GUIDELINES FOR IMPROVING ICT TEACHING COMPETENCIES OF UNDERGRADUATE PRIMARY EDUCATION STUDENTS: A CASE STUDY OF WEIFANG UNIVERSITY IN CHINA

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BY

XU XIAOXUAN

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Title	GUIDELINES FOR IMPROVING ICT TEACHING COMPETENCIES OF UNDERGRADUATE PRIMARY EDUCATION STUDENTS: A CASE STUDY OF WEIFANG UNIVERSITY IN CHINA
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This study aimed to examine the current status and influencing factors of information and communication technology (ICT) teaching competencies among undergraduate primary education students at Weifang University and to propose improvement guidelines. A mixed-methods approach was adopted, combining survey data from 252 students with semi-structured interviews involving five educational experts. The findings revealed that: 1) Students' ICT teaching competencies were at an intermediate level. 2) Statistically significant differences were found in technology-supported learning, technology-supported teaching, and overall ICT teaching competencies, with higher-year students performing better. Significant differences were also observed among students with different levels of academic performance, students in the top 30% consistently outperformed those in the middle 30%-70% and bottom 30% groups. In contrast, no statistically significant differences were observed based on gender or participation in additional internship experiences beyond the university's standard requirements. 3) Regression analysis indicated that attitude, self-efficacy, practical opportunities, and courses were significant positive predictors of ICT teaching competencies, while facilities, teacher support, and school culture showed no significant impact. Expert interview results provided guidelines for improving ICT teaching competencies at Weifang University. These guidelines cover seven key areas: fostering positive attitudes toward ICT integration, strengthening self-efficacy through confidence-building strategies, expanding practical opportunities for technology-enhanced teaching, refining course content and design, improving access to ICT infrastructure and resources, encouraging teacher educator support and modeling, and cultivating an ICT-positive school culture.

Keyword : ICT teaching competencies, Primary teacher education, Improvement guidelines

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As I write this final section of my thesis, it also marks the approaching end of my journey as a graduate student. I still vividly remember the moment two years ago, in August, when I stepped off the plane with a suitcase in hand and set foot on the land of Thailand, my heart was filled with both excitement and complexity. The excitement came from the fact that I was about to begin a two-year academic journey at one of the most prestigious teacher education universities in Thailand. Yet, there was also a sense of uncertainty and nervousness, as it was my first time studying abroad, far from home and stepping into an entirely new environment.

Looking back on these two years, the journey has been filled with both challenges and growth. I would not have made it through without the guidance, support, and encouragement of many people, to whom I am deeply grateful.

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I am deeply grateful to my friends for their companionship and comfort during times of confusion and loneliness.

Finally, I want to express my heartfelt thanks to my parents for their unwavering support, love, and encouragement throughout my study abroad journey.

When I board the flight home with my suitcase in hand, I think my emotions will again be a mix of excitement and complexity. I am excited to finally return to my long-awaited homeland, yet my heart feels heavy as I prepare to say goodbye to the university where I have spent the past two years, to the journey that has been filled with challenges and growth, and to the people whose warmth, support, and companionship have meant so much to me. Though the two-year journey is coming to an end, the experiences and memories will remain in my heart forever.

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CHAPTER 1

INTRODUCTION

Background

The rapid development of information and communication technology (ICT) is changing how people learn and think, which is also influencing the education industry (Li & Cai, 2024). Traditional teaching tools are being replaced by digital platforms, collaboration tools, and multimedia resources (Simões & Faustino, 2019), signifying a broader shift from conventional pedagogy to ICT-integrated instructional models. ICT competencies are one of the essential skills that modern teachers should possess (Simões & Faustino, 2019).

