' Career Guidance course, which helps improve their critical thinking ability.	4.27	.720	high	10
10.Students believe that teachers choice of teaching materials around their critical thinking skills training objectives, and providing cases and training materials closely related to their study life and future career can help promote the development of students' critical thinking ability.	4.27	.713	high	9

Table 4.2 (Continued)

Factors	μ	σ	Level	Ranking
11.Students believe that appropriate class size, relaxed classroom atmosphere, full use of social resources and experiential education in College Students' Career Guidance course, which can help them improve their critical thinking ability in employment practice.	4.33	.682	high	3
12.The campus can access the Internet anytime and anywhere, the classroom is clean and bright, the desks and chairs are warm and comfortable, and the multimedia equipment is complete, which facilitates the teaching process. Such conditions could improve students' problem-solving ability and critical thinking ability.	4.29	.679	high	7
Total Average of External Factors	**4.29**	**.616**	**high**	

The results of table 4.2 shows that the internal factors affecting critical thinking ability are found to be at a high level (μ=4.32). From the perspective of each item, it was found that No.2 has highest mean (μ=4.47), followed by No.3 (μ=4.39), while No.6 has lowest mean (μ=4.19).

For external factors affecting the critical thinking, the overall level is found to at a high level (μ=4.29). From the perspective of each item, it was found that No.11 has highest mean (μ=4.39), followed by No.8 (μ=4.31), while No.9 has lowest mean (μ=4.27).

Table 4.3 Common data of the respondent in Guangxi University of Finance and Economics. (N=50)

Data	Frequency	Percentage
Gender		
A. Male	14	28.00
B. Female	36	72.00
Total	**50**	**100.00**
Age		
A. below 18 yrs.	0	0.00
B. 18-19 yrs.	5	10.00
C. 20-21 yrs.	32	64.00
D. over 21 yrs.	13	26.00
Total	**50**	**100.00**

From table 4.3 the common data of the respondent in Guangxi University of Finance and Economics shows that the most gender is female, accounting for 72%. The age distribution of students is highest in the 20-21 years old age, accounting for 64%, consistent with the distribution of overall statistics.

Table 4.4 The result of questionnaire from students in Guangxi University of Finance and Economics. (N=50)

Factors	μ	σ	Level	Ranking
Internal factors (Psychology or physiology, Attitude, Knowledge or skills)				
1.Students realize the importance of the College Students' Career Guidance course and firmly believe that critical thinking ability are of great help to future career choice and personal evelopment.	4.36	.722	high	1

Table 4.4 (Continued)

Factors	μ	σ	Level	Ranking
2.Students believe that good personality, stable mood and friendly way of getting along will contribute to collecting, identifying and processing career information, which improves their critical thinking ability.	4.32	.794	high	4
3.Students believe that it is very important for students to have a good learning attitude towards College Students' Career Guidance course. They consider that thinking positively in class and summing up meticulously after class for students in the course could help students to collect, identify and deal with career information and improve job-hunting skills, which will enhance critical thinking ability.	4.32	.741	high	2
4.Students believe that students can combine their personal interests, majors and values to effectively plan their future careers and enhance their job search competitiveness through College Students' Career Guidance course. Because when you participate in the interview, you can better show your own advantages, and conduct in-depth analysis of professional problems or phenomena.	4.32	.741	high	3
5.The significance of the prior knowledge is to help students build a bridge between new knowledge and that they have already in College Students' Career Guidance course. After learning theoretical knowledge, students acquire vocational knowledge through various online platforms and digital resources, which helps to improve students' vocational cognitive ability.	4.24	.744	high	8

Table 4.4 (Continued)

Factors	μ	σ	Level	Ranking
6.Students believe that taking notes and participating in discussions in class can better understand and master new knowledge.	4.22	.679	high	10
Total Average of Internal factors	**4.30**	**.647**	**high**	
External factors(Method of teaching, Materials, Environment)				
7.Students believe that teachers adopt a variety of teaching methods such as case analysis, scenario simulation, role playing and group discussion in College Students' Career Guidance course, which can stimulate students' learning interest and promote the development of students' critical thinking ability.	4.26	.694	high	7
8.Students believe that teachers take the ability as the orientation, take the problem as the driving force, pay attention to the creation of situations, and guide students to think independently in College Students' Career Guidance course, which is conducive to improving their critical thinking ability	4.30	.678	high	5
9.Students believe that teachers use rich digital teaching resources, such as digital education platforms, online teaching videos, to achieve diversified learning in College Students' Career Guidance course, which helps improve their critical thinking ability.	4.24	.797	high	9
10.Students believe that teachers choice of teaching materials around their critical thinking skills training objectives, and providing cases and training materials closely related to their study life and future career can help promote the development of students' critical thinking ability.	4.20	.756	high	11

Table 4.4 (Continued)

Factors	μ	σ	Level	Ranking
11.Students believe that appropriate class size, relaxed classroom atmosphere, full use of social resources and experiential education in College Students' Career Guidance course, which can help them improve their critical thinking ability in employment practice.	4.30	.678	high	6
12.The campus can access the Internet anytime and anywhere, the classroom is clean and bright, the desks and chairs are warm and comfortable, and the multimedia equipment is complete, which facilitates the teaching process Such conditions could improve students' problem-solving ability and critical thinking ability..	4.20	.700	high	12
Total Average of External Factors	**4.25**	**.631**	**high**	

The results of table 4.4 shows that the internal factors affecting critical thinking ability are found to be at a high level (μ=4.30). From the perspective of each item, it was found that No.1 has highest mean (μ=4.36), followed by No.3 (μ=4.32), while No.6 has lowest mean (μ=4.22).

For external factors affecting the critical thinking, the overall level is found to at a high level (μ=4.25). From the perspective of each item, it was found that No.8 has highest mean (μ=4.30), followed by No.7 (μ=4.26), while No.12 have lowest mean (μ=4.20).

Table 4.5 Common data of the respondent in Baise University. (N=50)

Data	Frequency	Percentage
Gender		
A. Male	13	26.00
B. Female	37	74.00
Total	**50**	**100.00**
Age		
A. below 18 yrs.	0	0.00
B. 18-19 yrs.	8	16.00
C. 20-21 yrs.	29	58.00
D. over 21 yrs.	13	26.00
Total	**50**	**100.00**

From table 4.5 the common data of the respondent in Baise University shows that the most gender is female, accounting for 74%.The age distribution of students is highest in the 20-21 years old age, accounting for 58%, consistent with the distribution of overall statistics.

Table 4.6 The result of questionnaire from students in Baise University. (N=50)

Factors	μ	σ	Level	Ranking
Internal factors (Psychology or physiology, Attitude, Knowledge or skills)				
1.Students realize the importance of the College Students' Career Guidance course and firmly believe that critical thinking ability are of great help to future career choice and personal development.	4.40	.728	high	7
2.Students believe that good personality, stable mood and friendly way of getting along will contribute to collecting, identifying and processing career information, which improves their critical thinking ability.	4.68	.587	highest	1

Table 4.6 (Continued)

Factors	μ	σ	Level	Ranking
3.Students believe that it is very important for students to have a good learning attitude towards College Students' Career Guidance course. They consider that thinking positively in class and summing up meticulously after class for students in the course could help students to collect, identify and deal with career information and improve job-hunting skills, which will enhance critical thinking ability.	4.54	.613	highest	2
4. Students believe that students can combine their personal interests, majors and values to effectively plan their future careers and enhance their job search competitiveness through College Students' Career Guidance course. Because when you participate in the interview, you can better show your own advantages, and conduct in-depth analysis of professional problems or phenomena.	4.52	.544	highest	3
5.The significance of the prior knowledge is to help students build a bridge between new knowledge and that they have already in College Students' Career Guidance course. After learning theoretical knowledge, students acquire vocational knowledge through various online platforms and digital resources, which helps to improve students' vocational cognitive ability.	4.34	.626	high	11
6.Students believe that taking notes and participating in discussions in class can better understand and master new knowledge.	4.30	.707	high	12
Total Average of Internal factors	**4.46**	**.501**	**high**	
External factors(Method of teaching, Materials, Environment)				
7.Students believe that teachers adopt a variety of teaching methods such as case analysis,	4.40	.639	high	6

Table 4.6 (Continued)

Factors	μ	σ	Level	Ranking
scenario simulation, role playing and group discussion in College Students' Career Guidance course, which can stimulate students' learning interest and promote the development of students' critical thinking ability.				
8.Students believe that teachers take the ability as the orientation, take the problem as the driving force, pay attention to the creation of situations, and guide students to think independently in College Students' Career Guidance course, which is conducive to improving their critical thinking ability.	4.38	.635	high	9
9.Students believe that teachers use rich digital teaching resources, such as digital education platforms, online teaching videos, to achieve diversified learning in College Students' Career Guidance course, which helps improve their critical thinking ability.	4.34	.625	high	10
10.Students believe that teachers choice of teaching materials around their critical thinking skills training objectives, and providing cases and training materials closely related to their study life and future career can help promote the development of students' critical thinking ability.	4.44	.577	high	4
11.Students believe that appropriate class size, relaxed classroom atmosphere, full use of social resources and experiential education in College Students' Career Guidance course, which can help them improve their critical thinking ability in employment practice	4.42	.575	high	5
12.The campus can access the Internet anytime and anywhere, the classroom is clean and bright, the desks and chairs are warm and	4.38	.530	high	8

Table 4.6 (Continued)

Factors	μ	σ	Level	Ranking
comfortable, and the multimedia equipment is complete, which facilitates the teaching process. Such conditions could improve students' problem-solving ability and critical thinking ability.				
Total Average of External Factors	**4.39**	**.505**	**high**	

The results of table 4.6 shows that the internal factors affecting critical thinking ability are found to be at a high level (μ=4.46). From the perspective of each item, it was found that No.2 has highest mean (μ=4.68), followed by No.3 (μ=4.54), while No.6 has lowest mean (μ=4.30).

For external factors affecting the critical thinking, the overall level is found to at a high level (μ=4.39). From the perspective of each item, it was found that No.10 has highest mean (μ=4.44), followed by No.11 (μ=4.42), while No.9 has lowest mean (μ=4.34).

Table 4.7 Common data of the respondent in Guangxi Minzu University. (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.	0	0.00
B. 18-19 yrs.	5	10.00
C. 20-21 yrs.	32	64.00
D. over 21 yrs.	13	26.00
Total	**50**	**100.00**

From table 4.7 the common data of the respondent in Guangxi Minzu University shows that there were 21 male students, accounting for 42%, and 29 female students, accounting for 58%. The age distribution of students is highest in the 20-21 years old age, accounting for 64%, consistent with the distribution of overall statistics.

Table 4.8 The result of questionnaire from students in Guangxi Minzu University (N=50)

Factors	μ	σ	Level	Ranking
Internal factors (Psychology or physiology, Attitude, Knowledge or skills)				
1.Students realize the importance of the College Students' Career Guidance course and firmly believe that critical thinking ability are of great help to future career choice and personal development.	4.18	.919	high	9
2.Students believe that good personality, stable mood and friendly way of getting along will contribute to collecting, identifying and processing career information, which improves their critical thinking ability.	4.40	.857	high	1
3.Students believe that it is very important for students to have a good learning attitude towards College Students' Career Guidance course. They consider that thinking positively in class and summing up meticulously after class for students in the course could help students to collect, identify and deal with career information and improve job-hunting skills, which will enhance critical thinking ability.	4.32	.792	high	2
4. Students believe that students can combine their personal interests, majors and values to effectively plan their future careers and enhance their job search competitiveness through College Students' Career Guidance course. Because	4.12	.895	high	10

Table 4.8 (Continued)

Factors	μ	σ	Level	Ranking
when you participate in the interview, you can better show your own advantages, and conduct in-depth analysis of professional problems or phenomena.				
5.The significance of the prior knowledge is to help students build a bridge between new knowledge and that they have already in College Students' Career Guidance course. After learning theoretical knowledge, students acquire vocational knowledge through various online platforms and digital resources, which helps to improve students' vocational cognitive ability.	4.06	.867	high	11
6.Students believe that taking notes and participating in discussions in class can better understand and master new knowledge.	4.06	.890	high	12
Total Average of Internal factors	**4.19**	**.773**	**high**	
External factors(Method of teaching, Materials, Environment)				
7.Students believe that teachers adopt a variety of teaching methods such as case analysis, scenario simulation, role playing and group discussion in College Students' Career Guidance course, which can stimulate students' learning interest and promote the development of students' critical thinking ability.	4.22	.790	high	7
8.Students believe that teachers take the ability as the orientation, take the problem as the driving force, pay attention to the creation of situations, and guide students to think independently in College Students' Career Guidance course, which is conducive to improving their critical thinking ability	4.24	.771	high	5

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Table 4.8 (Continued)

Factors	μ	σ	Level	Ranking
9.Students believe that teachers use rich digital teaching resources, such as digital education platforms, online teaching videos, to achieve diversified learning in College Students' Career Guidance course, which helps improve their critical thinking ability.	4.22	.737	high	6
10.Students believe that teachers choice of teaching materials around their critical thinking skills training objectives, and providing cases and training materials closely related to their study life and future career can help promote the development of students' critical thinking ability.	4.18	.774	high	8
11.Students believe that appropriate class size, relaxed classroom atmosphere, full use of social resources and experiential education in College Students' Career Guidance course, which can help them improve their critical thinking ability in employment practice.	4.28	.784	high	3
12.The campus can access the Internet anytime and anywhere, the classroom is clean and bright, the desks and chairs are warm and comfortable, and the multimedia equipment is complete, which facilitates the teaching process. Such conditions could improve students' problem-solving ability and critical thinking ability.	4.28	.784	high	4
Total Average of External Factors	**4.24**	**.718**	**high**	

The results of table 4.8 shows that the internal factors affecting critical thinking ability are found to be at a high level (μ=4.19). From the perspective of each item, it was found that No.2 has highest mean (μ=4.40), followed by No.3 (μ=4.32), while No.6 has lowest mean (μ=4.06).

For external factors affecting the critical thinking, the overall level is found to at a high level (μ=4.24). From the perspective of each item, it was found that No.11 has highest mean (μ=4.28), followed by No.8 (μ=4.24), while No.10 has lowest mean (μ=4.18).

The lecturers interview analysis results

The interviews include three lecturers who taught the College Students' Career Guidance course in 1st semester of 2024 academic year. One lecture is from Guangxi University of Finance and Economics, one is Lecture from Baise University, one Lecture is from Guangxi Minzu University. The common data of the respondents are shown in table 4.9.

Table 4.9 Common data of the respondents in Guangxi Province overall. (N=3)

Data	Frequency	Percentage
Gender		
A. Male	1	33.30
B. Female	2	66.70
Total	**3**	**100.00**
Teaching experience		
A. below 3 yrs.	0	0.00
B. 3-6 yrs.	0	0.00
C. 7- 9 yrs.	1	33.30
D. over 9 yrs.	2	66.70
Total	**3**	**100.00**
Age		
A. below 30 yrs.	0	0.00
B. 30-40 yrs.	1	33.30
C. 41-50 yrs.	2	66.70
D. Over 50 yrs.	0	0.00
Total	**3**	**100.00**
Professional title		
A. Professor	0	0.00
B. Associate Professor	2	66.70
C. Assistant Professor	0	0.00
D. Lecturer	1	33.30
Total	**3**	**100.00**

From table 4.9 the common data of the lecturers shows that the most gender is female, accounting for 66.70% of the respondents, the most teaching experience falls in the range of above 9 years, making up 66.70%, while the most age is in the range of 41-50 years old, making up 66.7%.

