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Acceptance Letter

Dear: **Gu Linna, Lerlak Othakanon, and Wassaporn Jirojphan**

Paper Title: **Development of Primary Interdisciplinary Education Course Based on Project-Based Learning Combined with Research-Based Learning to Enhance Learning Achievement and Curriculum Development Ability of Third Year Student Teachers in Xi'an University**

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Sincerely

Asst. Prof. Dr. Sanya Kenaphoom
Editor-In-Chief

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Development of Primary Interdisciplinary Education Course Based on Project-Based Learning Combined with Research-Based Learning to Enhance Learning Achievement and Curriculum Development Ability of Third Year Student Teachers in Xi'an University

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ABSTRACT

Background and Aim: As current college students and future teachers, the student teachers' interdisciplinary awareness not only affects their quality but also the development of education. How to implement the concept of interdisciplinary education in student teachers' education, the development of interdisciplinary education courses is particularly important. This study was a research and development. The objectives of the research were 1) to compare student teachers' learning achievement before and after implementing Primary interdisciplinary education courses based on Project-Based Learning combined with Research-Based Learning. 2) to compare student teachers' curriculum development ability after implementing Primary interdisciplinary education courses based on Project-Based Learning combined with Research-Based Learning with the criterion set 3.51 and 3) to compare student teachers' satisfaction after implementing Primary interdisciplinary education courses based on Project-Based Learning combined with Research-Based Learning with the criterion set 3.51.

Materials and Methods: The sample was 30 students (one class) from Xi'an University which were derived by cluster random sampling. The instruments used in this study were 1) Primary Interdisciplinary Education Course based on Project-Based Learning combined with Research-Based Learning; 2) 8 lesson plans; 3) A learning achievement test with 0.868 of reliability, the item difficulty ranged from 0.47-0.77, and the discrimination ranged from 0.22-0.89; 4) An evaluation form of curriculum development ability (Scoring Rubric) with 0.757 of inter-rater reliability; 5) A students' satisfaction questionnaire with reliability of 0.855. The statistics used for data analysis were Mean, Standard deviation, t-test for dependent samples, and t-test for one sample.

Results: The results of the study were as follows: 1) The primary Interdisciplinary Education Course based on Project-Based Learning combined with Research-Based Learning was implemented and after implementation, the student teachers' learning achievement post-test scores were higher than pretest scores at.01 level of statistical significance ($t = 33.64$, $p<0.01$); 2) the student teachers' curriculum development ability post-test scores were higher than criteria of 3.51 at.01 level of statistical significance ($M = 66.02$, $SD = 2.34$); and 3) the student teachers' satisfaction post-test scores were higher than criteria of 3.51 at.01 level of statistical significance ($M = 4.71$, $SD = 0.15$).

Conclusion: The developed Primary Interdisciplinary Education Course based on Project-Based Learning combined with Research-Based Learning can enhance the student teachers learning achievement and curriculum development ability. The student teachers had the satisfaction of studying with Primary Interdisciplinary Education Course.

Keywords: Primary interdisciplinary education course, project-based learning, research-based learning, student teacher, learning achievement, curriculum development ability

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Introduction

Talent cultivation education comes first. With the development of the times, interdisciplinary education has gradually become one of the important ways to cultivate scientific and technological innovation talents. The interdisciplinary-related subject words frequently appear in the Chinese national education and teaching reform documents of all levels and types, including curriculum and instruction reform of primary school, secondary school, and university.

Ministry of Education of the People's Republic of China (2022) issued the Plan for Strengthening Basic Education Teachers in the New Era, which proposes to adapt to the reform and development of basic education, follow the law of teacher growth, reform the curriculum and teaching content of general colleges and universities, improve teaching methods and means, strengthen teaching practice, and improve the quality of general student education. Strengthen the leading role of colleges of education in the teacher education system, promote the combination of student and in-service education, innovate mechanisms for the teaching practice of teacher education students and the professional development of teachers, and improve the quality of teacher education students' education.