In China, teacher education is important for preparing future teachers, with 1.98 million undergraduate students enrolled in normal universities in 2022. These students represent the reserve force for future teachers, and their ability to effectively integrate ICT into teaching will have a direct impact on the quality of future education (Ren et al., 2018). As a result, teacher training institutions are expected to prepare future teachers to integrate ICT in their educational practice (Tondeur et al., 2016). However, the actual implementation of ICT in teacher education in China is hindered by several challenges, including teacher-centered methods that limit student engagement with ICT-based learning (Wang et al., 2023) a lack of technical support from educators who continue to rely on traditional tools despite advocating for ICT use (Liu et al., 2021), insufficient integration of ICT with subject content in courses (Ren, 2020), and broader issues such as faculty shortages, outdated resources, disconnect between theoretical and practical teaching content (Zuo, 2022). These issues may hinder the development of ICT teaching competencies among undergraduate teacher education students, as current research indicates that their overall ICT teaching competencies in China remain at an intermediate level (Wang et al., 2023). As a result, studies and scholarly literature have increasingly focused on the factors that influence the integration of ICT by teacher

education students, which include internal factors such as attitude, self-efficacy (Hatlevik, 2017; Jegede et al., 2007) and external factors such as facilities, courses, teacher support, practical opportunities, and school culture (Mirzajani et al., 2016; Soykan & Ozdamli, 2016; Yang et al., 2014).

Primary education holds a fundamental position in China's education system, making it essential to strengthen ICT teaching competencies among students majoring in primary education. As future educators responsible for promoting high-quality and innovative development in basic education, these students are expected to meet evolving technological and pedagogical demands. In response, the Ministry of Education issued the Standards for ICT Teaching Competencies of Teacher Education Students in 2018, building upon the earlier Standards for the Application of ICT Competencies for Primary and Secondary School Teachers (Trial) released in 2014. The standards outline three core dimensions—basic technological literacy, technology-supported learning, and technology-supported teaching—and serve as an important framework for guiding and regulating the cultivation of ICT teaching competencies among teacher education students in China.

Weifang is an important city in Shandong Province and has been actively improving its education system. In recent years, the city has taken a series of steps to promote the use of ICT in primary education, such as upgrading hardware and software, building a digital curriculum resource library, encouraging resource sharing, and helping primary school teachers use ICT tools and platforms in their teaching. In this context, Weifang University, as a key teacher education institution in the region, plays an important role in training future primary school teachers. However, some common problems found across China—such as teacher-centered teaching methods, lack of technical support, poor integration of ICT with subject content, shortage of staff, and outdated teaching resources (Liu et al., 2021; Ren, 2020; Wang et al., 2023; Zuo, 2022)—may also exist at Weifang University.

In conclusion, with the fast development of ICT and its growing use in education, it is important for teacher education students to improve their ICT teaching

skills. Although there has been research on ICT competencies in China, few studies focus on undergraduate students majoring in primary education at local universities like Weifang University. This study aims to investigate their current ICT teaching competencies and the factors that affect them, and to provide recommendations for improvement based on the findings.

Objectives of the Study

1. To investigate the current status of ICT teaching competencies among undergraduate primary education students at Weifang University.
2. To identify the factors influencing the development of ICT teaching competencies among undergraduate primary education students at Weifang University.
3. To provide guidelines for improving ICT teaching competencies of undergraduate primary education students at Weifang University.

Research Questions

1. What is the current status of ICT teaching competencies among undergraduate primary education students at Weifang University?
2. What are the factors influencing the development of ICT teaching competencies among undergraduate primary education students at Weifang University?
3. What are the guidelines for improving the ICT teaching competencies of undergraduate primary education students at Weifang University?

Significance of the Study

1. Provide guidelines for improving ICT teaching competencies of undergraduate primary education students: This study investigated the current status and influencing factors of ICT teaching competencies among undergraduate primary education students at Weifang University. The results could serve as a valuable reference for improving ICT teaching competencies among these students. Additionally, this study invited educational experts to provide suggestions based on the results of the

investigation, their professional suggestions would provide scientific guidance for developing ICT teaching competencies.

2. Guide students in improving their ICT teaching competencies: By completing the self-evaluation questionnaire, undergraduate primary education students may gain a clearer understanding of their current ICT teaching competencies and realize the specific dimensions of ICT teaching competencies they need to improve.