Interview Lecturers Results

After interviews with three lecturers, the factors that affect critical thinking ability of undergraduate students are summarized as follows.

Internal Factors

Psychology or physiology

The lecturers believed that the teacher's mood and attitude of facing difficulties have an important impact on the improvement of students' critical thinking ability, which is mainly reflected in the following aspects: First, the teacher's mood and attitude will affect the whole class. When teachers show positive emotions and optimistic attitude, students are more willing to participate in classroom teaching discussions and think independently. Secondly, teachers' positive emotions and optimistic attitude can create a safe learning environment in which students are more willing to express their views and stimulate their creativity. Thirdly, teachers' positive emotions and optimistic attitude can stimulate students' interest and motivation. When teachers demonstrate passion and interest in the profession, students are motivated to explore and research their preferred profession more deeply.

Attitude

The lecturers believed that when teachers are proud and satisfied with their profession, they will be passionate and motivated in teaching and actively participate in their own teaching process. A good teacher-student relationship makes students more willing to open their minds, express their personal opinions, and accept new ideas and challenges to promote students' critical thinking skills. The team spirit of the faculty encourages interaction and collaboration among students, as well as exploring and challenging existing ideas together to find the best solutions.

The lecturers said that when teachers show positive personal enthusiasm and enthusiasm for learning in the course, they will present knowledge in a more vivid and interesting way, guide students to focus on multiple aspects of the problem, and

put forward more in-depth and comprehensive viewpoints, which will help improve students' critical thinking ability.

Knowledge or skills

In the College Students' Career Guidance course, teachers with broad and deep knowledge can provide students with rich information on the job market and career development. When students are faced with a variety of career options and challenges, teachers' wealth of knowledge can help students better understand issues, present insightful perspectives, and make informed decisions. Teachers' good teaching skills can guide students to analyze problems deeply and examine problems from multiple angles, and cultivate students' ability of analysis, induction and reasoning.

In the interview, the lecturers mentioned that strengthening the continuing education training and professional practice of career guidance course teachers plays an important role in improving the critical thinking ability of college students. With the rapid changes in society and the job market, teachers need to constantly update their knowledge and skills to provide students with more accurate and practical career guidance. Through the training of teaching skills, teachers know how to design challenging and inspiring teaching activities, how to effectively impart knowledge and evaluate students' learning outcomes, which helps to improve the critical thinking ability of college students.

External Factors

Teaching Methods

In the interview, the lecturer said that in the teaching of the College Students' Career Guidance course, teachers adopt a variety of teaching methods (such as problem-driven, group cooperation, role playing, etc.), to guide students to discuss specific topics or problems, stimulate students' active thinking, and encourage students to analyze and solve problems from different perspectives. However, in the current teaching situation, some teachers have a single teaching organization form, which is mainly based on traditional teaching, and it is difficult to stimulate students' learning interest and participation.

The lecturers mentioned that in the classroom, teachers create an open and inclusive learning atmosphere, set challenging questions, guide discussion and

questioning, and design diverse assessment tools to improve students' critical thinking ability.

The lecturer said that digital transformation of education has become a global consensus. Teachers use new ICT (information and communications technology) and online resources in classroom teaching to provide students with broader and deeper information than traditional textbooks, provide students with hands-on participation in simulation experiments or scenarios, provide convenient collaborative learning platforms, and personalized learning support, which can greatly improve students' reasoning and critical thinking ability.

Materials

In the interview, the lecturer said that teachers tend to use a variety of teaching materials to enrich their teaching content and enhance the learning experience of students. The teaching materials commonly used by teachers, such as teaching materials, industry reports, online simulation recruitment platforms, workplace interview videos, etc. These teaching materials help students use critical thinking ability to analyze their own strengths and weaknesses, evaluate the development trend of the industry, and analyze the successful experience and lessons of professionals, which will help students become more competitive and adaptable in the future workplace.

Environment

In the College Students' Career Guidance course, a positive, interactive and open teaching environment is essential to improve students' critical thinking skills. Class sizes should be moderate, with no more than 60 students, to ensure that each student has more opportunities to participate in class discussions and more personalized instruction for students. A wealth of book resources help students gain an in-depth understanding of industry trends and development paths, and inspire students to actively search, analyze and evaluate information. A good classroom atmosphere can stimulate students' interest in learning and encourage them to think independently and proactively.

In the College Students' Career Guidance course, teachers hope that universities can provide teaching conditions to carry out innovation and entrepreneurship education and vocational education, so as to provide students with a more comprehensive and in-depth learning experience. By participating in

innovative educational practices, students learn how to find, analyze and solve problems, which not only helps improve students' critical thinking ability, but also makes them fully prepared for their future career development.

After analyzing data collected from both groups of informants, the researcher synthesizes those factors dividing them into 2 main types – internal and external factors as shown in table 4.10 below.

Table 4.10 Summary of factors affecting critical thinking ability for undergraduate students

Students' opinion		Lecturers' opinion		Synthesized opinion	
Internal Factors	**External Factors**	**Internal Factors**	**External Factors**	**Internal Factors**	**External Factors**
1) Students believe that critical thinking ability is helpful for future career choices and personal development. Personal character, emotion and learning motivation affect students' learning motivation and learning effect.	1) Students believe that the use of various teaching methods such as case analysis, scenario simulation, role playing and group discussion can stimulate students' interest in learning and promote the development of	1) The lecturers believe that critical thinking ability is of great help to students' future career choices and personal development. Teachers' mood, attitude towards difficulties and professional identity will affect	1) The lecturer believes that teachers use new ICT (information and communications technology) and online teaching resources in the classroom, and diversified teaching methods (such as problem-driven, group cooperation,	1) Psychology or physiology: Both teachers and students agree that critical ability is of great help to students' future career choices and personal development. Personal emotion, personality and learning motivation	1) Method of teaching: Both teachers and students indicated that the use of a variety of modern teaching techniques and teaching methods (such as problem driven, primary school cooperation, role playing, etc.) is helpful to stimulate students' interest in learning and

Table 4.10 (Continued)

Students' opinion		Lecturers' opinion		Synthesized opinion	
Internal Factors	**External Factors**	**Internal Factors**	**External Factors**	**Internal Factors**	**External Factors**
	students' critical thinking ability.	students' learning motivation and learning effect.	role playing, etc.) to guide students to discuss around specific topics or issues. It can stimulate students to think actively.	play an important role in the improvement of critical thinking ability.	active thinking.
2) Students believe that combining personal interests, disciplines and values in choosing a career can better demonstrate their own strengths and provide in-depth	2) Students believe that teachers' choice of appropriate teaching materials and use of rich digital teaching resources, such as digital education	2) Lecturers believe that when teachers are proud and satisfied with their profession, teaching is full of passion and motivation, and knowledge will be	2) The lecturers believe that teachers use a variety of teaching materials (such as textbooks, industry reports, workplace interview videos, etc.) to help students use critical	2) Attitude: Both teachers and students say that class is a process of teacher-student interaction. When teachers are full of passion in class, students' learning	2) Materials: Both teachers and students believe that diversified teaching Materials and teaching resources can meet the needs of different students and realize the diversification of

Table 4.10 (Continued)

Students' opinion		Lecturers' opinion		Synthesized opinion	
Internal Factors	**External Factors**	**Internal Factors**	**External Factors**	**Internal Factors**	**External Factors**
analysis of professional issues or phenomena.	platforms, online teaching videos, to achieve diversified learning can help improve their critical thinking ability.	presented in a more vivid and interesting way, which is conducive to students' in-depth and comprehensive analysis of problems.	thinking skills to analyze their own strengths and weaknesses, so as to be more competitive and adaptable in the future workplace.	motivation and learning effect are better.	students' learning.
3) Students believe that taking notes and participating in discussions in class can better understand and master new	3) Students believe that the appropriate class size, relaxed classroom atmosphere, complete Internet	3) Lecturers believe that teachers with broad and deep knowledge and strengthening teacher continuing	3) Lecturers believe that a positive, interactive and open teaching environment is essential to improve students' critical	3) Knowledge or skills: Both teachers and students believe that students' careful note-taking and participation in	3) Environment: Both teachers and students believe that appropriate class size, perfect teaching equipment and relaxed and

Table 4.10 (Continued)

Students' opinion		Lecturers' opinion		Synthesized opinion	
Internal Factors	**External Factors**	**Internal Factors**	**External Factors**	**Internal Factors**	**External Factors**
knowledge, thus improving students' critical thinking ability.	and multimedia equipment help students to participate in class discussions and express their views.	education can help students better understand issues, present insightful perspectives, and make informed decisions.	thinking skills. The class size is moderate and the classroom atmosphere is harmonious, which is conducive to students' open thinking and personal opinions.	discussions in class can help students better understand and master new knowledge, thus improving their critical thinking ability.	harmonious classroom atmosphere are conducive to students' open thinking and personal opinions, which can improve students' critical thinking ability.

From table 4.10 shows that the both student and teacher respondents unanimously agree that internal and external factors together influence the development of critical thinking ability for undergraduate students. Internal factors include psychological or physiological factors, attitude factors, knowledge or skills factors. Psychological or physiological factors include teachers' and students' cognition of critical thinking ability, good physical fitness, character and personality quality, stable mood and emotion, good habits of thinking and behavior, correct motivation for learning and a relaxed and pleasant way of getting along. Attitudes include students' interest and preference in the course, active participation in class discussions, independent and active thinking. Knowledge or skills includes students' existing cognitive structure, life experience and social experience.

External factors include method of teaching, materials and environment. Method of teaching include the use of a variety of modern teaching techniques, the selection of appropriate teaching methods, such as problem driven, group cooperation, role play, situational simulation, visit practice. Materials include teaching materials, industry reports, assessment software, online simulation recruitment platform, career interview videos, network resources and library resources. Environment includes two aspects: hard environment and soft environment. The hard environment includes classroom environment and teaching facilities, while the soft environment includes class size, class culture and learning atmosphere. A good learning environment can effectively improve students' learning results.

From the result of objective 1 about internal factor and external factor from the students and lecturers, the researcher took the result about internal factor : 1) psychology or physiology to motivate students’ learning, 2) Attitude to have interaction between students and lecturers, 3) knowledge or skill to help students better understand and master new knowledge. About external factor: 1) Method of teaching, the lecturers used the variety technique to motivate the students’ learning, 2) Materials, the lecturers used the variety materials to be suitable for the contents, 3) Environment, the lecturers provided a group of students, equipment and relaxed harmonious and atmosphere classroom. From above the lecturers took the result to do the handout in part 2 included lesson plan and scoring rubric form.

Part 2: Analysis results serving objective 2: To develop problem-based learning instructional model to enhance critical thinking ability of undergraduate students.

To serve objective 2, 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, and presented by frequency and percentage of the experts as shown in table and description below.

Table 4.11 Frequency and percentage of confirmability of utility, feasibility, propriety, and accuracy of the instructional model components in 3 areas by experts

No	Components of problem-based learning instructional model	Opinion of the experts															
		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	3	100.00	0	0.00	3	100.00	0	0.00	3	100.00	0	0.00	3	100.00	0	0.00
2	Objectives	3	100.00	0	0.00	3	100.00	0	0.00	3	100.00	0	0.00	3	100.00	0	0.00
3	Contents	3	100.00	0	0.00	3	100.00	0	0.00	3	100.00	0	0.00	3	100.00	0	0.00
4	Methods of Teaching & Materials	3	100.00	0	0.00	3	100.00	0	0.00	3	100.00	0	0.00	3	100.00	0	0.00
5	Evaluation	3	100.00	0	0.00	3	100.00	0	0.00	3	100.00	0	0.00	3	100.00	0	0.00

From table 4.11 the confirmability of each component of the instructional model by 3 experts 100 % 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 3 experts or 100% of all experts; feasibility by 3 experts or 100%; propriety by 3 experts or 100%; and accuracy by 3 experts or 100%.

Objectives

The utility of objectives of the instructional model is confirmed to be appropriate by 3 experts or 100% of all experts; feasibility by 3 experts or 100%; propriety by 3 experts or 100%; and accuracy by 3 experts or 100%.

Contents

The utility of contents of the instructional model is confirmed to be appropriate by 3 experts or 100% of all experts; feasibility by 3 experts or 100%; propriety by 3 experts or 100%; and accuracy by 3 experts or 100%.

Methods of Teaching & Materials

The utility of methods of teaching & materials of the instructional model is confirmed to be appropriate by 3 experts or 100% of all experts; feasibility by 3 experts or 100%; propriety by 3 experts or 100%; and accuracy by 3 experts or 100%.

Evaluation

The utility of evaluation of the instructional model is confirmed to be appropriate by 3 experts or 100% of all experts; feasibility by 3 experts or 100%; propriety by 3 experts or 100%; and accuracy by 3 experts or 100%.

Part 3: Analysis results serving objective 3: To study the results of problem-based learning instructional model to enhance critical thinking ability of undergraduate students.

This section provides the results of of implementing problem-based learning instructional model to enhance critical thinking ability of undergraduate students. The analysis results are presented by reporting undergraduate students' performance according to rubric score-based assessment criteria and satisfaction of critical thinking ability through problem-based learning instructional model as specified in chapter 3 with tables and descriptive analysis.

Critical thinking over all 12 standards

Table 4.12 Relative developmental score of students' critical thinking ability (Summary the level: Critical thinking ability over all 12 standards) enhancement through problem-based learning instructional model.

Score	Grade
49-60	Excellent
37-48	Good
25-36	Medium
13-24	Pass
Less than 13	Poor

Table 4.13 Summary at excellent level: Critical thinking ability over all 12 standards

Aspects of assessment	Frequency	Percentage	Ranking
1. Perception ability	12	24.00	1
2. Analytical ability	11	22.00	2
3. Reasoning ability	8	16.00	5
4. Evaluation ability	8	16.00	5
5. Problem-solving ability	10	20.00	3
6. Reflective ability	9	18.00	4

Table 4.13 shows that after implementing the problem-based learning instructional model, students' performance assessed at excellent level. The first was“Perception ability”, accounting for 24%, the second was “Analytical ability”, accounting for 22%, the last were“Reasoning ability”and“Evaluation ability”, both accounting for 16%.

Table 4.14 Summary at good level: Critical thinking ability over all 12 standards

Aspects of assessment	Frequency	Percentage	Ranking
1. Perception ability	33	66.00	3
2. Analytical ability	33	66.00	3
3. Reasoning ability	35	70.00	1
4. Evaluation ability	33	66.00	3
5. Problem-solving ability	32	64.00	6
6. Reflective ability	34	68.00	2

Table 4.14 shows that after implementing the problem-based learning instructional model, students' performance assessed at good level. The first was“Reasoning ability”, accounting for 70%, the second was “Reflective ability”, accounting for 68%, the last was“Problem-solving ability”, accounting for 64%.

Table 4.15 Summary at medium level: Critical thinking ability over all 12 standards

Aspects of assessment	Frequency	Percentage	Ranking
1. Perception ability	5	10.00	6
2. Analytical ability	6	12.00	5
3. Reasoning ability	7	14.00	3
4. Evaluation ability	9	18.00	1
5. Problem-solving ability	8	16.00	2
6. Reflective ability	7	14.00	3

Table 4.15 shows that after implementing the problem-based learning instructional model, students' performance assessed at medium level. The first was“Evaluation ability”, accounting for 18%, the second was “Problem-solving ability”, accounting for 16%, the last was“Perception ability”, accounting for 10%.