China has been exploring reforms in the field of education, including curriculum reform and teaching reform. Colleges and universities, as the main training ground for teachers, have an important mission, and the quality of teacher education programs is the top priority to ensure the quality of talent training. However, the problems of teacher education courses in colleges and universities in Southwest China found that the curriculum system of teacher education in higher education colleges and universities meets the needs of the times, but there are still some problems. Specifically manifested in 1) the overall layout is not proper; 2) the single type, of course, tends to be technical; and 3) course evaluation is difficult to meet the developmental function demand. Dong & Liu (2022) investigated the current situation of teacher training in educational research literacy for primary education majors and found that the main problems include: 1) the generalization of the training objectives for educational research literacy; 2) the lack of courses that specialize in training educational research ability; 3) the insufficiency of malefactor learning in the teaching of theoretical courses for teacher trainees; 4) the lack of implementation of training in educational research in the practical teaching process; 5) the lack of training in educational research activities for a small number of students outside of class. The training of educational research activities is only for a small number of students, and the evaluation mechanism of educational research literacy is not perfect.

At the same time, to solve the problems of Chinese students' insufficient sense of innovation and low practical and problem-solving abilities, countless educators in China have devoted themselves to theoretical research and combined advanced foreign educational concepts with Chinese reality to develop curriculum systems and teaching modes suitable for Chinese localities. Among them, Project-based learning had been developing rapidly these years and had produced fruitful results in schools and universities. Based on the above analysis, it can be seen that: 1) the development of society has put forward the requirements of the times for the development of interdisciplinary education courses; 2) the national policies of teaching education reform have provided policy support for the development of interdisciplinary education course; 3) the theoretical and practical research of domestic experts on teaching methods such as Project-Based Learning combined with Research-Based Learning has provided the theoretical basis for the development of interdisciplinary education course; 4) there are problems with the current teacher education curriculum: the link between theory and practice is not strong, the course content is outdated, the instructional strategies are single, and the variety of courses does not meet the needs of the students.

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Therefore, Xi'an University had the requirement and conditions to develop a Primary Interdisciplinary education course based on Project-Based Learning combined with Research-Based Learning to enhance the learning achievement and curriculum development ability of third-year student teachers.

Objective

1) To compare student teachers' learning achievement before and after implementing Primary interdisciplinary education courses based on Project-Based Learning combined with Research-Based Learning.

2) To compare student teachers' curriculum development ability after implementing Primary interdisciplinary education courses based on Project-Based Learning combined with Research-Based Learning with the criterion set 3.51.

3) To compare student teachers' satisfaction after implementing Primary interdisciplinary education courses based on Project-Based Learning combined with Research-Based Learning with the criterion set 3.51.

Literature Review

1. Curriculum development theory

Curriculum development is a multifaceted concept with varying interpretations among scholars. Tyler (1949) explained curriculum development from four aspects educational objectives, educational experience, organization, and evaluation of objectives." Taba (1962) advocated a so-called grass-roots model of school-based curriculum development which could strike a balance between general principles and practical experience. Sato & Zhong (2003) suggest from the perspective of curriculum implementation that curriculum development was the planned and strategic refinement of educational materials and learning activities by educators by the educational philosophy, leading to teaching and learning activities that meet the growth and development of children. Zhong et al (2008) believed that curriculum development was a continuous process of preparing, experimenting, checking, and improving the curriculum. Cong (2000) proposed that curriculum development was to put forward specific propositions and views in each category of curriculum objectives, curriculum content, and curriculum evaluation and to realize them to form a specific curriculum development model.

This study adopted Tyler's model to define the Primary interdisciplinary education course, aiming to enhance the student teachers' learning achievement and curriculum development. The curriculum encompasses six aspects: principles, objectives, content, instructional strategies, materials and resources, and evaluation methods.

2. Primary interdisciplinary education course

Jacob (1989) thought interdisciplinary curriculum as a disciplinary perspective and curricular approach in which teachers examine some important subject, question, problem, issue, topic, or experience from a multidisciplinary field through the conscious use of methodology and epistemology. According to Bernstein (2015), an interdisciplinary curriculum selects a real-world problem or subject matter of significance to students, transforms the problem into a topic of inquiry, and then students use concepts, knowledge, and methods from two or more disciplines to carry out a sustained inquiry on the topic and form a product that materializes the concepts, thus developing interdisciplinary understandings and core literary.

Lin & Yang (2010) argued that in an interdisciplinary curriculum, the teacher was no longer a single transmitter of knowledge, but a researcher in the classroom, a collaborator in student learning, and a guide to student learning and development. Zeng (2007) believed that a single-type teacher was a teacher who

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possessed knowledge of a single subject and paid attention to teaching only from the perspective of his or her subject knowledge and paid no attention to the knowledge and skills of other subjects in his or her teaching activities.