Scope of the Study

1. Questionnaire Survey

This study was limited to the undergraduate primary education students at Weifang University, China. 252 students were asked to complete a questionnaire designed to investigate the current status of ICT teaching competencies and the influencing factors on internal factors (attitude, self-efficacy) and external factors (facilities, courses, teacher support, practical opportunities, school culture).

2. Semi-structured Interviews

This study invited five educational experts to provide suggestions based on the results of the investigation on the current status and the influencing factors of ICT teaching competencies among undergraduate primary education students at Weifang University. These suggestions were used to inform guidelines aimed at improving ICT teaching competencies within the context of teacher education, specifically focused on improving the ICT teaching competencies at the undergraduate teacher education level for primary education.

Variables of the Study

The independent variables in this study are the factors expected to influence ICT teaching competencies, which include internal factors (attitude, self-efficacy) and external factors (facilities, courses, teacher support, practical opportunities, school culture). The dependent variable is ICT teaching competencies, which consist of three

sub-dimensions: basic technological literacy, technology-supported learning, and technology-supported teaching.

Definition of Terms

ICT: it refers to a set of technologies used to collect, store, protect, edit, transmit, create, and share information in various forms. In this study, ICT refers to technologies that support teacher education students in collecting, storing, protecting, editing, transmitting, creating, and sharing information in the process of learning and teaching.

ICT teaching competencies: it refers to the ability of teachers to effectively integrate ICT in educational practice. In this study, ICT teaching competencies refer to the ability of teacher education students to use ICT to support their learning as learners, and the ability to use ICT to support teaching as future teachers. The dimensions of ICT teaching competencies include basic technological literacy, technology-supported learning, and technology-supported teaching.

Primary education major: It refers to an educational program designed to train professionals capable of providing education to primary students. In this study, it refers to the undergraduate educational program designed by Weifang University to prepare future teachers who specialize in teaching primary students.

Teacher education students: teacher education students are individuals enrolled in normal universities programs specifically designed to prepare them for careers as teachers. In this study, it refers to undergraduate teacher education students majoring in primary education at Weifang University.

Factor: it refers to the various elements or conditions that have an impact on a particular phenomenon or outcome. In this study, it refers to the conditions that may either promote or hinder the development of ICT teaching competencies in teacher education students, which are categorized into internal (attitude, self-efficacy) and external factors (facilities, courses, teacher support, practical opportunities, school culture).