Table 4.16 Summary the level: Critical thinking ability over all 12 standards

Development level	Frequency	Percentage
Excellent	9	18.00
Good	37	74.00
Medium	4	8.00
Pass	0	0.00
Poor	0	0.00

Summary the level of students' critical thinking ability through problem-based learning instructional model in figure 4.1.

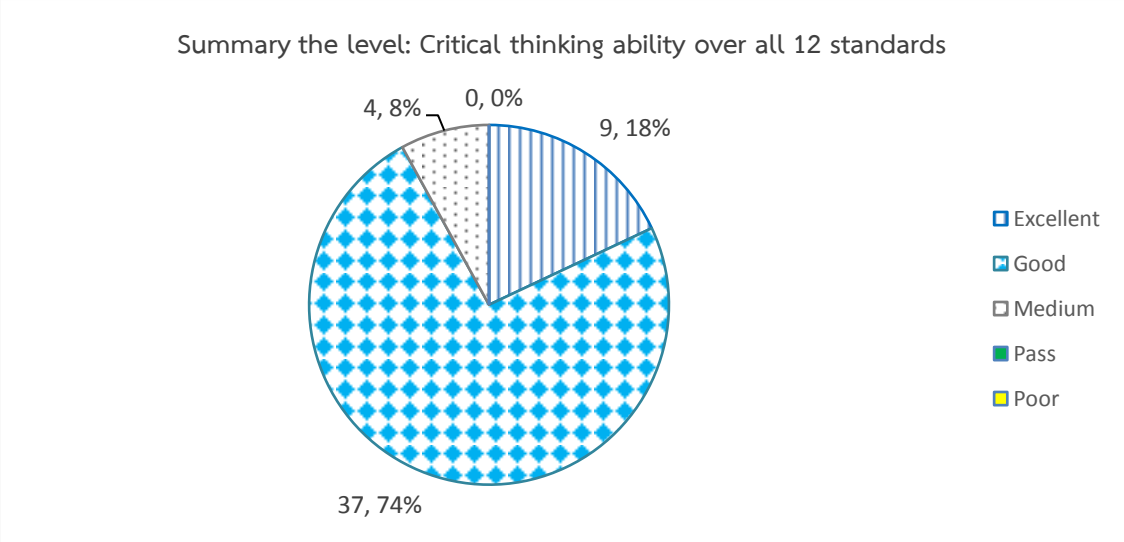

Figure 4.1 Relative the level of students' critical thinking ability (Summary the level: Critical thinking ability over all 12 standards) through problem-based learning instructional model

Table 4.16 shows that after implementing the problem-based learning instructional model, most of the students (92%) showed a good or excellent level of critical thinking ability. Among them, 9 were excellent (18%), 37 were good (74%), 4 were medium (8%), there were no student at a pass or poor development level of critical thinking ability.

Overall, as can be seen from figure 4.1, after implementing the problem-based learning instructional model, the critical thinking ability of most students (92%) has been improved. This result is consistent with the research hypothesis that after implementing the problem-based learning instructional model, students' critical thinking ability will increase by 80% overall (Good level or higher). Therefore, we can conclude that the problem-based learning instructional model is effective for enhancing undergraduate students' critical thinking ability.

Perception ability

Table 4.17 Relative developmental score of students' critical thinking ability (Criteria to evaluate 1. Perception ability) enhancement through problem-based learning instructional model.

Criteria to evaluate 1: Perception ability

Standard 1: Collecting employment information Standard 2: Screening employment information	
Score	**Grade**
9-10	Excellent
7-8	Good
5-6	Medium
3-4	Pass
Less than 3	Poor

Summary the level item 1: Perception ability

Development level	Frequency	Percentage
Excellent	12	24.00
Good	33	66.00
Medium	5	10.00
Pass	0	0.00
Poor	0	0.00

Summary the level item 1 Perception ability through problem-based learning instructional model in figure 4.2.

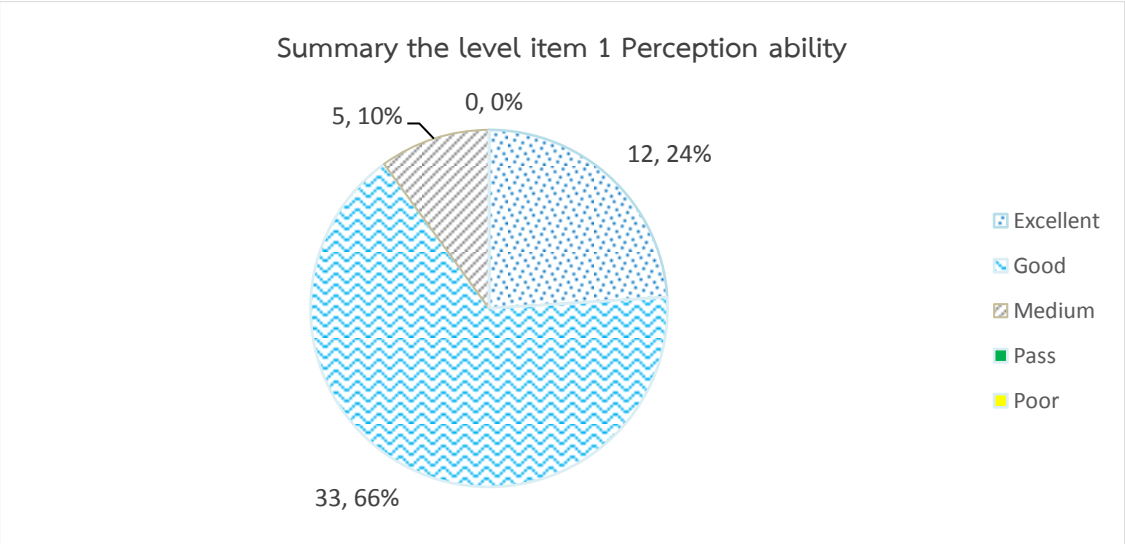

Figure 4.2 Relative the level of students' critical thinking ability (Summary the level item 1. Perception ability) through problem-based learning instructional model

From table 4.17 and figure 4.2, it can be seen that most of the students (90%) showed a good or excellent level of perception ability, exceeding the expected 80% in the research hypothesis. Among them, 12 were excellent (24%), 33 were good (66%), 5 were medium (10%), there were no student at a pass or poor development level of perception ability. This indicates that the problem-based learning instructional model has a significant positive impact on students' critical thinking ability.

Analytical ability

Table 4.18 Relative developmental score of students' critical thinking ability (Criteria to evaluate 2. Analytical ability) enhancement through problem-based learning instructional model.

Criteria to evaluate 2: Analytical ability	
Standard 1: Analyzing employment information	
Standard 2: Determining employment information	
Score	**Grade**
9-10	Excellent
7-8	Good
5-6	Medium

Table 4.18 (Continued)

Score	Grade
3-4	Pass
Less than 3	Poor

Summary the level item 2: Analytical ability

Development level	Frequency	Percentage
Excellent	11	22.00
Good	33	66.00
Medium	6	12.00
Pass	0	0.00
Poor	0	0.00

Summary the level item 2 Analytical ability through problem-based learning instructional model in figure 4.3.

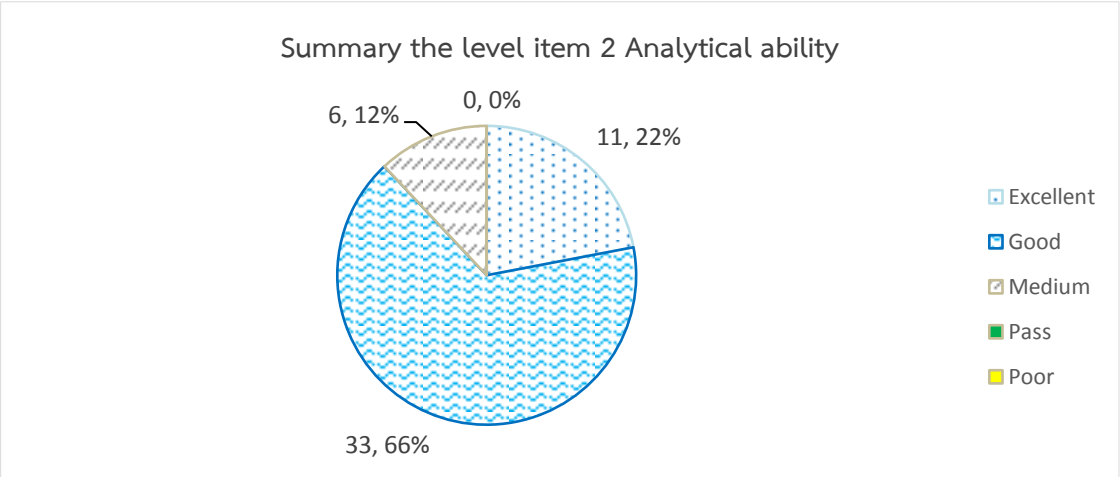

Figure 4.3 Relative the level of students' critical thinking ability (Summary the level item 2. Analytical ability) through problem-based learning instructional model

From table 4.18 and figure 4.3, it can be seen that most of the students (88%) showed a good or excellent level of analytical ability, exceeding the expected 80% in the research hypothesis. Among them, 11 were excellent (22%), 33 were good (66%), 6 were medium (12%), there were no student at a pass or poor development level of analytical ability. This indicates that the problem-based learning instructional model has a significant positive impact on students' critical thinking ability.

Reasoning ability

Table 4.19 Relative developmental score of students' critical thinking ability (Criteria to evaluate 3. Reasoning ability) enhancement through problem-based learning instructional model.

Criteria to evaluate 3: Reasoning ability

Standard 1: Using employment theories and methods to inference the needs of employers

Standard 2: Creating a resume and prepare for an interview based on employment skills

Score	Grade
9-10	Excellent
7-8	Good
5-6	Medium
3-4	Pass
Less than 3	Poor

Summary the level item 3: Reasoning ability

Development level	Frequency	Percentage
Excellent	8	16.00
Good	35	70.00
Medium	7	14.00
Pass	0	0.00
Poor	0	0.00

Summary the level item 3: Reasoning ability

Summary the level item 3 Reasoning ability through problem-based learning instructional model in figure 4.4.

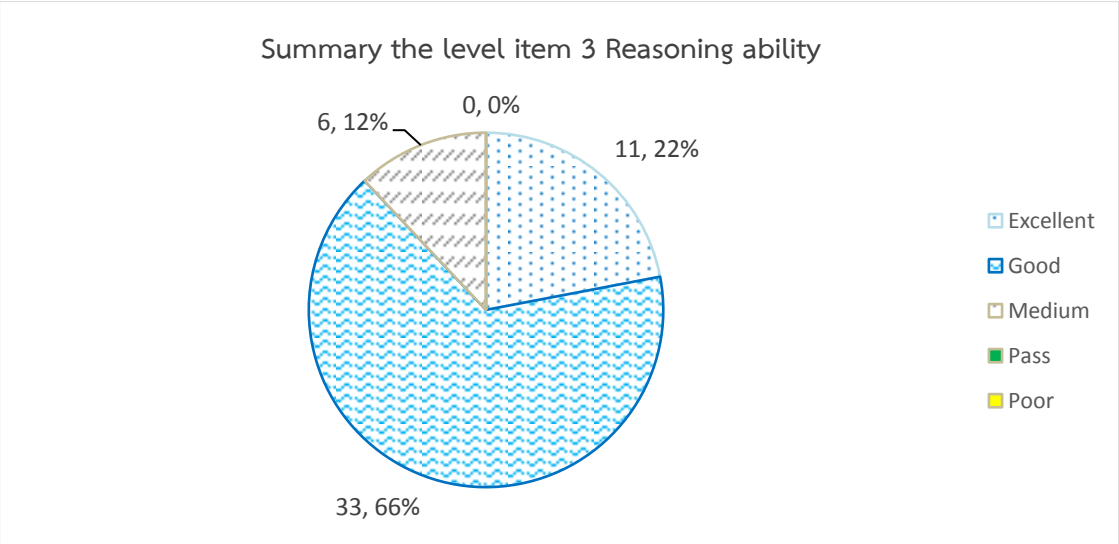

Figure 4.4 Relative the level of students' critical thinking ability
(Summary the level item 3. Reasoning ability)
through problem-based learning instructional model

From table 4.19 and figure 4.4 it can be seen that most of the students (86%) showed a good or excellent level of reasoning ability, exceeding the expected 80% in the research hypothesis. Among them, 8 were excellent (16%), 35 were good (70%), 7 were medium (14%), there were no student at a pass or poor development level of reasoning ability. This indicates that the problem-based learning instructional model has a significant positive impact on students' critical thinking ability.

Evaluation ability

Table 4.20 Relative developmental score of students' critical thinking ability (Criteria to evaluate 4. Evaluation ability) enhancement through problem-based learning instructional model.

Criteria to evaluate 4: Evaluation ability

Standard 1: Finding your own value position for employers Standard 2: Evaluating the outcome for resume and interview	
Score	**Grade**
9-10	Excellent
7-8	Good
5-6	Medium
3-4	Pass
Less than 3	Poor

Summary the level item 4: Evaluation ability

Development level	Frequency	Percentage
Excellent	8	16.00
Good	33	66.00
Medium	9	18.00
Pass	0	0.00
Poor	0	0.00

Summary the level item 4 Evaluation ability through problem-based learning instructional model in figure 4.5.

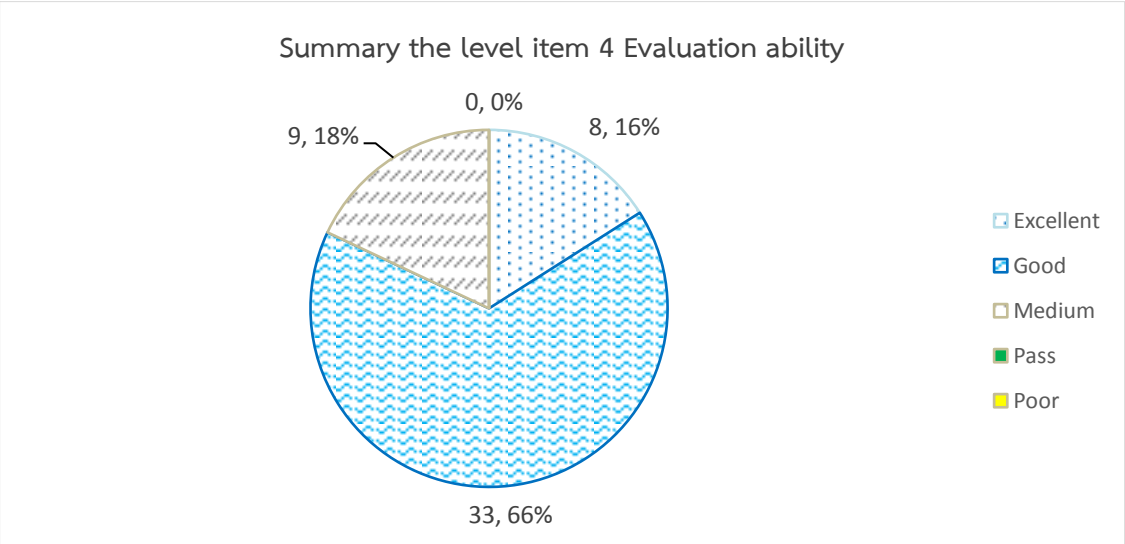

Figure 4.5 Relative the level of students' critical thinking ability
(Summary the level item 4. Evaluation ability)
through problem-based learning instructional model

From table 4.20 and figure 4.5, it can be seen that most of the students (82%) showed a good or excellent level of evaluation ability, exceeding the expected 80% in the research hypothesis. Among them, 8 were excellent (16%), 33 were good (66%), 9 were medium (18%), there were no student at a pass or poor development level of evaluation ability. This indicates that the problem-based learning instructional model has a significant positive impact on students' critical thinking ability.