Based on the above viewpoints, the researcher believed that the Primary interdisciplinary education course was a teacher education course for student teachers, and the ultimate goal was to enhance the interdisciplinary knowledge of student teachers majoring in primary education and to cultivate the curriculum development ability of student teachers majoring in primary education, including Curriculum understanding ability, Curriculum design ability, Curriculum implementation ability, and Curriculum evaluation ability.

3. Project-based learning

At present, the definition of project-based learning in China and other countries tends to be mostly from the perspective of a process-based approach.

Solomon (2003) explained that project-based learning aimed to solve challenging interdisciplinary problems in the form of project teamwork. Krajcik et al (2004) believed that project-based teaching refers to the organization and guidance of the teacher, through the driving question to carry out teaching activities, students learned to cooperate and communicate in practical activities. The U. S. Buck Institute for Educational Research. (2007) defined project-based learning as a systematic teaching methodology, which was the process of inquiry based on real-life situations, as well as the process of materialization of creativity and the production of project results, throughout the practical activities, students were able to master the necessary knowledge and skills and were able to use their acquired knowledge and skills in the practical activities.

In China, According to Li & Tian (2013), project-based learning refers to the design of driving questions by teachers based on the outline of the curriculum guide and students' existing learning experience, to stimulate students to master relevant knowledge and skills in the process of problem exploration, and ultimately, to design project works and show the results of their investigations. According to Xu (2012), project-based learning refers to a new type of inquiry learning in which students investigate real-life problems under the guidance of teachers and in which students can solve a series of interrelated problems within a certain period. Sang et al (2023) pointed out that: Project-Based Learning was an educational concept, instructional model, learning approach, curriculum form, and subject integration method. Liu & Zhong (2002) pointed out that the project-based learning model, which originated from Dewey's concept of "learning by doing", was divided into six main steps: selecting a project, formulating a plan, exploring the activity, producing the work, communicating the results and evaluating the activity.

In summary, this study defined project-based learning as a mode of teaching and learning in which students were placed in authentic problem situations, teachers and students worked together to design core-driven problems, and students worked in teams to find solutions to the problems, in which they were required to integrate and apply knowledge from different disciplines and thus achieved a deeper understanding of specific concepts. Unlike traditional teaching methods that relied heavily on lectures and textbooks, project-based learning encouraged active learning, critical thinking, collaboration, and problem-solving.

4. Research-based learning

Research-based learning emphasizes the active participation of students in research and investigations that lead to an in-depth understanding of problems and self-directed learning. Experts and scholars in China and abroad have conducted a great deal of research on Research-based learning.

The studies were as follows:

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Srikoon et al (2014) explained that Research-based learning was a learning model to introduce students to how to learn and build their knowledge, it was one of the outcome-based learning techniques, that closed the gap between theory and application. Kerdmanee et al (2015) even specifically mentioned that Research-based learning was Research-based instruction with the core principle of equipping students with the skills to acquire knowledge independently. Al-Maktoumi (2016) provided a synonym for inquiry-based learning where Research-based learning was an activity connecting research with pedagogical instruction in a learning environment; thus, this research activity allowed students to recognize the variety and complexity of building knowledge in a cross-disciplinary scope. Rattanaprom (2019) explained that Research-based learning referred to the main point of equipping students with certain skills that enable them to build their knowledge. Herrmann et al (2019) that research-based learning needs the right way to be implemented, what the expected outcome was, and how effective it was. It involved the learner to design, experience, and reflect on the entire process of learning. Inquiry formed one of the important elements of Research-based learning, which also developed creativity and discovered new techniques breaking the monotonous process of solution development.