Conceptual Framework

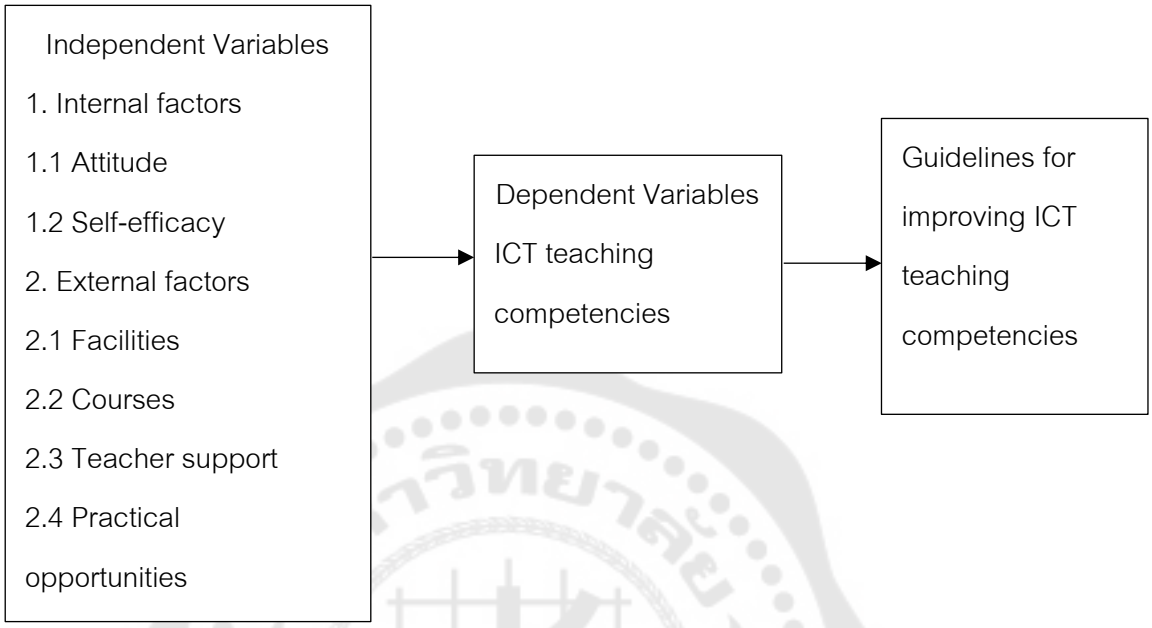

FIGURE 1: The Conceptual Framework

CHAPTER 2

LITERATURE REVIEW

The study aimed to investigate the current status and influencing factors of ICT teaching competencies among undergraduate primary education students at Weifang University, with the goal of providing guidelines to better support the improvement of their ICT teaching competencies. This chapter reviews some of the previous studies and relevant literature used to support this study. This chapter contains the following aspects:

1. ICT and ICT Competencies
2. Framework of ICT Teaching Competencies of Teacher Education Students
3. Literature Review on Influencing Factors of ICT Teaching Competencies
4. Theoretical Basis
5. Background of Undergraduate Primary Education Students at Weifang University
6. Related Research

ICT and ICT Competencies

There is no universally accepted definition of ICT because the concepts, methods, and applications involved are constantly evolving (Tunde Toyese et al., 2018). Although challenging to define, ICT can be better understood through a synthesis of previous scholarly definitions. Tinio (2003) described ICT as encompassing a broad range of technological tools—such as computers, the Internet, broadcast technologies (radio and television), and telephones—which are used to communicate, create, disseminate, store, and manage information. Olakulehin (2007) emphasized ICT as technologies for collecting, storing, editing, retrieving, and transferring information in various forms. Similarly, Alkamel and Mohammed (2018) defined ICT as technologies employed to transmit, process, store, create, display, share, or exchange information through electronic means. Synthesizing these definitions, this study considers ICT as a

set of technologies for collecting, storing, protecting, editing, transmitting, creating, and sharing information in various forms.

While ICT provides tools for managing and disseminating information, effective integration into education requires specific competencies. Competency, like ICT, is a broad concept with diverse definitions tailored to specific contexts. Parry (1996) described competency as the integration of knowledge, skills, and attitudes essential to fulfilling job roles and responsibilities, directly linked to performance and measurable by standards. Similarly, Kopaiboon et al. (2014) defined competency as an individual's knowledge, skills, and attitudes that enable effective task performance. The United Nations Industrial Development Organization viewed competency as a blend of knowledge, skills, and behaviors for personal development, while Skorková (2016) emphasized the ability to perform specific tasks requiring qualities, skills, and proficiency. Despite varying definitions, a consensus emerges around core components: knowledge, skills, and attitudes (Staskevica, 2019).

Building on these definitions, this study delves into ICT competencies, which integrate ICT and competency concepts. Scholars have approached ICT competencies from diverse educational perspectives. Vilppola et al. (2022) identified six core components: the creation of digital learning materials, planning digital environments, synchronous instruction, ICT proficiency, digital interaction, and digital assessment. Du (2017) defined teachers' ICT competencies as the ability to integrate ICT into subject teaching for design, implementation, management, and evaluation. Li and Zhang (2011) emphasized informational teaching attitudes, concepts, skills, and research for professional development, while Jiao (2014) framed ICT competencies as cognition, ability, and ethics in using ICT tools for teaching and growth.

In the context of Chinese teacher education, where future teachers are expected to integrate ICT into teaching practice, this study adopted Ren et al. (2018) definition of ICT teaching competencies: the ability of teacher education students to use ICT to support their learning as learners and to enhance their teaching as future

teachers. The specific dimensions of ICT teaching competencies will be detailed in the following section.