Problem-solving ability

Table 4.21 Relative developmental score of students' critical thinking ability (Criteria to evaluate 5. Problem-solving ability) enhancement through problem-based learning instructional model.

Criteria to evaluate 5: Problem-solving ability

Standard 1: Asking questions for the employer's needs

Standard 2: Putting forward a feasible solution for proposed problems

Score	Grade
9-10	Excellent
7-8	Good
5-6	Medium
3-4	Pass
Less than 3	Poor

Summary the level item 5: Problem-solving ability

Development level	Frequency	Percentage
Excellent	10	20.00
Good	32	64.00
Medium	8	16.00
Pass	0	0.00
Poor	0	0.00

Summary the level item 5 Problem-solving ability through problem-based learning instructional model in figure 4.6.

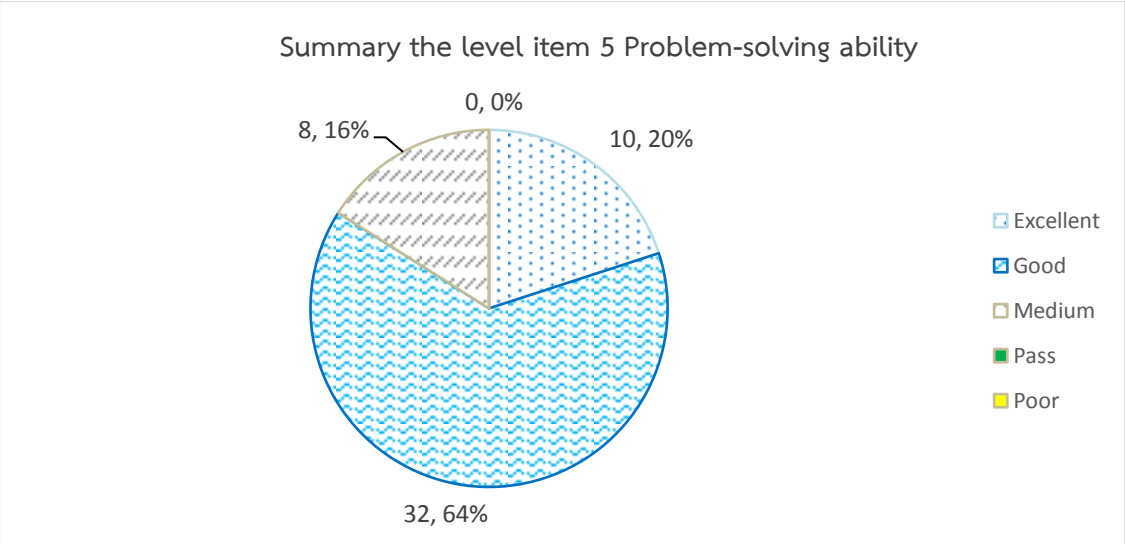

Figure 4.6 Relative the level of students' critical thinking ability
(Summary the level item 5.Problem-solving ability)
through problem-based learning instructional model

From table 4.21 and figure 4.6, it can be seen that most of the students (84%) showed a good or excellent level of problem-solving ability, exceeding the expected 80% in the research hypothesis. Among them, 10 were excellent (20%), 32 were good (64%), 8 were medium (16%), there were no student at a pass or poor development level of problem-solving ability. This indicates that the problem-based learning instructional model has a significant positive impact on students' critical thinking ability.

Reflective ability

Table 4.22 Relative developmental score of students' critical thinking ability (Criteria to evaluate 6. Reflective ability) enhancement through problem-based learning instructional model:

Criteria to evaluate 6: Reflective ability

Standard 1: Finding the weaknesses of the solution
Standard 2: Dealing with reflection and improvement

Score	**Grade**
9-10	Excellent
7-8	Good
5-6	Medium
3-4	Pass
Less than 3	Poor

Summary the level item 6: Reflective ability

Development level	**Frequency**	**Percentage**
Excellent	9	18.00
Good	34	68.00
Medium	7	14.00
Pass	0	0.00
Poor	0	0.00

Summary the level item 6 Reflective ability through problem-based learning instructional model in figure 4.7.

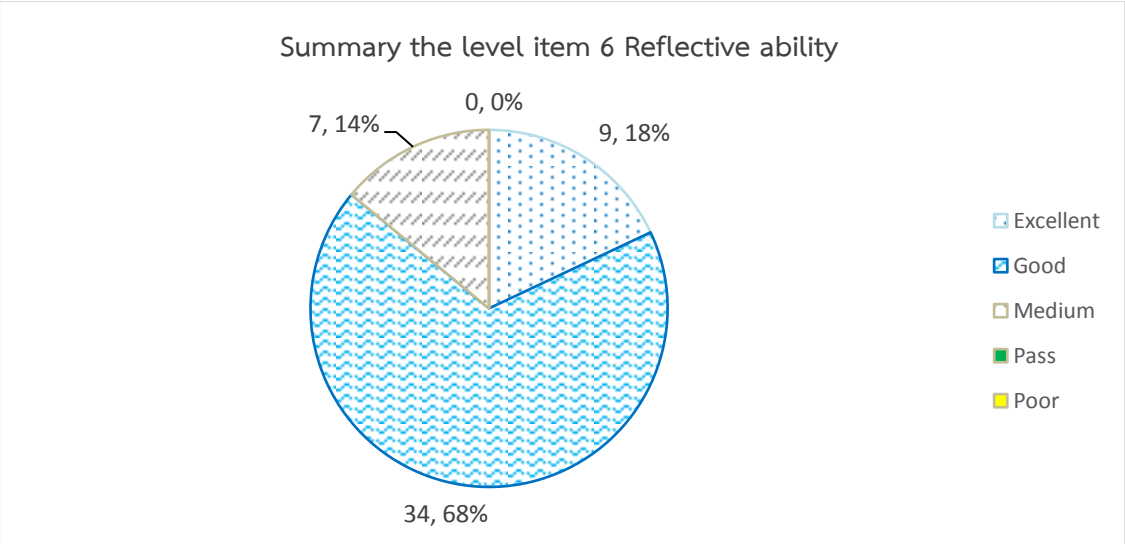

Figure 4.7 Relative the level of students' critical thinking ability
(Summary the level item 6. Reflective ability)
through problem-based learning instructional model

From table 4.19 and figure 4.7, it can be seen that most of the students (86%) showed a good or excellent level of reflective ability, exceeding the expected 80% in the research hypothesis. Among them, 9 were excellent (18%), 34 were good (68%), 7 were medium (14%), there were no student at a pass or poor development level of reflective ability. This indicates that the problem-based learning instructional model has a significant positive impact on students' critical thinking ability.

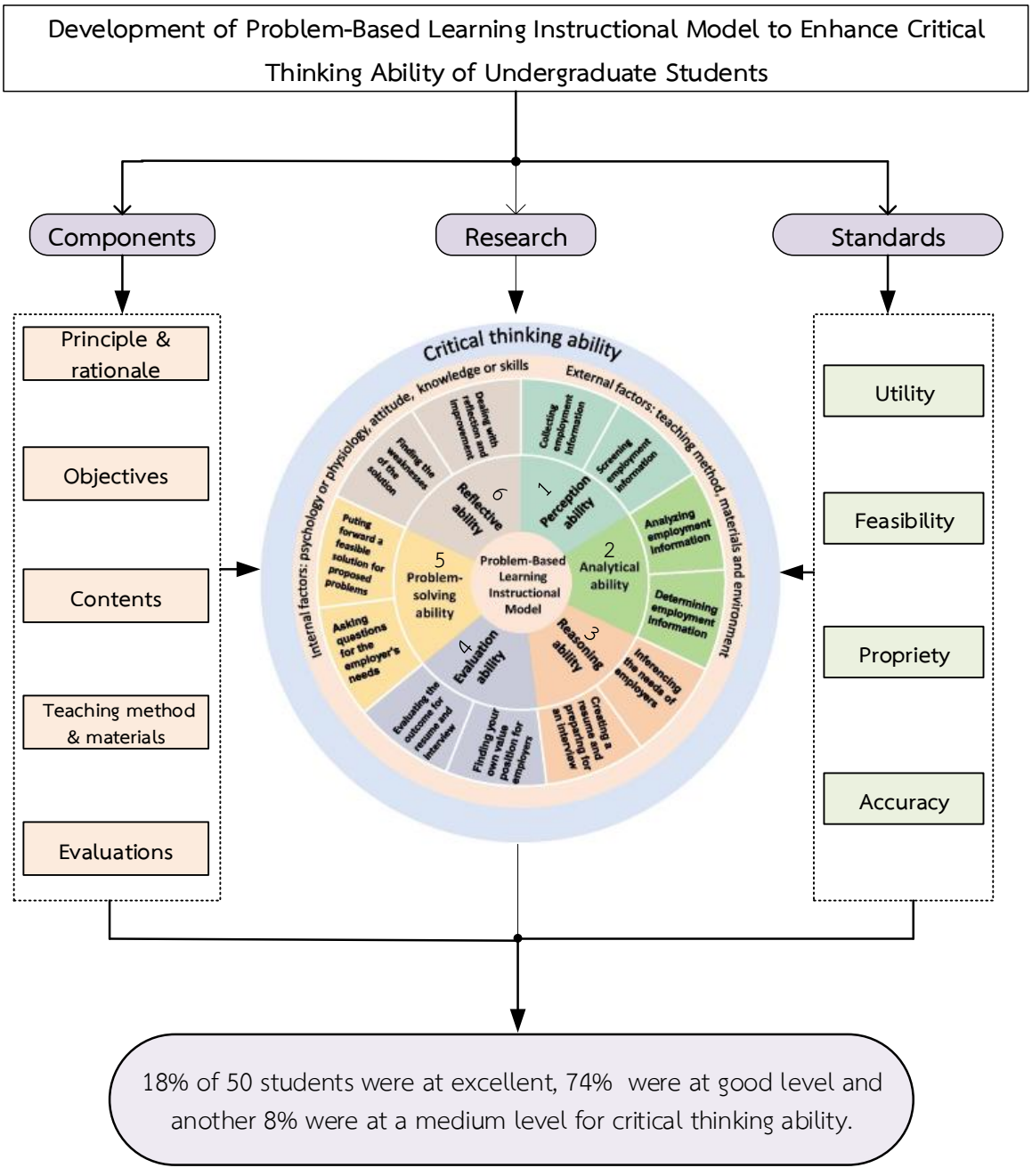

Figure 4.8 Development the problem-based learning (PBL) instructional model after implementation

Chapter 5
Conclusion, Discussion and Recommendations

This chapter explains the conclusion, discussions and recommendations for further study on "Development of Problem-Based Learning Instructional Model to Enhance Critical Thinking Ability of Undergraduate Students". It can be concluded and discussed as follows. Further, some approaches are recommended on basis of the findings.

The research objectives were:

1. To examine the factors affecting critical thinking ability of undergraduate students.

2. To develop problem-based learning instructional model to enhance critical thinking ability of undergraduate students.

3. To study the results of problem-based learning instructional model to enhance critical thinking ability of undergraduate students.

Conclusion

1. There were two factors to critical thinking ability of undergraduate students internal factors and external factors. The internal factors involved psychology or physiology, attitude, knowledge or skills. As for external factors referred to method of teaching, teaching materials, and teaching environment.

2. Problem-based learning instructional model to enhance critical thinking ability of undergraduate students was 100% as assessed by three specialists conformed to utility, feasibility, propriety, and accuracy standards. The model developed by five components: 1) Principle and rationale, study the course and students' critical thinking ability and take the result from objective 1 to do model, 2) Objectives, take from objective 2 in research, 3) Contents, take from the structure of course to experiment, 4) Method of teaching & materials, take from the steps to teach by problem-based learning instructional model and 5) Evaluation, by scoring rubric form to undergraduate students' critical thinking ability.

3. After the experiment, it was found that 18% of 50 students were at excellent, 74% of 50 students were at good level in critical thinking ability and

another 8% were at a medium level. The result is consistent with the research hypothesis that 80% upwards of the participants would have critical thinking ability at a good level after learning through problem-based learning instructional model.

Discussions

In the study of “Development of Problem-Based Learning Instructional Model to Enhance Critical Thinking Ability of Undergraduate Students”, the factors affecting critical thinking ability for undergraduate students are discussed as follows:

1. The data obtained through the questionnaire surveys of students and interviews with lecturers indicate that both internal and external factors jointly affect the improvement of critical thinking ability for undergraduate students.

The internal factors involved psychology or physiology, attitude, and knowledge or skills for enhancing critical thinking ability for undergraduate students. The survey shows that students' attention to the course and the importance of critical thinking ability for undergraduate students have a great impact on the development of their own critical thinking skills, and students' physical, psychological, emotional and psychological state will affect their learning effect. Fitrianti & Nur (2018) believed that internal factors are the driving force that arises from a person to achieve, which can promote people to learn knowledge or skills independently. Internal factors are the factors of some the characteristics and emotions that come from you personally include intelligence, talents, interests, motivations, which can increase learner’s achievements (Chamidy et al., 2023). Internal factors are conducive to the use and promotion of problem-based learning methods and effectively improve learners' critical thinking ability. Because learners' motivation and interest are one of the most important driving forces for learning, helping learners to improve their perception ability, analytical ability, reasoning ability, etc.

The external factors to critical thinking ability for undergraduate students include teaching methods, materials, and environment. Liu (2023) considered that the external factors are that the growth environment includes domestic factors and educational factors. A large number of studies have shown that lecturers' teaching methods and school environment affect students' academic performance (Joyce et al. 2014). Liu (2023) proposed problem-based learning (PBL) teaching method to

achieve the more significant teaching effects for students' mastery of theoretical knowledge, practical skills, and critical thinking ability compared with traditional teaching methods. Group cooperative teaching method relies on group tasks to complete according to problem-based learning. Lecturers accomplish teaching objectives and students complete the input and output of knowledge (Bai et al., 2022). The purposes of lecturers and students are enhanced and consistent, which not only improves class time but also fully reflects the knowledge output oriented teaching principle. Through strengthening the communication between lecturers and students and between students and students, lecturers and students can complement each other in different intelligence levels, cognitive structures and critical thinking ability, and problem-solving ability in group cooperative teaching (Ding & Zhang, 2023). The teaching environment has an important impact on the teaching quality. Increasing investment in infrastructure and optimizing the structure of the teaching staff could rationally allocate educational resources and promote the balanced development of disciplines. The relationship between teaching environment and teaching quality has an important impact on students' critical thinking ability and innovation ability (Gao & Abidin, 2023).

Therefore, the interaction between internal and external factors integrally affects the teaching achievement of "College Students' Career Guidance course" and the development of critical thinking ability of undergraduate students. In practical teaching, the lecturers not only emphasize learning motivation, learning attitude and students' knowledge and skills, but also attach great importance to innovative teaching methods, advanced teaching materials and a good learning environment. In other words, internal factors and external factors influence students' learning effects, especially their creative ability, critical thinking ability and problem-solving ability. Therefore, the development of problem-based learning instructional model to enhance critical thinking ability of undergraduate students is very important and meaningful.