In China, according to Jiang (2001), Research-based learning was based on students' independent and exploratory learning, selecting and identifying research topics from students' life and social life, and was mainly carried out in an individual or group cooperative manner. Mao (2001) stated that Research-based learning was based on "acquiring knowledge, applying knowledge" and mastering the general process of scientific research as its basic content. Regarding the characteristics of Research-based learning, Zhang (2000) pointed out that there were four basic features of Research-based learning: 1) emphasis on the process, 2) emphasis on application, 3) emphasis on experience, and 4) emphasis on full participation. According to Huo & Zhang (2000), Research-based learning had some distinctive features as follows: 1) Research-based learning mainly organized students' learning activities around the formulation and solution of problems (or themes or topics); 2) Research-based learning was a kind of open learning; 3) Research-based learning emphasized students' autonomy and inquiry learning; 4) Research-based learning focused on the process of learning as well as the feelings and experiences of students in the learning process. About the effects of Research-based learning. Zhuang (2001) summarized the benefits of Research-based learning: 1) Students could learn the basic methods of scientific research, change the way of learning, and cultivate the spirit of innovation; 2) Students could get the ability 0f collect and processing information; 3) Students could improve their ability to express themselves, communicate and cooperate with others; 4) Enhancing the students' sense of responsibility and sense of mission to the society. About the steps of Research-based learning. Li (2021) summarized the five basic steps of Research-based learning: 1) Asking questions: learners were engaged in the exploration of science-based questions; 2) Collecting data: learners valued the role of empirical evidence in explaining and evaluating science-based questions; 3) forming explanations: learners formed explanations of scientific questions based on empirical evidence; 4) Evaluating results: learners evaluated their explanations based on other explanations; 5) Testing results: learners communicated and validated their proposed explanations.

In summary, this study defined Research-based learning as an educational approach that emphasizes the integration of research activities into the learning process. The students explored themes and topics of interest through hands-on research, including formulating research questions, conducting experiments or investigations, analyzing data, drawing conclusions, and presenting findings. Research studies aimed to develop critical thinking, problem-solving skills, and a deeper understanding of subject knowledge. Through active participation in research activities, students can develop a range of academic and practical skills such

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as information literacy, data analysis, and communication skills. Research-based learning also encourages students to take ownership of their learning and promotes a deeper engagement with the material.

5. Teaching steps of Primary interdisciplinary education course based on Project-Based Learning combined with Research-Based Learning

In the newly created Primary interdisciplinary education course, the new instructional strategies included 6 steps as follows:

Step 1: Identifying a research topic

The teacher identifies a research question with the student teacher based on the chapter content of the course.

Step 2: Develop a driving question

Teachers formulate a driving question around the research topic that is open-ended, stimulates the interest of the student teachers, and guides the student teachers to conduct in-depth thinking and research.

Step 3: Research skills training

Teachers provide student teachers with the necessary training in research skills, such as training in literature search, data collection, and experimental design.

Step 4: Designing a Mini-Project

student teachers design a mini-project around the driving question.

Step 5: Collecting and analyzing data

The student teacher collects and analyses data to complete the mini-project.

Step 6: Reflecting and evaluating

student teachers work in their groups to introduce their research process and the completion of their mini-projects to learn from each other; student teachers share their project results. Teachers comment on the student teachers' presentations and summarize the key elements of learning.

6. Learning achievement

Gagne (1977) proposed a classification system: 1) Intellectual skill learning; 2) Cognitive strategy learning; 3) Verbal information learning; 4) Motor skill learning; 5) Attitude learning. He emphasized that there was no simple hierarchical relationship between these five outcomes and that each learning outcome had its characteristics and depended on different internal and external conditions. Bloom et al (1956) categorized cognitive domain objectives into six categories: knowledge, comprehension, application, analysis, synthesis, and evaluation. Bloom's student, Anderson et al (2001) made some improvements to the original taxonomy and adjusted the original terminology: the original "knowledge" became "remember", "comprehension" became "understand", "application" became "apply", "analysis" became "analyze" and "evaluation" became "evaluate", "synthesis" became "create".

In the research, the learning achievement of student teachers referred to the knowledge level of students. It was quantifiable and widely used in life. In the field of education, teachers use grades to measure the performance of students over a specific period. It can be assessed through a test paper prepared by the researcher. Learning achievement in this research focused on assessing the academic performance of student teachers using Bloom's cognitive domain objectives, which were related to remembering, understanding, applying, analyzing, evaluating, and creating. The test paper contained 40 multiple-choice items. The details are given below

7. Curriculum development ability

According to Zhao (2007), curriculum development ability refers to the psychological characteristics that teachers possess when engaging in a series of curriculum activities, or the ability of teachers to complete

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various curriculum activities. Tian (2013) defined curriculum development ability as the dynamic power that teachers possess based on their curriculum knowledge and skills, which directly impacts the effectiveness of curriculum activities' operation. Li (2021) discussed the relationship between curriculum and teaching, and the relationship between curriculum development ability and teaching ability. Regarding the relationship between curriculum and teaching, the basic viewpoints in pedagogy included: the theory of inclusion, that was, the curriculum covered teaching and teaching covered the curriculum; the theory of independence, that was, the curriculum and teaching were relatively independent, belonging to the lower concepts of education; the theory of mutual influence, that was, the curriculum and teaching were organically integrated and interconnected.