Framework of ICT Teaching Competencies of Teacher Education Students

Numerous international educational organizations and institutions have established ICT teaching competencies frameworks to assess and improve teachers' ICT teaching competencies. In 2008, the International Society for Technology in Education (ISTE) issued a set of standards for teachers, emphasizing the use of technology to enhance student learning and foster creative thinking. These standards also guide teachers in designing activities and assessments suited for the digital era, modeling digital practices, promoting responsible digital citizenship, and actively engaging in professional development and leadership growth (Trust, 2018).

As science and technology continue to advance, higher requirements are being placed on teachers' ICT teaching competencies. In response, ISTE updated its standards in 2017, reflecting the evolving nature of the teaching profession and the role of technology in enhancing learning. The updated standards provide informative guidance for educators in making decisions about curriculum design, instructional methods, and professional learning, while also encouraging the transformation of teaching through effective technology use. The 2017 standards categorize teachers' roles into seven areas: learner, leader, citizen, collaborator, designer, facilitator, and analyst, each with specific expectations.

Due to the growing demand for digital competencies in European societies, the European Commission's Joint Research Centre initiated the DigComp project, led by Ferrari. This project developed a comprehensive framework that defines digital competencies for citizens. First published in 2013 and updated in 2016 and 2017, the framework evolved into the European Framework for the Digital Competences of Educators (DigCompEdu), which outlines six key dimensions: professional engagement, digital resources, teaching and learning, assessment, empowering learners, and facilitating learners' digital competence.

Similarly, in 2018, UNESCO released the ICT Competency Framework for Teachers Version 3 (ICT CFT Version 3) to guide both pre-service and in-service teacher training across educational systems. This framework organizes 18 ICT-related competencies into three levels—knowledge acquisition, knowledge deepening, and knowledge creation—each comprising six dimensions: understanding ICT in education policy, curriculum and assessment, pedagogy, application of digital skills, organization and management, and teacher professional learning.

In 2014, the Ministry of Education of China issued the *Standards for the Application of ICT Competencies for Primary and Secondary School Teachers (Trial)*, outlining requirements across five dimensions: technological literacy, planning and preparation, organization and management, assessment and diagnosis, and learning and development. Since teacher education students represent the future teaching workforce, the development of their ICT competencies should align with these requirements. Thus, this set of standards serves as a foundational reference when considering how to shape competencies for teacher education students.

However, because teacher education students and in-service primary and secondary teachers face different instructional environments and capability requirements, it is necessary to reframe these standards to reflect the unique characteristics of teacher education students. In response, Ren et al. (2018) proposed the *Standards for ICT Teaching Competencies of Teacher Education Students*, which identifies expectations for students in both their current role and future professional identity. These standards comprise three dimensions: basic technological literacy (foundational skills), technology-supported learning (transferable student competencies), and technology-supported teaching (professional teaching abilities). Considering the alignment with China's educational context and development trajectory, this study adopts the standards proposed by Ren et al. (2018) as the core theoretical framework.