2. Problem-based learning instructional model to enhance critical thinking ability of undergraduate students was 100% as assessed by 3 experts conformed to utility, feasibility, propriety, and accuracy standards. The model developed by 5 components: 1) Principle and rationale, study the course and students' critical thinking ability and take the result from objective 1 to do model, 2) Objectives, take

from objective 2 in research, 3) Contents, take from the structure of course to experiment, 4) Method of teaching & materials, take from the steps to teach by problem-based learning instructional model and 5) Evaluation, by scoring rubric form to undergraduate students' critical thinking ability.

In terms of principle & rationale, the practicability, feasibility, appropriateness and accuracy of the principle and basis of this mode have been unanimously recognized by experts. The problem-based learning instructional model is based on Constructivist theory and Humanistic theory. This instructional model is conducive to enhance students' critical thinking ability and problem-solving ability.

In terms of teaching objectives, the teaching objectives under this mode were unanimously recognized by the three experts. It is clear that the effective teaching objectives are the prerequisite for carrying out teaching activities. The teaching objectives are closely related to the teaching content and set around the development of students' ability.

In terms of contents, the three experts agreed that the content is reasonable and appropriate. The content is well organized with clear internal logic, which is well adapted to the teaching model and can effectively enhance the students' critical thinking ability.

In terms of teaching methods and teaching materials, the three experts considered that well-designed teaching activities and interesting learning experiences have good adaptability to the teaching mode, and can effectively promote the improvement of students in this model.

In evaluation part, the experts approve of the effectiveness and suitability of evaluation and feedback mechanism in improving students' achievement, and can provide effective feedback on students' critical thinking ability.

In short, the experts agreed unanimously the practicability, feasibility, appropriateness and accuracy of the instructional model based on problem-based learning. The robustness and adaptability of this model can effectively enhance critical thinking ability for undergraduate students. So the experts thought that this model can be implemented in teaching.

3. After the experiment, it was found that 18% of 50 students were at excellent, 74% of 50 students were at good level in critical thinking ability as follows:

Firstly, obtaining information is prerequisites for the foundation of employment, and analyzing information and judging information are crucial for enhancing critical thinking ability. That is, the researchers called as perception ability. Perception ability is an important part of critical thinking ability, which is to obtain information, judge information and stimulate learners' learning interest (Davidson, et al., 2019). Through the implementation of problem-based learning instructional model, most of the students (90%) showed good perception ability, exceeding the expected 80% in the research hypothesis. Among them, 12 were excellent (24%), 33 were good (66%), 5 were medium (10%). This indicates that the problem-based learning instructional model has a significant positive impact on perception ability.

Secondly, analytical ability and reasoning ability are essential components of critical thinking ability. Analytical ability is exceptionally important to obtaining strong overall critical thinking ability, which obtains the objective analysis of a complex problem to form a judgment (Nasution, et al., 2023). Through implementing problem-based learning instructional model, students' analytical ability level has been enhanced. From the data, among 50 students, 11 students are excellent, accounting for 22%, 33 students are good, accounting for 66%, and 6 students, are average, accounting for 12%. Reasoning ability plays an important role in developing critical thinking ability and analytical ability as well as preparing individuals to deal with the complexities of the real world (Sappaile, et al., 2023). Through implementing problem-based learning instructional model, students' reasoning ability level has been enhanced. Most of the students (86%) showed good reasoning ability, exceeding the expected 80% in the research hypothesis. Among them, 8 were excellent (16%), 35 were good (70%), 7 were medium (14%). This indicates that problem-based learning instructional model have the significant positive impacts on students' analytical ability and reasoning ability.

Thirdly, from determining the quality of evidence to assessing the validity of an argument, evaluation ability is essential for critical thinking and problem-solving. To develop this ability, it is important to practice analyzing information from different sources and coming to sound conclusions (Quansah, et al., 2024). Most of the students (82%) showed good evaluation ability, exceeding the expected 80% in the research hypothesis. Among them, 8 were excellent (16%), 33 were good (66%),

9 were medium (18%). This indicates that through problem-based learning instructional model, students' evaluation ability has been significantly improved.

Fourthly, problem-solving ability plays a crucial role in developing students' critical thinking ability. Problem-solving ability could involve a series of steps for finding solutions to questions or concerns that arise throughout life and aid in resolving issues faced in different environments (Ningsih, Putri, & Purwanto, 2024). Among the students, 10 were excellent (20%), 32 were good (64%), 8 were medium (16%). This indicates that the problem-based learning instructional model has a significant positive impact on students' problem-solving ability.

Fifthly, reflective ability is propeller of critical thinking ability, which sums up the advantages and disadvantages of the solution and thinks about next work. Reflective practices help to determine the focus of learning activities and to professionally respond to the difficulty and problems (Doron, Eichler & Rajhans, 2022). Reflective ability contains finding the weaknesses of the solution and dealing with reflection and improvement. Through problem-based learning instructional model, most of the students (86%) showed good reflective ability. Among them, 9 were excellent (18%), 34 were good (68%), 7 were medium (14%). This indicates that through problem-based learning instructional model, students' reflective ability has been significantly improved.

In summary, perception ability, analytical ability, reasoning ability, evaluation ability, problem-solving ability, and reflective ability are important dimensions which contribute significantly to the improvement of students' critical thinking ability. Experiments have shown that through the implementation of problem-based learning instructional models, the majority of students have achieved good or excellent critical thinking skills. In addition, students have greatly improved their positive attitudes towards learning through problem-based learning.

Recommendations

In the study of “Development of Problem-Based Learning Instructional Model to Enhance Critical Thinking Ability of Undergraduate Students”, the researcher put forward the following recommendations to students, lecturers and school administrators. Details are as follows:

To students:

1. Increase students' learning interest, learning enthusiasm and learning autonomy. The tasks assigned by the lecturer are interesting and practical. For, students, there are a lot of basic knowledge and exercises that need to be completed through individual and group efforts by means of problem-based learning method.

2. Participate actively in all kinds of learning and training activities for students in order to master employ ability skills and improve critical thinking ability. Through group work, students communicate the problems, discuss the topics, find the solutions and report their learning results. This approach is ideal for improving students' problem-solving skills.

3. Promote greatly the learning of other disciplines and skills with new approaches and emerging technological tools for students. In problem-based learning instructional model, it needs to be corrected by systematically examining each critical thinking and problem-solving process presented through students' real lives to be able to present a solution. Through this training, students acquire the appropriate methods and skills to deal with various challenges and crises, which lay a solid foundation for future students' critical thinking ability.

To lecturers:

1. Attach more importance to training courses in critical thinking ability. From the perspective of lecturers, lecturers need to improve their ability of problem-based learning. This instructional model can provide students with sufficient thinking, individual practice, teamwork, and improve students' problem-solving skills and critical thinking ability.

2. Improve lecturers' teaching ability and critical thinking ability of problem-based learning instructional model. Lecturers should constantly receive training and self-training, have the ability to teach problem-based learning teaching methods. Rigorous and logical critical thinking ability of lecturers is the best demonstration for students. Meanwhile, they should encourage students to express freely their own opinions and propose different solutions to problems.

3. Guide consciously students to use the advantages of problem-based learning model and advanced tools. Lecturers should guide the students to use APP platform for personalized training, and praise the students with advanced learning

methods. In addition, group cooperation of problem-based learning is a more effective learning strategy for enhancing critical thinking ability.

To universities:

1. Optimize the talent training target and class hour arrangement of talent training. Schools should combine the professional characteristics and talent training positioning. For students, the universities pay attention to the training of students' critical thinking ability.

2. Strengthen the development of the teaching platform, update the teaching equipment, and improve the quality of teaching environment. Modern information technology equipment is especially suitable for students to conduct practical training, and simulate VR and AR for professional knowledge according to problem-based learning.

3. Strengthen the training and guidance of lecturers' teaching methods. Students can have an in-depth understanding, so as to better carry out the new teaching mode and ensure the teaching effect.

Future Research

Looking forward to the future, the follow-up research of problem-based instructional model can also be carried out from the following aspects:

1. Development of problem-based learning instructional model to enhance another ability for undergraduate students.

2. Development of another instructional model to enhance critical thinking ability for undergraduate students.

3. The effectiveness of the implementation of this instructional model in other professional practice courses can be further investigated after the research experience is mature and the research power is expanded.

4. The implementation of instructional model through problem-based learning for students of other levels needs to be further explored and researched.

In summary, the application of problem-based learning instructional model is of great significance to the future research of career guidance course teaching in colleges and universities. Therefore, future research can focus on exploring how to design more effective teaching programs, and improve students' learning interests and learning effects.

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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

1. Assistant Professor Dr. Tanaput Chancharoen	Educational management and Learning Management Innovation Program Bansomdejchaopraya Rajabhat University
2. Professor Dr. Wu Xianyong	International Education Program Baise University
3. Associate Professor Dr. Hong Xing	Educational Management Program Guangxi University of Finance and Economics

List of experts to evaluate the format Instructional Model

1. Assistant Professor Dr. Wanida Ploysangwal	English Program University of the Thai Chamber of Commerce
2. Associate Professor Dr. Panas Jansritong	Admistration Program Krirk University
3. Associate Professor Dr. Zhu Huajin	National Education Program Guangxi Minzu University

Appendix B
Official Letter

Ref.No. MHESI 0643.14/428

Graduate School
Bansomdejchaopraya Rajabhat University
1061 Itsaraparb 15 Hirunrujee
Thonburi Bangkok 10600

28 February 2024

Subject Invitation to be the expertise for research instruments' quality

Dear Assistant Professor Dr. Tanaput Chancharoen

Attachment Questionnaire 1 set

Regarding the thesis entitled "Development of Problem-Based Learning Instructional Model to Enhance Critical Thinking Ability of Undergraduate Students" of Mrs. Chen Qifeng, a Ph.D. student majoring in Curriculum and Instruction Programme at Bansomejchaopraya Rajabhat University code number 6373103108, Thailand under the supervision of Associate Professor Dr. Areewan Iamsa-ard as major advisor, Assistant Professor Dr. Wapee Kong-In and Associate Professor Dr. Sarayuth Sethakajorn as co-advisor.

The Curriculum Management Committee considered that you are an expertise who has the knowledge and ability to provide useful advice on constructing research instruments for students.

Please be respected as an expert to examine such research instruments. Thank you very much for your concern.

Sincerely,

(Assistant Professor Akaranun Asavarutpokin)
Vice Dean Acting for Dean of Graduate School

Graduate School
Tel.+662-473-7000 ext. 1814

Ref.No. MHESI 0643.14/429

Graduate School
Bansomdejchaopraya Rajabhat University
1061 Itsaraparb 15 Hirunrujee
Thonburi Bangkok 10600

28 February 2024

Subject Invitation to be the expertise for research instruments' quality

Dear Professor Dr. Wu Xianyong

Attachment Questionnaire 1 set

Regarding the thesis entitled "Development of Problem-Based Learning Instructional Model to Enhance Critical Thinking Ability of Undergraduate Students" of Mrs. Chen Qifeng, a Ph.D. student majoring in Curriculum and Instruction Programme at Bansomejchaopraya Rajabhat University code number 6373103108, Thailand under the supervision of Associate Professor Dr. Areewan Iamsa-ard as major advisor, Assistant Professor Dr. Wapee Kong-In and Associate Professor Dr. Sarayuth Sethakajorn as co-advisor.

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Vice Dean Acting for Dean of Graduate School

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Ref.No. MHESI 0643.14/430

Graduate School
Bansomdejchaopraya Rajabhat University
1061 Itsaraparb 15 Hirunrujee
Thonburi Bangkok 10600

28 February 2024

Subject Invitation to be the expertise for research instruments' quality

Dear Associate Professor Dr. Hong Xing

Attachment Questionnaire 1 set

Regarding the thesis entitled "Development of Problem-Based Learning Instructional Model to Enhance Critical Thinking Ability of Undergraduate Students" of Mrs. Chen Qifeng, a Ph.D. student majoring in Curriculum and Instruction Programme at Bansomejchaopraya Rajabhat University code number 6373103108, Thailand under the supervision of Associate Professor Dr. Areewan Iamsa-ard as major advisor, Assistant Professor Dr. Wapee Kong-In and Associate Professor Dr. Sarayuth Sethakajorn as co-advisor.

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Sincerely,

(Assistant Professor Akaranun Asavarutpokin)
Vice Dean Acting for Dean of Graduate School

Graduate School
Tel.+662-473-7000 ext. 1814

Ref.No. MHESI 0643.14/432

Graduate School
Bansomdejchaopraya Rajabhat University
1061 Itsaraparb 15 Hirunrujee
Thonburi Bangkok 10600

28 February 2024

Subject Invitation to be the expertise for research instruments' quality

Dear Dr. Panas Jansritong

Attachment Evaluation sheets

Regarding the thesis entitled "Development of Problem-Based Learning Instructional Model to Enhance Critical Thinking Ability of Undergraduate Students" of Mrs. Chen Qifeng, a Ph.D. student majoring in Curriculum and Instruction Programme at Bansomejchaopraya Rajabhat University code number 6373103108, Thailand under the supervision of Associate Professor Dr. Areewan Iamsa-ard as major advisor, Assistant Professor Dr. Wapee Kong-In and Associate Professor Dr. Sarayuth Sethakajorn as co-advisor.

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Sincerely,

(Assistant Professor Akaranun Asavarutpokin)
Vice Dean Acting for Dean of Graduate School

Graduate School
Tel.+662-473-7000 ext. 1814

Ref.No. MHESI 0643.14/431

Graduate School
Bansomdejchaopraya Rajabhat University
1061 Itsaraparb 15 Hirunrujee
Thonburi Bangkok 10600

28 February 2024

Subject Invitation to be the expertise for research instruments' quality

Dear Assistant Professor Dr. Wanida Ploysangwal

Attachment Evaluation sheets

Regarding the thesis entitled "Development of Problem-Based Learning Instructional Model to Enhance Critical Thinking Ability of Undergraduate Students" of Mrs. Chen Qifeng, a Ph.D. student majoring in Curriculum and Instruction Programme at Bansomejchaopraya Rajabhat University code number 6373103108, Thailand under the supervision of Associate Professor Dr. Areewan Iamsa-ard as major advisor, Assistant Professor Dr. Wapee Kong-In and Associate Professor Dr. Sarayuth Sethakajorn as co-advisor.

The Curriculum Management Committee considered that you are an expertise who has the knowledge and ability to provide useful advice on constructing research instruments for students.

Please be respected as an expert to examine such research instruments. Thank you very much for your concern.

Sincerely,

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Vice Dean Acting for Dean of Graduate School

Graduate School
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Ref.No. MHESI 0643.14/433

Graduate School
Bansomdejchaopraya Rajabhat University
1061 Itsaraparb 15 Hirunrujee
Thonburi Bangkok 10600

28 February 2024

Subject Invitation to be the expertise for research instruments' quality

Dear Associate Professor Dr. Zhu Huajin

Attachment Evaluation sheets

Regarding the thesis entitled "Development of Problem-Based Learning Instructional Model to Enhance Critical Thinking Ability of Undergraduate Students" of Mrs. Chen Qifeng, a Ph.D. student majoring in Curriculum and Instruction Programme at Bansomejchaopraya Rajabhat University code number 6373103108, Thailand under the supervision of Associate Professor Dr. Areewan Iamsa-ard as major advisor, Assistant Professor Dr. Wapee Kong-In and Associate Professor Dr. Sarayuth Sethakajorn as co-advisor.