In this research, Curriculum development ability refers to the comprehensive ability in 4 aspects, including curriculum understanding ability, curriculum designing ability, curriculum implementation ability, and curriculum evaluation ability. That means after implementing the Primary interdisciplinary education course, the student teachers were able to integrate the contents of two or more subject curricula based on the concept of curriculum integration and to systematically plan, organize, implement evaluate, and continuously improve the components of the curriculum. The instruments used to measure the student teachers' curriculum development ability in this study was the evaluation form of the scoring rubric including 4 components and 15 indicators.

1) Curriculum understanding ability refers to understanding national curriculum standards, course materials, primary education, and the student teachers' abilities; 2) Curriculum designing ability refers to formulating curriculum objectives, selecting curriculum contents, designing teaching activities and strategies, and designing teaching evaluation methods; 3) Curriculum implementation ability referred to organize teaching activities; applying teaching methods and strategies; selecting and applying media, and mobilizing students' motivation to learn; 4) Curriculum evaluation ability referred to evaluate the achievement of curriculum objectives, judging the effectiveness of curriculum contents, summarizing the process of curriculum implementation, and making corrections to the curriculum.

8. Students' satisfaction

Students' satisfaction in this paper referred to the degree of recognition and overall feelings of student teachers towards the interdisciplinary education course based on Project-Based Learning combined with Research-Based Learning. student teachers' satisfaction questionnaire was used to evaluate student teachers' satisfaction.

The students' satisfaction scale in this research contained 2 sections: Section 1 recorded the student teachers' personal information. Section 2 was the five-point scale Likert questionnaire ranging from Very satisfied, Satisfied, Neutral, Dissatisfied, and Very Dissatisfied. This section of the questionnaire consisted of questions or statements asking about student teachers' opinions toward the implementation of a Primary interdisciplinary education course including 4 aspects (content, Instructional strategies, media and resources, evaluation) 16 items.

Conceptual Framework

The research title Development of Primary Interdisciplinary Education Course Based on Project-Based Learning Combined with Research-Based Learning to Enhance Learning Achievement and Curriculum Development Ability of Third Year Student Teachers at Xi'an University was designed as the conceptual framework as follows:

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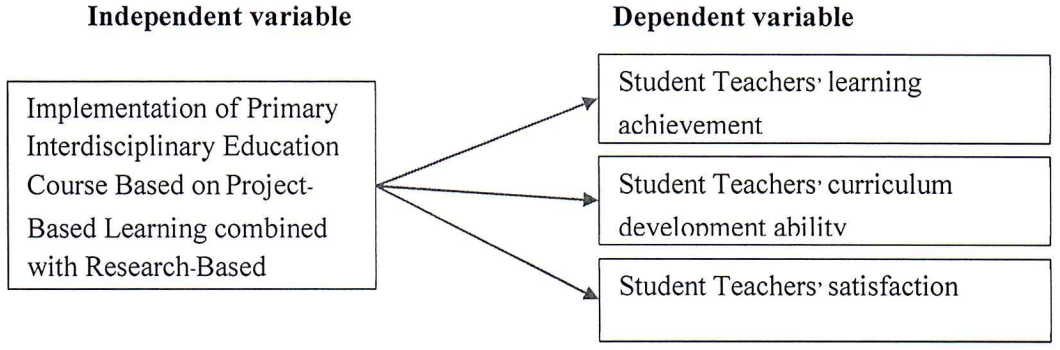


Figure 1 Conceptual Framework

Methodology

Population and sample: The population of this study was 90 third-year students (3 Classes) of Xi'an University and the sample of this study was 30 third-year student teachers (1 class) majoring in Primary education of Xi'an University which was derived by cluster random sampling.

Research Instruments: Research instruments were the tools for researching to collect data. The research instruments used in this study were:

1. Experimental instruments

1.1 Primary Interdisciplinary Education Course Based on Project-Based Learning Combined with Research- Based Learning. 5 experts evaluated the draft course, in the 11 items of the Primary Interdisciplinary Education Course evaluation form, the lowest item "The evaluation is appropriate to the course" was M=4.20, SD=0.45, and the highest item "The course contents are appropriate for the objectives of the course", "The instructional media and resources are appropriate to the teaching and learning process" was M=4.80, SD=0.45. It was revealed that a Primary Interdisciplinary Education Course Based on Project-Based Learning combined with Research-Based Learning was appropriate to implement.