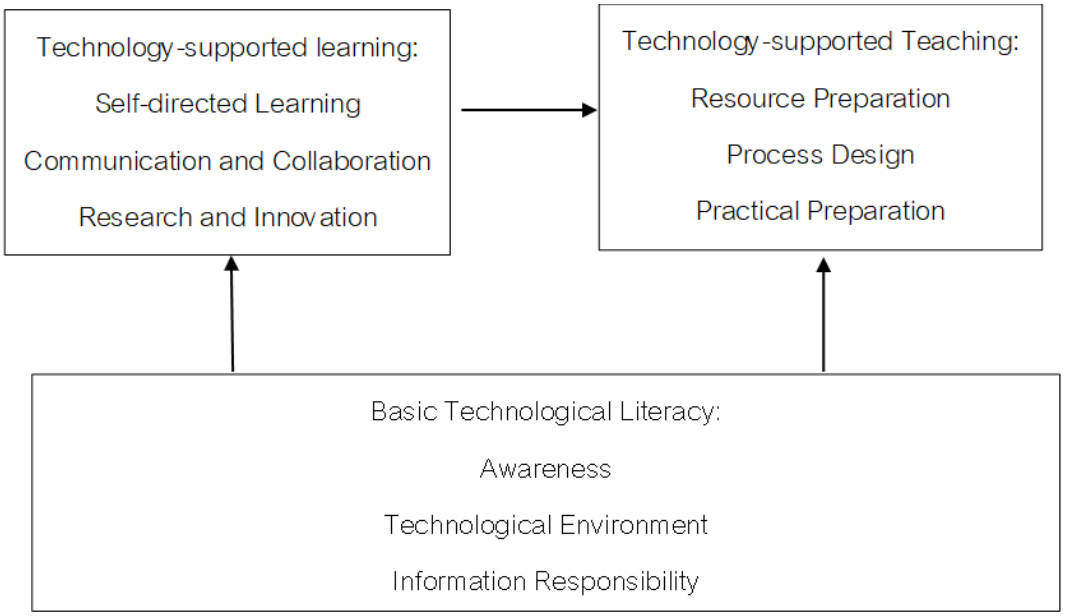

FIGURE 2: The Framework of ICT Teaching Competencies for Teacher Education Students

As shown in FIGURE 2, basic technological literacy includes three sub-dimensions: awareness, technological environment, information responsibility. These sub-dimensions refer to a proactive awareness toward learning and applying ICT, mastery of essential teaching software, hardware, and platforms, and fundamental information ethics. Technology-supported learning comprises three sub-dimensions: self-directed learning, communication and collaboration, research and Innovation. Self-directed learning refers to the ability to utilize information technology for autonomous learning. Communication and collaboration denote the ability to actively use information technology to communicate effectively, share, and collaborate with others. Research and innovation involve using appropriate information technology tools to identify and analyze problems in learning and daily life and creatively solve them. Technology-supported teaching consists of three sub-dimensions: resource preparation, process design, practical preparation. Resource preparation refers to the ability to plan, create, evaluate, optimize, and manage digital educational resources according to predefined teaching scenarios. It also includes the ability to select and use technological resources appropriately to provide learners with rich learning

opportunities and personalized learning experiences. Process design encompasses the skills required for designing ICT-based teaching processes, including mastery of application models, principles, methods, activity strategies, evaluation techniques, and related tools relevant to ICT-based instructional design. Practical preparation refers to the practical application skills needed during actual teaching implementation, such as the ability to track, analyze, evaluate, and intervene in the teaching process using information technology.

TABLE 1 The Standard of ICT Teaching Competencies for Teacher Education Students

Dimension	Sub-dimension	Description
Basic Technological Literacy	Awareness	Understand the role of ICT in teaching and learning.
		Proactively explore and apply ICT to support lifelong learning and promote personal development.
	Technological Environment	Master the common operations of ICT teaching equipment and solve common issues.
		Proficiently use general software related to teaching and learning, as well as subject-specific software.
		Proficiently use online learning platforms and social software.
	Information responsibility	Apply information security knowledge to daily situations and consciously adhere to legal and ethical standards.
		Advocate for the safe, legal, and responsible use of ICT tools, and actively influence others.

TABLE 1 (continued)

Dimension	Sub-dimension	Description
Technology-supported learning	Self-directed Learning	Actively acquire valuable resources to broaden professional perspectives on education and teaching.
		Use ICT tools to support goal management, time management, and information management, improving the quality and efficiency of self-directed learning.
		Consciously plan and record learning process and outcomes, developing a habit of self-reflection.
	Communication and Collaboration	Actively use ICT tools to communicate and share effectively with peers, teachers and experts.
		Collaborate effectively with others to address specific learning tasks and real-world problems.
	Research and Innovation	Use critical thinking and appropriate ICT tools to identify and analyze problems in learning and daily life.
		Be skilled at collecting and analyzing data, interpreting results, making reasonable judgments, and developing solutions.
		Use ICT tools to construct knowledge, design and develop original works, and creatively solve problems.