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Sincerely,

(Assistant Professor Akaranun Asavarutpokin)
Vice Dean Acting for Dean of Graduate School

Graduate School
Tel.+662-473-7000 ext. 1814

Ref.No. MHESI 0643.14/434

Graduate School
Bansomdejchaopraya Rajabhat University
1061 Itsaraparb 15 Hirunrujee
Thonburi Bangkok 10600

28 February 2024

Subject Request for data collection

Dear President of Guangxi University of Finance and Economics

Attachment 1.50 copy of questionnaires
2.one interview paper

Regarding the thesis entitled "Development of Problem-Based Learning Instructional Model to Enhance Critical Thinking Ability of Undergraduate Students" of Mrs. Chen Qifeng, a Ph.D. student majoring in Curriculum and Instruction Programme at Bansomejchaopraya Rajabhat University code number 6373103108, Thailand under the supervision of Associate Professor Dr. Areewan Iamsa-ard as major advisor, Assistant Professor Dr. Wapee Kong-In and Associate Professor Dr. Sarayuth Sethakajorn as co-advisor.

The researcher needs to collect data using questionnaire in terms of factors affecting critical thinking ability of undergraduate students from 50 students majoring in network and new media in School of Journalism and Cultural Communication at Guangxi University of Finance and Economics. 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 email to 897336999@qq.com. The researcher plans to use this data for her 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,

(Assistant Professor Akaranun Asavarutpokin)
Vice Dean Acting for Dean of Graduate School

Graduate School
Tel.+662-473-7000 ext. 1814

Ref.No. MHESI 0643.14/435

Graduate School
Bansomdejchaopraya Rajabhat University
1061 Itsaraparb 15 Hirunrujee
Thonburi Bangkok 10600

28 February 2024

Subject Request for data collection

Dear President of Baise University

Attachment 1.50 copy of questionnaires
2.one interview paper

Regarding the thesis entitled “Development of Problem-Based Learning Instructional Model to Enhance Critical Thinking Ability of Undergraduate Students" of Mrs. Chen Qifeng, a Ph.D. student majoring in Curriculum and Instruction Programme at Bansomejchaopraya Rajabhat University code number 6373103108, Thailand under the supervision of Associate Professor Dr. Areewan Iamsa-ard as major advisor, Assistant Professor Dr. Wapee Kong-In and Associate Professor Dr. Sarayuth Sethakajorn as co-advisor.

The researcher needs to collect data using questionnaire in terms of factors affecting critical thinking ability of undergraduate students from 50 students majoring in network and new media in School of Journalism and Cultural Communication at Guangxi University of Finance and Economics. 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 email to 897336999@qq.com. The researcher plans to use this data for her thesis completion and further necessary publication as required by the Ph.D. course.

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Vice Dean Acting for Dean of Graduate School

Graduate School
Tel.+662-473-7000 ext. 1814

Ref.No. MHESI 0643.14/436

Graduate School
Bansomdejchaopraya Rajabhat University
1061 Itsaraparb 15 Hirunrujee
Thonburi Bangkok 10600

28 February 2024

Subject Request for data collection

Dear President of Guangxi Minzu University

Attachment 1.50 copy of questionnaires
2.one interview paper

Regarding the thesis entitled “Development of Problem-Based Learning Instructional Model to Enhance Critical Thinking Ability of Undergraduate Students" of Mrs. Chen Qifeng, a Ph.D. student majoring in Curriculum and Instruction Programme at Bansomejchaopraya Rajabhat University code number 6373103108, Thailand under the supervision of Associate Professor Dr. Areewan Iamsa-ard as major advisor, Assistant Professor Dr. Wapee Kong-In and Associate Professor Dr. Sarayuth Sethakajorn as co-advisor.

The researcher needs to collect data using questionnaire in terms of factors affecting critical thinking ability of undergraduate students from 50 students majoring in network and new media in School of Journalism and Cultural Communication at Guangxi University of Finance and Economics. 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 email to 897336999@qq.com. The researcher plans to use this data for her 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,

(Assistant Professor Akaranun Asavarutpokin)
Vice Dean Acting for Dean of Graduate School

Graduate School
Tel.+662-473-7000 ext. 1814

Ref.No. MHESI 0643.14/437

Graduate School
Bansomdejchaopraya Rajabhat University
1061 Itsaraparb 15 Hirunrujee
Thonburi Bangkok 10600

28 February 2024

Subject Request for permission to implement experiment

Dear President of Guangxi University of Finance and Economics

Regarding the thesis entitled "Development of Problem-Based Learning Instructional Model to Enhance Critical Thinking Ability of Undergraduate Students" of Mrs. Chen Qifeng, a Ph.D. student majoring in Curriculum and Instruction Programme at Bansomejchaopraya Rajabhat University code number 6373103108, Thailand under the supervision of Associate Professor Dr. Areewan Iamsa-ard as major advisor, Assistant Professor Dr. Wapee Kong-In and Associate Professor Dr. Sarayuth Sethakajorn as co-advisor.

The researcher needs to implement an experiment in compliance with approved methodology and collect data in terms of critical thinking ability of undergraduate students from network and new media in School of Journalism and Cultural Communication majoring students from class A who enroll in College Students' Career Guidance course at Guangxi University of Finance and Economics during the 1st semester of academic year 2024. Hence, I'm formally requesting permission to implement the experiment and access the aforementioned data. The researcher plans to use this data for her thesis completion and further necessary publication as required by the Ph.D. course.

The researcher plans to use this data for her 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,

(Assistant Professor Akaranun Asavarutpokin)
Vice Dean Acting for Dean of Graduate School

Graduate School
Tel.+662-473-7000 ext. 1814

Appendix C
Research Instrument

- Questionnaire for students (Objective 1)
- Interview for lecturers (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 Problem-Based Learning Instructional Model to Enhance Critical Thinking Ability of Undergraduate Students" conducted by Chen Qifeng, a Ph.D. student in Curriculum and Instruction Programme at Bansomdejchaopraya Rajabhat University under the supervision of Associate Professor Dr. Areewan Iamsa-ard as major advisor, Assistant Professor Dr. Wapee Kong-In and Associate Professor Dr. Sarayuth Sethakajorn as co-advisor.

This questionnaire is divided into 3 sections i.e.

Section 1 Common data of the respondent

Section 2 The information on factors affecting critical thinking 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:

Directions*: Please put ✓into the □ according to your own personal data.*

Section 1 Common data of the respondent

1. Gender

□ A. Male □ B. Female

2. Students from

☐ A. Guangxi University of Finance and Economics

☐ B. Baise University

☐ C. Guangxi Minzu University

3. Age

☐ A. Below 18 yrs. ☐ B. 18-19 yrs.

☐ C. 20-21 yrs. ☐ D. over 21 yrs.

Section 2 The information on factors affecting critical thinking ability of undergraduate students

Directions: *Please rate the following factors affecting the problem-based learning instructional model by putting ✓ into the attitude level column based on the criteria given below. Each question can select only one answer.*

5 means you STRONGLY agree with the contents.

4 means you QUITE agree with the contents.

3 means you remain NEUTRAL. with the contents

2 means you DO NOT QUITE agree with the contents

1 means you DO NOT STRONGLY agree with the contents

Table 1 Questionnaire on factors affecting critical thinking ability of undergraduate students

Questions	Answers				
	5	4	3	2	1
Internal Factors(Psychology or physiology no.1-2, attitude no.3-4, knowledge or skills no.5- 6)					
1. Students realize the importance of the College Students' Career Guidance course and firmly believe that critical thinking ability are of great help to future career choice and personal development.					
2. Students believe that good personality, stable mood and friendly way of getting along will contribute to collecting, identifying and processing career information, which improves their critical thinking ability.					
3. Students believe that it is very important for students to have a good learning attitude towards College Students' Career Guidance course. They consider that thinking positively in class and summing up meticulously after class for students in the course could help students to collect, identify and deal with career information and improve job-hunting skills, which will enhance critical thinking ability.					
4. Students believe that students can combine their personal interests, majors and values to effectively plan their future careers and enhance their job search competitiveness through College Students' Career Guidance course. Because when you participate in the interview, you can better show your own advantages, and conduct in-depth analysis of professional problems or phenomena.					

Table 1 (Continued)

Questions	Answers				
	5	4	3	2	1
5. The significance of the prior knowledge is to help students build a bridge between new knowledge and that they have already in College Students' Career Guidance course. After learning theoretical knowledge, students acquire vocational knowledge through various online platforms and digital resources, which helps to improve students' vocational cognitive ability.					
6. Students believe that taking notes and participating in discussions in class can better understand and master new knowledge.					
External factors (Teaching method no.7-8, Materials no. 9-10, Environment no.11-12)					
Questions	**Answers**				
	5	4	3	2	1
7. Students believe that teachers adopt a variety of teaching methods such as case analysis, scenario simulation, role playing and group discussion in College Students’ Career Guidance course, which can stimulate students' learning interest and promote the development of students' critical thinking ability.					
8. Students believe that teachers take the ability as the orientation, take the problem as the driving force, pay attention to the creation of situations, and guide students to think independently in College Students’ Career Guidance course, which is conducive to improving their critical thinking ability.					

Table 1 (Continued)

Questions	Answers				
	5	4	3	2	1
9. Students believe that teachers use rich digital teaching resources, such as digital education platforms, online teaching videos, to achieve diversified learning in College Students' Career Guidance course, which helps improve their critical thinking ability.					
10. Students believe that teachers choice of teaching materials around their critical thinking ability training objectives, and providing cases and training materials closely related to their study life and future career can help promote the development of students' critical thinking ability.					
11. Students believe that appropriate class size, relaxed classroom atmosphere, full use of social resources and experiential education in College Students' Career Guidance course, which can help them improve their critical thinking ability in employment practice.					
12. The campus can access the Internet anytime and anywhere, the classroom is clean and bright, the desks and chairs are warm and comfortable, and the multimedia equipment is complete, which facilitates the teaching process. Such conditions could improve students' critical thinking ability.					

Section 3 Suggestions for improving the better instruction

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Thank you for your kind cooperation for completing the questionnaire!

Researcher

Mrs. Chen Qifeng

Interview for Lecturers (Objective 1)

Directions:

These questionnaires are the instruments for collecting data in 1st phase of the research entitled "Development of Problem-Based Learning Instructional Model to Enhance Critical Thinking Ability of Undergraduate Students" conducted by Chen Qifeng, a Ph.D. student in Curriculum and Instruction Programme at Bansomdejchaopraya Rajabhat University under the supervision of Associate Professor Dr. Areewan Iamsa-ard as major advisor, Assistant Professor Dr. Wapee Kong-In and Associate Professor Dr. Sarayuth Sethakajorn as co-advisor.

This interview is divided into 3 sections i.e.

Section 1 Common data of the respondent

Section 2 Interview on factors to enhance critical thinking ability of undergraduate students

Section 3 Comment and recommendation for improving the better instruction

Data obtained from this interview 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

☐ A. Male ☐ B. Female

2. Lecturers from

☐ A. Guangxi University of Finance and Economics

☐ B. Baise University

☐ C. Guangxi Minzu University

3. Experience teaching

☐ A. Below 3 yrs. ☐ B. 3-6 yrs.

☐ C. 7- 9 yrs. ☐ D. over 9 yrs.

4. Age

☐ A. below 30 yrs. ☐ B. 30-40 yrs.

☐ C. 41-50 yrs. ☐ D. over 50 yrs.

5. Professional title

☐ A. Professor ☐ B. Associate professor

☐ C. Assistant Professor ☐ D. Lecturer

Section 2 Interview on factors to enhance critical thinking ability of undergraduate students

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. Do you think that teachers' positive mood and optimism to face difficulties will improve students' critical thinking ability? Please write the reason.

2. Do you think that the recognition of the teaching profession, good teacher-student relationship and team work spirit will positively affect students' enthusiasm and interest in learning, which promotes students' critical thinking ability? Do you agree? Please write down your reasons.

3. Do you think that passion for class teaching, learning attitude, and attitude towards dilemma can affect critical thinking ability? Write down your reasons please.

4. Do you think that teachers' knowledge, teaching skills and teaching experience for College Students' Career Guidance course play an important role in promoting students' critical thinking ability? If you agree please write the reason.

5. Do you think that teachers should continue to receive training in vocational education and teaching skills in College Students' Career Guidance course? Is this very important for promoting students' critical thinking ability? Please write down the reasons.

6. How do you organize the classroom teaching to promote students' critical thinking ability in College Students' Career Guidance course, such as problem-driven, group discussion, role play and the assessment of learning outcome? What strategies do you motivate students to promote their critical thinking ability?

7. Do you think that teacher's teaching ability to use new ICT (information and communications technology) and online resources for instructional contexts can greatly improve students' critical thinking ability? Please write down the reasons.

8. What kind of teaching materials do you often use to the teaching in College Students' Career Guidance course? How can these teaching materials improve students' critical thinking ability? Please list teaching materials and illustrate their roles.

9. What kind of teaching environment (such as class size, library resources, classroom atmosphere, etc.) can help to improve students' critical thinking ability in College Students' Career Guidance course?

10. Do you want your school to support you in developing innovation and entrepreneurship education and vocational education in order to enhance students' critical thinking ability in College Students' Career Guidance course?

Section 3: Comment and recommendation for improving the better instruction.

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Thank you for your kind cooperation for completing the interview!

Researcher

Mrs. Chen Qifeng

Questionnaire for experts (Objective 2)

Assessment Form of the Quality of Problem-Based Learning Instructional Model to Enhance Critical Thinking Ability of Undergraduate Students

Dear assessors,

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

1. Major Advisor: Associate Professor Dr. Areewan Iamsa-ard
2. Co-advisor: Assistant Professor Dr. Wapee Kong-In
3. Co-advisor: Associate Professor Dr. Sarayuth Sethakajorn

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

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 Chen Qifeng

Curriculum and Instruction Program

Bansomdejchaopraya Rajabhat University

Assessment of confirm the quality of Problem-based Learning Instructional Model

Assessor: Assistant Professor Dr.Wanida Ploysangwal
Position: English Program
Workplace : University of the Thai Chamber of Commerce
Directions: Please assess the congruence between components of Utility Standard, Feasibility Standard, Propriety Standard, Accuracy Standard by putting ✓ in the box according to the following criteria.

Assessment Items	Rating Result		
	Agree	Disagree	Remarks
Utility Standards 1. Problem-based learning instructional model is useful to students to enhance learning achievement.			
2. Problem-based learning instructional model is useful to lecturers to enhance learning achievement.			
3. Problem-based learning instructional model includes necessary and enough contents.			
4. Problem-based learning instructional model promotes to enhance learning achievement more compared to traditional teaching.			
5. Problem-based learning instructional model increases the learning achievement of students and enhance critical thinking ability.			

Table (Continued)

Assessment Items	Rating Result		
	Agree	Disagree	Remarks
Feasibility Standards 1. The lecturer can apply problem-based learning instructional model to enhance critical thinking ability to their work and it is worth the time for actual use.			
2. The lecturer can develop the students to problem-based learning instructional model.			
3. Problem-based learning instructional model to lecturer is easy to use.			
4. The students always develop their learning all time by problem-based learning instructional model to enhance critical thinking ability.			
5. The students are comfortable in learning by themselves with problem-based learning instructional model to enhance critical thinking ability.			
Propriety Standards 1. Problem-based learning instructional model to enhance critical thinking ability is appropriate for lecturers to use assessment results to improve the students' ability.			
2. Problem-based learning instructional model to enhance critical thinking ability is appropriateness for students to create knowledge by themselves.			
3. Problem-based learning instructional model to enhance critical thinking ability is convenient to use.			