1.2. Lesson plans. 5 experts evaluated the 8 lesson plans. According to the expert evaluation form, the total of lesson plan 1 was M=4.53, SD=0.52, the total of lesson plan 2 was M=4.45, SD=0.50, the total of lesson plan 3 was M=4.51, SD=0.48, the total of lesson plan 4 was M=4.46, SD=0.50, the total of lesson plan 5 was M=4.51, SD=0.46, the total of lesson plan 6 was M=4.50, SD=0.53, the total of lesson plan 7 was M=4.54, SD=0.50, the total of lesson plan 8 was M=4.54, SD=0.52. It was revealed that lesson plans were appropriate to implement.

2. Instruments for collecting data: Instruments for measuring student teachers' learning achievement and curriculum development ability wwere divided into 3 sections:

Section 1: Test for student teachers' learning achievement

The test for student teachers' learning achievement was 40 items of multiple choice with 0.868 of reliability, the item difficulty ranged from 0.47-0.77, and the discrimination ranged from 0.22-0.89, which meanto the test was qualified and could be used to collect data.

Section 2: An evaluation form of curriculum development ability (Scoring Rubric)

An evaluation form of curriculum development ability (Scoring Rubric) consisted of4 one-level indicators and 15 two-level indicators with 0.757 of inter-rater reliability, which means the evaluation form of curriculum development ability (Scoring Rubric) was qualified and can be used to collect data.

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Section 3: Questionnaire for students' satisfaction

The questionnaire for students' satisfaction consisted of16 questions which had a reliability of 0.855, which meanto the questionnaire was qualified and could be used to collect data.

Data collection: The procedures of data collection during the curriculum implementation process were as follows:

1) Before the instruction, the sample received the pretest to evaluate the learning achievement.

2) The sample group was taught by a combination method of Project-Based Learning combined with Research- Based Learning. During instruction through the curriculum implementation process, the researcher observed and recorded data including the teaching process, learning process, classroom atmosphere, student teachers' behavior, and teacher's behavior that occurred in the classroom.

3) After finishing the instruction, the samples received the post-test by using the learning achievement test and the curriculum development ability evaluation form (Scoring rubric).

4) The samples were given the student teachers' satisfaction questionnaire toward the course.

Data analysis: The data analyzed were as follows:

1) Statistics used to evaluate the student teachers' learning achievement was a t-test for the dependent sample.

2) Statistics used to determine the student teachers' curriculum development ability was a t-test for one sample.

3) Statistics used to assess the student teachers' satisfaction were arithmetic mean, standard deviation, and t-test for one sample.

Results

According to the research objectives, the results were as follows:

Section 1: Result of comparing student teachers' learning achievement before and after implementing Primary Interdisciplinary Education Course Based on Project-Based Learning combined with Research-Based Learning by using t-tests for dependent samples.

Table 1: The finding comparing the different scores of learning achievement before and after implementing the Primary Interdisciplinary Education Course (n = 30)

Components	n	Pretest scores		Post-test scores		*t*	p
		M	*SD*	*M*	*SD*		
learning achievement	30	22.53	7.84	27.50	7.47	33.64**	.001

*p<0.01

As presented in Table 1, the mean score of the pre-test was M=22.53, SD=7.84 and the mean score of the post-test was M=27.50, SD=7.47. Then, t=33.64, p=0.001<0.01, indicating that student teachers' learning achievement had been higher improved after implementing the Primary Interdisciplinary Education Course.

Section 2: Result of comparing student teachers' curriculum development ability after implementing Primary Interdisciplinary Education Course Based on Project-Based Learning combined with Research-Based Learning with the criterion set 3.51 by using a t-test for one sample.

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Table 2: The finding comparing the student teachers' curriculum development ability after implementing the Primary Interdisciplinary Education Course with the criterion set 3.51.

Group	n	Full score	Criteria score	Mean	SD	t	p
Experimental group	30	75	52.5	66.02	2.34	146.10**	0.001

*p<0.01

As presented in Table 2, the mean score of the post-test of student teachers' curriculum development ability was 66.02, SD was 2.34. The finding of this table revealed that after implementing the course, the post-test score of student teachers' curriculum development ability was greater than the criterion set 3.51.