TABLE 1 (continued)

Dimension	Sub-dimension	Description
Technology-supported Teaching	Resource Preparation	Master the tools and methods for processing and creating various forms of digital teaching resources, scientifically and reasonably produce digital teaching resources based on predefined teaching scenarios.
		Scientifically assess digital educational resources in specific application scenarios and propose improvement strategies.
		Be able to scientifically plan and manage digital educational resources.
		Be able to select and integrate digital educational resources appropriately to provide students with personalized learning experiences.
	Process Design	Understand the principles and methods of teaching models and clarify the advantages of ICT application in different models.
		Based on predefined ICT teaching scenarios, reasonably select teaching models to complete process design.
		Scientifically design diversified learning activities and guidance strategies that promote learner autonomy, cooperation, and inquiry.

TABLE 1 (continued)

Dimension	Sub-dimension	Description
Technology-supported Teaching		Scientifically design ICT-based teaching evaluation plans and reasonably select, modify, and apply ICT-based teaching evaluation tools.
	Practical Preparation	Understand the teaching implementation strategies in an ICT-based teaching environment and comprehend the basic principles and methods of instructional intervention.
		Be able to effectively use technology to track and analyze the learning process and propose targeted improvement measures.
		In real or simulated teaching scenarios, reasonably apply information technology to support teaching practices.

Literature Review on Factors that Influence ICT Teaching Competencies

Sang et al. (2010) found that self-efficacy had a direct positive impact on teacher education students' overall ICT teaching competencies. Similarly, Tezci (2011) emphasized the significant role of self-efficacy in shaping teacher education students' use of information technology. Furthermore, they found that male teacher education students generally exhibited higher levels of ICT knowledge and usage compared to female students, although the difference was not significant. Self-efficacy is not only crucial for the use of ICT but also for effective teaching practice, as it influences teachers' strategies for evaluating information, their digital competence, and their use of ICT in school (Hatlevik, 2017). Additionally, mental representations such as self-efficacy,

which reflect an individual's perceived performance, competencies, and abilities, play a key role in the development of digital competences (Peiffer et al., 2020).

Attitude is another critical factor influencing ICT teaching competencies. Jegede et al. (2007) found that attitude is significantly related to ICT competencies and can predict them. A strong positive correlation exists between teachers' ICT skills, their attitudes toward ICT, and the actual application of ICT in classroom teaching (Rastogi & Malhotra, 2013). Pang and Wang (2022) identified that attitude, course implementation, and teacher support significantly impact the ICT teaching competencies of education master's students. Similarly, Chu et al. (2023) highlighted a direct impact of teacher education students' attitudes toward technology on their digital teaching competencies. Pozas and Letzel (2023) further revealed that attitudes, along with the ability to teach and apply technology in practice, are the most significant predictors of future ICT usage among teacher education students. Although male teacher education students generally displayed a more positive attitude toward ICT use than their female counterparts, no gender differences were observed in future ICT integration.

In addition to internal factors like gender, self-efficacy and attitude, external factors also play an essential role in ICT teaching competencies. Yang et al. (2014) proposed that these competencies are influenced by both individual factors (e.g., students' beliefs and practices) and external factors, such as teacher demonstrations, school culture, and technology-related teacher education courses. Individual beliefs and practices directly impact ICT teaching competencies, while external factors like teacher demonstrations shape these beliefs and practices, thereby indirectly affecting competency development. Mirzajani et al. (2016) identified key external factors such as teacher guidance and sufficient resource access, while noting that the lack of technical support could hinder effective technology integration. Soykan and Ozdamli (2016) also found that information technology courses focusing on educational practices significantly enhanced pre-service special education teachers' ICT competencies.