Table (Continued)

4. Problem-based learning instructional model to enhance learning achievement is a systematic process to use.			
5. Problem-based learning instructional model to enhance learning achievement is clear and suitable for use in learning and students' development.			
Accuracy Standards 1. Problem-based learning instructional model to enhance learning achievement is comprehensively analyzed from different contexts and sufficient for the synthesis of patterns.			
2. Problem-based learning instructional model to enhance learning achievement has a clear process.			
3. Problem-based learning instructional model to enhance learning achievement are described and the acquisition is clear.			
4. Problem-based learning instructional model to enhance learning achievement uses the burgeoning techniques and tools which acquires accurate information and communication.			
5. Problem-based learning instructional model to enhance learning achievement is a correct and comprehensive learning system.			

Suggestions

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Lesson Plan(Objectives 3)

Teaching

Teaching based on problem-based learning instructional model refers to an integrated teaching model that is taught in 4 steps in the classroom:

Item 1: Perception ability

Standard 1: Collecting employment information

Standard 2: Screening employment information

objectives

1. Master the methods and ways to collect employment information according to students' job intentions.

2. Learn to process employment information according to students' job intention.

Contents

Employment information collection and processing

Method of teaching

Step 1: Design problem-based learning tasks (30 minutes)

Design questions related to employment information collection and processing to help students clarify problem-based learning tasks. According to learning objectives and contents, the lecturers push teaching materials (teaching videos, PPT, learning links and related academic articles), issue independent learning task list to students. Students need to answer the following questions carefully designed by the teachers.

1. What is your employment direction?
2. What employment information do you care about?
3. In what ways and means can you obtain this employment information?
4. What do you deal with the employment information you obtain?

In problem-based learning tasks design, lecturers need to design questions and tasks that meet the teaching needs according to teaching objectives and students' level. Finally, a problem-based learning scheme is formed. Students try to analyze and understand the problem-based learning information according to the questions provided by lecturers. Students are prepared to critically address these

questions and tasks by consulting materials and turning to the Internet.

Step 2: Student self-directed learning (1 hour)

The lecturers set learning objectives and development objectives, and designs corresponding teaching tasks. After the task is clear, the teacher needs to create the corresponding teaching situation according to the task. Lecturers create problem situations related to critical thinking ability in order to stimulate students' interest and motivation to solve problems. Create teaching situations through cases, videos, role games and other forms, so that students can understand and solve problems 1.1-1.4 in specific teaching situations. Through problem situations, students have a preliminary understanding. The specific steps are as follows.

1. Teachers provide corresponding teaching tasks according to students' employment intentions.

2. Students sort out the tasks assigned by the teachers and explore the answers according to the tasks

3. Students have a preliminary understanding of the learning content and objectives through the study of tasks

Step 3: Group discussion and results presentation (1.5 hours)

Teachers evaluate the completion of students' tasks before class, explain the knowledge that students cannot understand before class, present classroom practical training tasks, discuss and communicate in groups, and report and display the results. Teachers should summarize and evaluate students according to their classroom performance and students' self-evaluation and mutual evaluation. Specific steps: task leading, new knowledge discovering, scenario simulation.

According to the learning objectives, this section is divided into 3 component as follow:

Task leading

The teacher guides the students in interpreting and identifying problems. Then The teachers organize students to share understanding and discussion of tasks.

New knowledge discovering

1. Meaning, types, components, necessity for students of employment information are interpreted and analyzed .

2. Collection direction of employment information: Professional matching, development prospects, suitable for their own characteristics, have a role to play the space.

3. Methods of collecting employment information. Consulting the labor department and employment guidance agencies to find out the latest trends in

employment and the employment information they provide; understanding the recruitment conditions, the status quo of the employer and the demand for talents with the help of the media and the Internet; providing you with effective employment information by using your family, friends and school resources around you.

4. Analysis and judgement of employment information: the information collected through various channels is classified according to the region and characteristics. and then according to their own career selection standards for grade classification, choose their own employment positions.

Scenario simulation

Students organize teams to collect employment information, categorize, extract valid employment information and prioritize according to the specialty. Furthermore, students revise and improve the collection and processing of employment information through group sharing and teacher comments.

Students Activities

1. Organizing teams to collect, categorize, extract and prioritize employment information

2. The group presents the results

3. Revise and improve collection and processing of employment information

Lecturer Activities

1. Listen to the students' presentations and sharing
2. Comment on student presentations and sharing

Step 4: Evaluation and revision (30 minutes)

1. Each group reports on stage, and shares employment information collection and processing according to the specific situation.

2. Teachers summarize and evaluate the learning and task completion according to the students' performance.

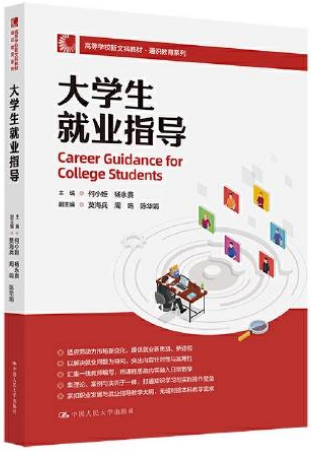
3. Students reflect on how to effectively collect employment information based on feedback.

4. Evaluation: Students self-assessment, group mutual assessment, lecturer evaluation.

Learning materials

Offline resources

1.Textbook



Oneline resources

1. Chinese University MOOC： https://www.icourse163.org/search.htm

2. Teaching PPT

3. Clip Video

https://www.bilibili.com/video/BV1Pv4y1e739/

https://www.bilibili.com/video/BV1js4y1j7RA/

https://www.bilibili.com/video/BV1vF41177xH/?vd_source=85abd323a797a3fe14a10882504532bd

https://www.bilibili.com/video/BV1FL4y1M7GB/?p=1

Homework and Discussion

1. How to distinguish between real and fake employment information?

2. What are some more effective ways to find the employment information you need?

Evaluation

Table 1 Criteria to evaluate item 1. Perception ability

Item	5	4	3	2	1
Item 1: Perception ability					
Standard 1: Collecting employment information	Accurately find the relevant employment information through search engines, recruitment websites, social media and other channels	Be able to better find the relevant employment information through search engines, recruitment websites, social media and other channels	Could find the relevant employment information through search engines, recruitment websites, social media and other channels	It is more difficult to find the relevant employment information through search engines, recruitment websites, social media and other channels	It is impossible to find the relevant employment information through search engines, recruitment websites, social media and other channels
Standard 2: Screening employment information	Accurately screen employment information that matches your major and interests	Be able to better screen employment information that matches your major and interests	Could screen employment information that matches your major and interests	It is more difficult to screen employment information that matches your major and interests	It is impossible to screen employment information that matches your major and interests

Table 2 Criteria to evaluate Item 1 perception ability 2 Standards

Standard 1: Collecting employment information	
Standard 2: Screening employment information	
Score	**Grade**
9-10	Excellent
7-8	Good
5-6	Medium
3-4	Pass
Less than 3	Poor

Scoring rubric for form (Objective 3)

Assessment form for Validity of Rubric

Research Title: Development of Problem-Based Learning Instructional Model to Enhance Critical Thinking Ability of Undergraduate Students

Research Objectives: 3. To study the results of problem-based learning instructional model to enhance critical thinking ability of undergraduate students.

Assessor: Assistant Professor Dr. Tanaput Chancharoen

Position: Educational management and Learning Management Innovation 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

Table 1 Scoring rubric form

Item	5	4	3	2	1
Item 1: Perception ability					
Standard 1: Collecting employment information	Accurately find the relevant employment information through search engines, recruitment websites, social media and other channels	Be able to better find the relevant employment information through search engines, recruitment websites, social media and other channels	Could find the relevant employment information through search engines, recruitment websites, social media and other channels	It is more difficult to find the relevant employment information through search engines, recruitment websites, social media and other channels	It is impossible to find the relevant employment information through search engines, recruitment websites, social media and other channels
Standard 2: Screening employment information	Accurately screen employment information that matches your major and interests	Be able to better screen employment information that matches your major and interests	Could screen employment information that matches your major and interests	It is more difficult to screen employment information that matches your major and interests	It is impossible to screen employment information that matches your major and interests

Table 1 (Continued)

Item	5	4	3	2	1
Item 2: Analytical ability					
Standard 1: Analyzing employment information	Accurately analyze employment information that matches your major and employment demand	Be able to better analyze employment information that matches your major and employment demand	Could analyze employment information that matches your major and employment demand	It is more difficult to analyze employment information that matches your major and employment demand	It is impossible to analyze employment information that matches your major and employment demand
Standard 2: Determining employment information	Accurately determine employment information that matches your major and employment demand	Be able to better determine employment information that matches your major and employment demand	Could determine employment information that matches your major and employment demand	It is more difficult to determine employment information that matches your major and employment demand	It is impossible to determine employment information that matches your major and employment demand

Table 1 (Continued)

Item	5	4	3	2	1
Item 3. Reasoning ability					
Standard 1: Using employment theories and methods to inference the needs of employers	Accurately use employment theories and methods to inference the needs of employers	Be able to better use employment theories and methods to inference the needs of employers	Could use employment theories and methods to inference the needs of employers	It is more difficult to use employment theories and methods to inference the needs of employers	It is impossible to use employment theories and methods to inference the needs of employers
Standard 2: Creating a resume and prepare for an interview based on employment skills	Accurately create a resume and prepare for an interview based on employment skills	Be able to better create a resume and prepare for an interview based on employment skills	Could create a resume and prepare for an interview based on employment skills	It is more difficult to create a resume and prepare for an interview based on employment skills	It is impossible to create a resume and prepare for an interview based on employment skills
Item 4. Evaluation ability					
Standard 1: Finding your own value position for employers	Accurately find your own value position for employers	Be able to better find your own value position for employers	Could find your own value position for employers	It is more difficult to find your own value position for employers	It is impossible to find your own value position for employers

Table 1 (Continued)

Item	5	4	3	2	1
Standard 2: Evaluating the outcome of resume and interview	Accurately evaluate the outcome of resume and interview	Be able to better evaluate the outcome of resume and interview	Could evaluate the outcome of resume and interview	It is more difficult to evaluate the outcome of resume and interview	It is impossible to evaluate the outcome of resume and interview
Item 5. Problem-solving ability					
Standard 1: Asking questions for the employer's needs	Accurately ask questions for the employer's needs	Be able to better ask questions for the employer's needs	Could ask questions for the employer's needs	It is more difficult to ask questions for the employer's needs	It is impossible to ask questions for the employer's needs
Standard 2: Putting forward a feasible solution for proposed problems	Accurately put forward a feasible solution for proposed problems	Be able to better put forward a feasible solution for proposed problems	Could put forward a feasible solution for proposed problems	It is more difficult to put forward a feasible solution for proposed problems	It is impossible to put forward a feasible solution for proposed problems
Item 6. Reflective ability					
Standard 1: Finding the weaknesses	Accurately find the weaknesses of the solution	Be able to better find the weaknesses of the solution	Could put forward find the weaknesses of the solution	It is more difficult to find the weaknesses of the solution	It is impossible to find the weaknesses of the solution
Standard 2: Dealing with reflection and improvement	Accurately deal with reflection and improvement	Be able to better deal with reflection and improvement	Could deal with reflection and improvement	It is more difficult to deal with reflection and improvement	It is impossible to deal with reflection and improvement

Table 2 Assessment form

No.	Items	Assessment Results			Remarks
		+1	0	-1	
1	**Perception ability**				
	Standard 1: Collecting employment information				
	Standard 2: Screening employment information				
2	**Analytical ability**				
	Standard 1: Analyzing employment information				
	Standard 2: Determining employment information				
3	**Reasoning ability**				
	Standard 1: Using employment theories and methods to inference the needs of employers				
	Standard 2: Creating a resume and prepare for an interview based on employment skills				
4	**Evaluation ability**				
	Standard 1: Finding your own value position for employers				
	Standard 2: Evaluating the outcome of resume and interview				
5	**Problem-solving ability**				
	Standard 1: Asking questions for the employer's needs				
	Standard 2: Putting forward a feasible solution for proposed problems				
6	**Reflective ability**				
	Standard 1: Finding the weaknesses of the solution Standard 2: Dealing with reflection and improvement				

Table 3 Criteria to evaluate Item 1 Perception ability

Score	Grade
9-10	Excellent
7-8	Good
5-6	Medium
3-4	Pass
Less than 3	Poor

Table 4 Criteria to evaluate Item 2 Analytical ability

Score	Grade
9-10	Excellent
7-8	Good
5-6	Medium
3-4	Pass
Less than 3	Poor

Table 5 Criteria to evaluate Item 3 Reasoning ability

Score	Grade
9-10	Excellent
7-8	Good
5-6	Medium
3-4	Pass
Less than 3	Poor

Table 6 Criteria to evaluate Item 4 Evaluation ability

Score	Grade
9-10	Excellent
7-8	Good
5-6	Medium
3-4	Pass
Less than 3	Poor

Table 7 Criteria to evaluate Item 5 Problem-solving ability

Score	Grade
9-10	Excellent
7-8	Good
5-6	Medium
3-4	Pass
Less than 3	Poor

Table 8 Criteria to evaluate Item 6 Reflective ability

Score	Grade
9-10	Excellent
7-8	Good
5-6	Medium
3-4	Pass
Less than 3	Poor

Table 9 Criteria to evaluate critical thinking ability over all

Score	Grade
49-60	Excellent
37-48	Good
25-36	Medium
13-24	Pass
Less than 13	Poor

Appendix D
The Results of the Quality Analysis of Research Instruments

- IOC Questionnaire for students
- IOC Interview for lecturers
- IOC Lesson Plan
- IOC Scoring rubric form

Table Appendix 1: Evaluation Results of IOC for Factor Analysis (For Students)

No.	Items	Experts' rating			Total	MEAN	Results
		Exp. 1	Exp. 2	Exp.3			
Section 1	**Common data of the respondent**						
1	Gender ☐A. Male ☐B. Female	+1	+1	+1	3	1.00	Valid
2	Students from ☐A Guangxi University of Finance and Economics ☐B. Baise University ☐C. Guangxi Minzu University	+1	+1	+1	3	1.00	Valid
3	Age ☐A. Below 18 yrs. ☐B. 18-19 yrs. ☐C. 20-21 yrs. ☐D. over 21 yrs.	+1	+1	+1	3	1.00	Valid
Section 2	**The information on factors affecting critical thinking ability of Undergraduate Students**						
	Internal Factors(Psychology or physiology no.1-2, attitude no.3-4, knowledge or skills no.5- 6)						
1	Students realize the importance of the College Students' Career Guidance course and firmly believe that critical thinking ability are of great help to future career choice and personal development.	+1	+1	+1	3	1.00	Valid
2	Students believe that good personality, stable mood and friendly way of getting along will contribute to collecting,	+1	+1	+1	3	1.00	Valid

Table Appendix 1 (Continued)