Section 3: Result of comparing students' satisfaction after implementing Primary Interdisciplinary Education Course Based on Project-Based Learning combined with Research-Based Learning with the determined criterion 3.51 by using a t-test for one sample.

Table 3: Result of comparing the score of students' satisfaction after implementing Primary Interdisciplinary Education Course Based on Project-Based Learning combined with Research-Based Learning with the determined criterion 3.51.

Group	n	Full score	Criteria score	Mean	SD	t	p
Experimental group	**30**	**5**	**3.51**	**4.71**	**0.15**	**43.84****	**0.001**

*p<0.01

As presented in Table 3, the mean score of student teachers' satisfaction after implementing the Primary interdisciplinary education course was 4.71 from a possible full mark of 5.0 and the standard deviation was 0.15. SD was 2.34. The finding of this table revealed that after implementing the course, the post-test score of student teachers' satisfaction was greater than the criterion set 3.5.

Conclusion

Through implementing the Primary Interdisciplinary Education Course based on Project-Based Learning combined with Research-Based Learning, the student teachers' learning achievement post-test scores were higher than pretest scores at.01 level of statistical significance (t = 33.64, p<0.01); the student teachers' curriculum development ability post-test scores were higher than criteria 3.51 at.01 level of statistical significance (M = 66.02, SD =2.34); and the student teachers' satisfaction post-test scores were higher than criteria 3.51 at.01 level of statistical significance (M =4.71, SD =0.15).

Therefore, the development of a Primary Interdisciplinary Education Course based on Project-Based Learning combined with Research-Based Learning was conducive to enhancing learning achievement and curriculum development ability of third-year student Teachers at Xi'an University.

Discussion

To assess the effectiveness of the Primary Interdisciplinary Education course, the course was implemented with one class of 30 third-year student teachers. The results of the study indicated that the implementation of the Primary Interdisciplinary Education course based on Project-Based Learning combined with Research-Based Learning could enhance the learning achievement and curriculum development ability of the third-year student teachers at Xi'an University.

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The first reason why the course implementation achieved good results was the effectiveness of the project-based learning strategies. This was consistent with the studies of other researchers. During the implementation of the curriculum, the researcher positioned the student teachers not only as learners but also as future primary school teachers. This was in line with Kim (2019) in his study who stated that student teachers were both learners and teachers. While the student teacher experienced project-based learning first-hand as a student through the curriculum, the student teacher, as a future primary school teacher, learned how to design, implement, and evaluate an interdisciplinary curriculum in a process that combined theory and practice. Continuous progress was gained in the process. The effectiveness of project-based learning was likewise evidenced in the studies of other researchers. Blackburn (2017) pointed out that during the implementation of project-based learning, student teachers were better able to link theory and practice through the solution of authentic problems in the inquiry sample. Holst (1997) had 48 student teachers majoring in English education from a teacher training university attend half a semester of a traditional course and half a semester of a course in the project-based learning mode, and the results showed that the student teachers' dynamic shift in their classroom roles was visible, "being silent and essentially passive in the classroom"; whereas, after project-based learning. "They were very vocal, authoritative and engaged".

The second reason why the course implementation achieved good results was the researcher's innovative combination of research-based learning with project-based learning, such that the pedagogy was based on project-based learning and attempted to incorporate the research-based pedagogy into the course as both a content and pedagogical method. The combined 6-step approach was centered around an overarching project of 'completing a course design work', with each unit having a different 'research theme' and 'mini project' guided by a 'driving question'. "Mini-projects" were set up for each unit. Based on the knowledge and tools needed to achieve the objectives of each unit, the researcher introduced different research methods into the teaching and learning process, and the student teachers used these research tools to find, analyze, and apply knowledge related to interdisciplinary education, and finally completed their curriculum design work.

Recommendation

1. Recommendations for implementation

The Ministry of Education's Circular on Further Improving the Cultivation of Teacher Candidates under the "Excellent Teacher Program" explicitly emphasized the need to strengthen the cultivation of interdisciplinary (field) teaching ability of teacher trainees. As student teachers, "interdisciplinary innovative teachers" have become an important goal in the training of teacher trainees. student teachers have a dual identity, one as a university student, and the other as a future primary or secondary school teacher, this dual identity determines that they must master and learn to use interdisciplinary education, only then can they adapt to the future of education, and can they cultivate interdisciplinary talents in line with the requirements of the development of the times.

1) colleges and universities should offer interdisciplinary education courses to enrich the curriculum system of teacher trainees. At present, the curriculum system of Chinese colleges and universities for teacher training students follows the way of setting up the subject-oriented curriculum, which is mainly based on subject knowledge courses and subject teaching skills training courses, and lacks teacher education courses to cultivate students' ability to develop interdisciplinary courses, which is not conducive to the enhancement of the interdisciplinary innovation ability of the students themselves, and even more detrimental to the cultivation of next-generation interdisciplinary innovation talents by the teacher training students.

2) Interdisciplinary education courses in colleges and universities adopt project-based and research-based teaching methods. At present, teacher training courses in colleges and universities are still dominated

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by the traditional pedagogical training model of a single subject specialization, which is not conducive to the cultivation of student teachers' interdisciplinary thinking and abilities. The results of this study show that interdisciplinary education courses developed based on project-based and research-based learning can improve student teachers' interdisciplinary curriculum design ability. Therefore, subsequent studies should focus on creating an authentic interdisciplinary collaborative environment, designing progressive and simple-to-complex project themes based on students' learning foundations, and continually improving teacher trainees' interdisciplinary curriculum development ability.

3) Strengthen the teacher training of teachers teaching interdisciplinary education courses. At present, one of the main factors that many colleges and universities have not yet started interdisciplinary education courses in their teacher training programs is the lack of faculty for interdisciplinary education courses. It is recommended that the training of teachers in teacher training programs be strengthened to enhance their ability to learn and apply interdisciplinary education knowledge.

2. Recommendations for further research

1) Expanding the sample capacity of interviewed teachers to improve the quality of curriculum development. When investigating the six elements of curriculum development for interdisciplinary education in elementary school, the researcher chose only six teachers majoring in elementary education at Xi'an University as interviewees; the sample size of interviewees was small and they all came from the same major. The six elements of curriculum development may not have been fully identified. In the follow-up study, to draw more comprehensive conclusions, it is necessary to interview teachers from teacher education majors other than the elementary education major of Xi'an University to expand the sample capacity.

2) Conducting multiple rounds of teaching practice to improve the persuasiveness of the effectiveness of program implementation. This study only conducted student experiments in the primary education majors of Xi'an University, and the practice cycle is only one semester, the course application time is relatively short, which to a certain extent affects the judgment of the learning effect; in the follow-up study, we should continue to improve the course content and teaching steps, carry out multiple rounds of teaching practice, get more feedback, increase the persuasive power of the experiment, and constantly summarize the experience to improve the deficiencies in the course.

3) Expanding the student sample capacity and improving the replicability of research results. To better explore the impact of interdisciplinary education courses based on project-based and research-based learning on student teachers' academic performance and curriculum development ability, further investigations should be carried out on students majoring in education other than elementary education at Xi'an University in the follow-up study, to cultivate more complex educational talents for the society and achieve significant social benefits.

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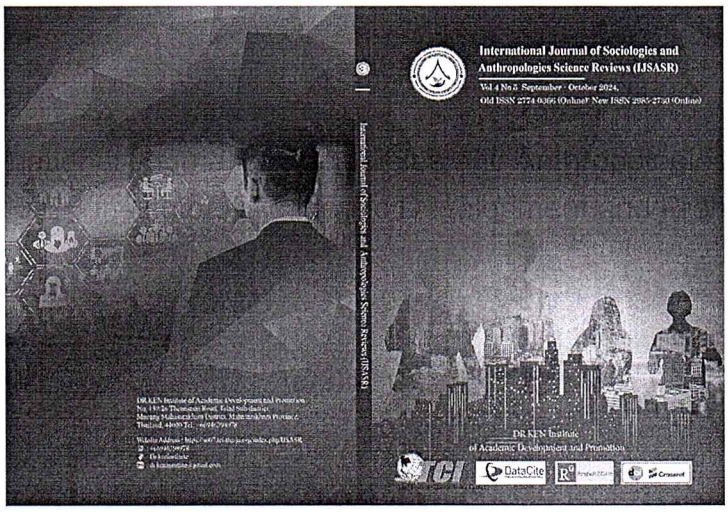
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