No.	Items	Experts' rating			Total	MEAN	Results
		Exp. 1	Exp. 2	Exp. 3			
	identifying and processing career information, which improves their critical thinking ability.						
3	Students believe that it is very important for students to have a good learning attitude towards College Students' Career Guidance course. They consider that thinking positively in class and summing up meticulously after class for students in the course could help students to collect, identify and deal with career information and improve job-hunting skills, which will enhance critical thinking ability.	+1	+1	+1	3	1.00	Valid
4	Students believe that students can combine their personal interests, majors and values to effectively plan their future careers and enhance their job search competitiveness through College Students' Career Guidance course. Because when you participate in the interview, you can better show your own advantages, and conduct in-depth analysis of professional problems or phenomena.	+1	+1	+1	3	1.00	Valid
5	The significance of the prior knowledge is to help students build a bridge between new knowledge and that they have already in College Students' Career Guidance course. After	+1	+1	+1	3	1.00	Valid

Table Appendix 1 (Continued)

No.	Items	Experts' rating			Total	MEAN	Results
		Exp. 1	Exp. 2	Exp. 3			
	learning theoretical knowledge, students acquire vocational knowledge through various online platforms and digital resources, which helps to improve students' vocational cognitive ability.						
6	Students believe that taking notes and participating in discussions in class can better understand and master new knowledge.	+1	+1	+1	3	1.00	Valid
	External factors (Teaching method no.7-8, Materials no. 9-10, Environment no.11-12)						
7	Students believe that teachers adopt a variety of teaching methods such as case analysis, scenario simulation, role playing and group discussion in College Students' Career Guidance course, which can stimulate students' learning interest and promote the development of students' critical thinking ability.	+1	+1	+1	3	1.00	Valid
8	Students believe that teachers take the ability as the orientation, take the problem as the driving force, pay attention to the creation of situations, and guide students to think independently in College Students' Career Guidance course, which is conducive to improving their critical thinking	+1	+1	+1	3	1.00	Valid

Table Appendix 1 (Continued)

No.	Items	Experts' rating			Total	MEAN	Results
		Exp.1	Exp. 2	Exp. 3			
	ability.						
9	Students believe that teachers use rich digital teaching resources, such as digital education platforms, online teaching videos, to achieve diversified learning in College Students' Career Guidance course, which helps improve their critical thinking ability.	+1	+1	+1	3	1.00	Valid
10	Students believe that teachers choice of teaching materials around their critical thinking skills training objectives, and providing cases and training materials closely related to their study life and future career can help promote the development of students' critical thinking ability.	+1	+1	+1	3	1.00	Valid
11	Students believe that appropriate class size, relaxed classroom atmosphere, full use of social resources and experiential education in College Students' Career Guidance course, which can help them improve their critical thinking ability in employment practice.	+1	+1	+1	3	1.00	Valid
12	The campus can access the Internet anytime and anywhere, the classroom is clean and bright, the desks and chairs are warm and comfortable, and the multimedia equipment is	+1	+1	+1	3	1.00	Valid

Table Appendix 1 (Continued)

No.	Items	Experts' rating			Total	MEAN	Results
		Exp. 1	Exp. 2	Exp. 3			
	completed, which facilitates the teaching process. Such conditions could improve students' problem-solving ability and critical thinking ability.						
	Total (In Overview)				42	1.00	Valid

Note: Valid when≥0.6

Table Appendix 2: Evaluation Results of IOC for Factor Analysis(For Lecturers)

No.	Items	Experts' rating			Total	MEAN	Results
		Exp. 1	Exp. 2	Exp. 3			
Section 1	**Common data of the respondent**						
1	Gender	+1	+1	+1	3	1.00	Valid
	☐A. Male ☐B. Female						
2	Lecturers from	+1	+1	+1	3	1.00	Valid
	☐A Guangxi University of Finance and Economics						
	☐B. Baise University						
	☐C. Guangxi Minzu University						
3	Teaching experience	+1	+1	+1	3	1.00	Valid
	☐A. Below 3 yrs. ☐B. 4-6 yrs.						
	☐C. 7- 9 yrs. ☐D. Over 9 yrs.						
4	Age	+1	+1	+1	3	1.00	Valid
	☐A. below 30 yrs. ☐B. 30-40 yrs.						
	☐C. 41-50 yrs. ☐D. over 50 yrs.						
5	Professional title	+1	+1	+1	3	1.00	Valid
	☐A. Professor ☐B. Associate professor						
	☐C. Assistant Professor ☐D. Lecturer						
Section 2	**Interview on factors to enhance critical thinking ability of undergraduate students**						
	Internal factors (Psychology no. 1, Attitude no. 2-3, Knowledge no.4-5)						

Table Appendix 2 (Continued)

No.	Items	Experts' rating			Total	MEAN	Results
		Exp. 1	Exp. 2	Exp. 3			
1	Do you think that teachers' positive mood, optimism to students' face difficulties, and patience with students will improve cognitive ability and problem-solving ability, and affect students' critical thinking ability in College Students' Career Guidance course? Please write the reason.	+1	+1	+1	3	1.00	Valid
2	Do you think that teachers' thinking habit, passion for the classroom and life attitude (including learning attitude, attitude towards dilemma, the view of the world life and values, etc.) can affect students' understanding ability, reasoning ability and critical thinking ability? Write down your reasons please.	+1	+1	+1	3	1.00	Valid
3	Do you think that teachers' positive personal enthusiasm about education, and learning in College Students' Career Guidance course will positively affect students' enthusiasm and interest in learning, which promotes students' critical thinking ability? Do you agree? Please write down your reasons.	+1	+1	+1	3	1.00	Valid
4	Do you think that teachers' knowledge and teaching skills of College Students' Career Guidance course play an important role in promoting students' critical thinking ability? If you	+1	+1	+1	3	1.00	Valid

Table Appendix 2 (Continued)

No.	Items	Experts' rating			Total	MEAN	Results
		Exp. 1	Exp. 2	Exp. 3			
	agree please write the reason.						
5	Do you think that teachers should continue to receive training in vocational education and teaching skills in College Students' Career Guidance course? Is this very important for promoting students' critical thinking ability? Please write down the reasons.	+1	+1	+1	3	1.00	Valid
	External factors(Teaching Method no. 6-7, Materials no. 8, Environment no.9-10)						
6	How do you organize the classroom teaching to promote students' critical thinking ability in College Students' Career Guidance course, such as teaching content, cases analysis, group works and the assessment of learning outcome, etc.? What strategies do you motivate students to promote their critical thinking ability?	+1	+1	+1	3	1.00	Valid
7	Do you think that teacher's teaching ability to create and to use new ICT (information and communications technology) and online resources for instructional contexts in College Students' Career Guidance course can greatly improve students' reasoning ability and critical thinking ability? Please write down the reasons.	+1	+1	+1	3	1.00	Valid

Table Appendix 2 (Continued)

No.	Items	Experts' rating			Total	MEAN	Results
		Exp. 1	Exp. 2	Exp. 3			
8	What kind of materials and tools do you often use to the teaching in College Students' Career Guidance course? How can these materials and tools improve students' perception ability and critical thinking ability? Please list materials and tools and illustrate their roles.	+1	+1	+1	3	1.00	Valid
9	What kind of teaching environment (such as class size, library resources, classroom atmosphere, etc.) can help to improve students' critical thinking ability in College Students' Career Guidance course?	+1	+1	+1	3	1.00	Valid
10	Are there any strategies in your teaching that need to be improved? Do you want your school to support you in developing innovation and entrepreneurship education and vocational education in order to enhance students' critical thinking ability in College Students' Career Guidance course?	+1	+1	+1	3	1.00	Valid
	Total (In Overview)				36	1.00	Valid

Note**:** Valid when≥0.6

Table Appendix 3: Evaluation Results of IOC for instructional model

No.	Items	Experts' rating			Total	MEAN	Results
		Exp. 1	Exp. 2	Exp. 3			
1	**Utility Standards**						
	1. Problem-based learning instructional model is useful to students to enhance learning achievement.	+1	+1	+1	3	1.00	Valid
	2. Problem-based learning instructional model is useful to lecturers to enhance learning achievement.	+1	+1	+1	3	1.00	Valid
	3. Problem-based learning instructional model includes necessary and enough contents.	+1	+1	+1	3	1.00	Valid
	4. Problem-based learning instructional model promotes to enhance learning achievement more compared to traditional teaching.	+1	+1	+1	3	1.00	Valid
	5. Problem-based learning instructional model increases the learning achievement of students and enhance critical thinking ability.	+1	+1	+1	3	1.00	Valid
2	**Feasibility Standards**						
	1. The lecturer can apply problem-based learning instructional model to enhance critical thinking ability to their work and it is worth the time for actual use.	+1	+1	+1	3	1.00	Valid
	2. The lecturer can develop the students to problem-based learning instructional model.	+1	+1	+1	3	1.00	Valid

Table Appendix 3 (Continued)

No.	Items	Experts' rating			Total	MEAN	Results
		Exp. 1	Exp. 2	Exp. 3			
	3. Problem-based learning instructional model to lecturer is easy to use.	+1	+1	+1	3	1.00	Valid
	4. The students always develop their learning all time by problem-based learning instructional model to enhance critical thinking ability.	+1	+1	+1	3	1.00	Valid
	5. The students are comfortable in learning by themselves with problem-based learning instructional model to enhance critical thinking ability.	+1	+1	+1	3	1.00	Valid
3	**Propriety Standards**						
	1. Problem-based learning instructional model to enhance critical thinking ability is appropriate for lecturers to use assessment results to improve the students' ability.	+1	+1	+1	3	1.00	Valid
	2. Problem-based learning instructional model to enhance critical thinking ability is appropriateness for students to create knowledge by themselves.	+1	+1	+1	3	1.00	Valid
	3. Problem-based learning instructional model to enhance critical thinking ability is convenient to use.	+1	+1	+1	3	1.00	Valid
	4. Problem-based learning instructional model to enhance learning achievement is a systematic process to use.	+1	+1	+1	3	1.00	Valid

Table Appendix 3 (Continued)

No.	Items	Experts' rating			Total	MEAN	Results
		Exp. 1	Exp. 2	Exp. 3			
	5. Problem-based learning instructional model to enhance learning achievement is clear and suitable for use in learning and students' development.	+1	+1	+1	3	1.00	Valid
4	**Accuracy Standards**						
	1. Problem-based learning instructional model to enhance learning achievement is comprehensively analyzed from different contexts and sufficient for the synthesis of patterns.	+1	+1	+1	3	1.00	Valid
	2. Problem-based learning instructional model to enhance learning achievement has a clear process.	+1	+1	+1	3	1.00	Valid
	3. Problem-based learning instructional model to enhance learning achievement are described and the acquisition is clear.	+1	+1	+1	3	1.00	Valid
	4. Problem-based learning instructional model to enhance learning achievement uses the burgeoning techniques and tools which acquires accurate information and communication.	+1	+1	+1	3	1.00	Valid
	5. Problem-based learning instructional model to enhance learning achievement is a correct and comprehensive learning system.	+1	+1	+1	3	1.00	Valid

Table Appendix 4: Evaluation Results of IOC for rubric Observation

No.	Items	Experts' rating			Total	MEAN	Results
		Exp. 1	Exp. 2	Exp. 3			
	Perception ability						
1	Standard 1: Collecting employment information	+1	+1	+1	3	1.00	Valid
2	Standard 2: Screening employment information	+1	+1	+1	3	1.00	Valid
	Analytical ability						
3	Standard 1: Analyzing employment information	+1	+1	+1	3	1.00	Valid
4	Standard 2: Determining employment information	+1	+1	+1	3	1.00	Valid
	Reasoning ability						
5	Standard 1: Using employment theories and methods to inference the needs of employers	+1	+1	+1	3	1.00	Valid
6	Standard 2: Creating a resume and prepare for an interview based on employment skills	+1	+1	+1	3	1.00	Valid
	Evaluation ability						
7	Standard 1: Finding your own value position for employers	+1	+1	+1	3	1.00	Valid
8	Standard 2: Evaluating the outcome of resume and interview	+1	+1	+1	3	1.00	Valid
	Problem-solving ability						
9	Standard 1: Asking questions for the employer's needs	+1	+1	+1	3	1.00	Valid
10	Standard 2: Putting forward a feasible solution for proposed problems	+1	+1	+1	3	1.00	Valid

Table Appendix 4 (Continued)

No.	Items	Experts' rating			Total	MEAN	Results
		Exp.1	Exp.2	Exp. 3			
	Reflective ability						
11	Standard 1: Finding the weaknesses	+1	+1	+1	3	1.00	Valid
12	Standard 2: Dealing with reflection and improvement	+1	+1	+1	3	1.00	Valid

Table Appendix 5: Evaluation Results of IOC for Lesson Plan

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

Appendix E
Certificate of English

BANSOMDEJCHAOPRAYA
RAJABHAT UNIVERSITY

This is to certify that

Mrs.Qifeng Chen

Achieved BSRU English Proficiency Test (BSRU-TEP) level

C2

Given on 13th February 2022

(Assistant Professor Dr Kulsirin Aphiratvoradej)

Director

Appendix F
The Document for Acceptance Research

ที่ อว ๐๖๔๓.๐๗/๐๑๖๑

คณะมนุษยศาสตร์และสังคมศาสตร์
มหาวิทยาลัยราชภัฏบ้านสมเด็จเจ้าพระยา
๑๐๖๑ ถนนอิสรภาพ แขวงหิรัญรูจี
เขตธนบุรี กรุงเทพฯ ๑๐๖๐๐

๑๘ มีนาคม ๒๕๖๗

เรื่อง ตอบรับการตีพิมพ์บทความทางวิชาการ

เรียน CHEN QIFENG

อ้างถึง บทความเรื่อง Development of Problem-Based Learning Instructional Model to Enhance Critical Thinking Ability of Undergraduate Students

ตามที่ท่านส่งบทความเรื่อง Development of Problem-Based Learning Instructional Model to Enhance Critical Thinking Ability of Undergraduate Students เพื่อลงตีพิมพ์ในวารสารมนุษยศาสตร์และสังคมศาสตร์ มหาวิทยาลัยราชภัฏบ้านสมเด็จเจ้าพระยา ของคณะมนุษยศาสตร์และสังคมศาสตร์ มหาวิทยาลัยราชภัฏบ้านสมเด็จเจ้าพระยา นั้น

ในการนี้ บทความดังกล่าวได้รับการตรวจพิจารณาจากผู้ทรงคุณวุฒิหลากหลายสถาบัน จำนวน ๓ ท่าน กองบรรณาธิการได้ดำเนินการพิจารณาเรียบร้อยแล้ว เห็นสมควรให้ตีพิมพ์บทความของท่านในวารสารปีที่ ๑๘ ฉบับที่ ๒ กรกฎาคม - ธันวาคม ๒๕๖๗ และจะนำวารสารดังกล่าวประชาสัมพันธ์เผยแพร่เพื่อให้เกิดประโยชน์ในเชิงวิชาการต่อไป

จึงเรียนมาเพื่อทราบ และขอขอบคุณมา ณ โอกาสนี้

ขอแสดงความนับถือ

(ผู้ช่วยศาสตราจารย์ ดร.ทัชชยา วนนะบวรเดชน์)
คณบดีคณะมนุษยศาสตร์และสังคมศาสตร์
Signature Code : ε/FJohBIHUXQfRtJKeu

สำนักงานคณบดีคณะมนุษยศาสตร์และสังคมศาสตร์
โทร ๐๒-๔๗๓-๗๐๐๐ ต่อ ๒๗๐๔
โทรสาร

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