Building on these findings, this study investigated the factors influencing ICT teaching competencies among undergraduate primary education students at Weifang

University. These factors are categorized into internal factors (attitude, self-efficacy) and external factors (facilities, courses, teacher support, practical opportunities, school culture). By investigating these students' ICT teaching competencies and the influencing factors, this study aims to provide tailored guidelines for enhancing ICT teaching competencies in a specific educational environment. According to Ajzen (2005), attitude is a predisposition to respond either favorably or unfavorably toward an object, person, or event. In this study, attitude specifically refers to the general support or opposition to integrating ICT into educational practice. Especially in this study, attitude is considered both as a component of ICT teaching competencies and as a factor influencing its development. The concept of self-efficacy was originally proposed by Bandura (1978) as part of social cognitive theory and is defined as an individual's confidence in successfully completing a specific task (Bandura, 1978). In this study, self-efficacy refers to the confidence of primary education students in their ability to effectively integrate ICT into their educational practices. Facilities refer to the hardware, software, and other resources that support primary education students integrate ICT into learning and teaching. Courses refer to a series of lectures and lessons supported by normal universities to improve ICT teaching competencies of undergraduate primary education students. Teacher support refers to the assistance and resources provided by teacher educators to help students effectively integrate ICT into learning and teaching. Practical opportunities refer to the chances or experiences that primary education students can apply their ICT knowledge and skills in actual teaching environments. School culture refers to the shared values, beliefs, practices, and behaviors within Weifang University that influence how ICT is integrated into teacher education programs.

Theoretical Basis

1. The Theory of Stages of Teacher Professional Development

Teacher professional development is a gradual and sustainable process that necessarily involves multiple stages of progression. Research on the stages of teacher development provides clear guidance for individual professional growth,

supports teacher education and training, and offers valuable theoretical insights. Both domestic and international scholars have conducted increasingly comprehensive studies on the stages of teacher professional development. Specific research examples are presented in Table 2.

TABLE 2 A Review of Research on the Stages of Teachers' Professional Development

Researcher	Specific Stage Descriptions
Fuller (1969)	self-concerns, task-concerns, and impact-concerns
Raths and Katz (1986)	survival stage, consolidation stage, renewal stage, and maturity stage
Newman et al. (1980)	survival stage, adjustment stage, and maturity stage
Stetty (1990)	novice stage, apprentice stage, professional stage, expert stage, distinguished stage, and renewal stage

Experts and scholars, from different perspectives, have categorized the process of professional growth in teacher education into various developmental stages. Despite differences in classification, their theories consistently highlight the dynamic, staged, systematic, and long-term nature of teacher professional development. An analysis of these stage theories reveals that most scholars begin their research from the pre-service preparation phase. The development of ICT teaching competencies among pre-service teachers is a critical aspect of professional growth and is gradually refined through practical experience. Therefore, the theory of teacher professional development stages holds significant scientific value and reference meaning for the cultivation of ICT teaching competencies among pre-service teachers, providing theoretical guidance for the development of training strategies proposed in this study.

2. Social Learning Theory

Environment, the person, and behavior are the three decisive factors in Bandura's Social Learning Theory. Bandura believed that these three factors influence and interact with each other, rather than having a one-way or partially two-way relationship. Together, they form an interconnected system of mutual influence, which Bandura referred to as "reciprocal determinism" in Social Learning Theory. He illustrated the interaction among these three factors with a simple and intuitive diagram (as Figure 3).

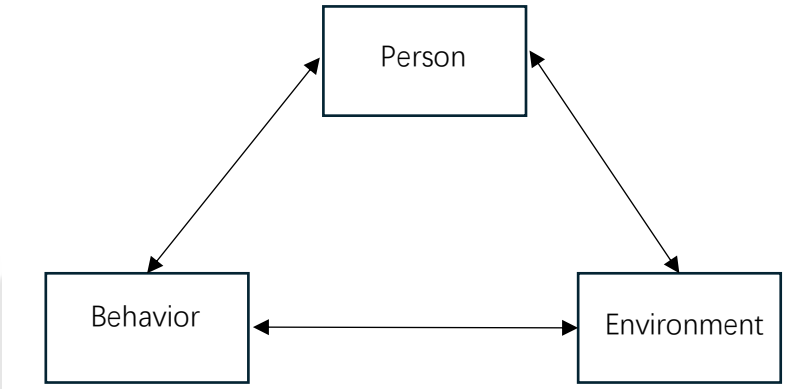

FIGURE 3 Diagram of the Relationship Between Person, Behaviors, and Environment in Interactive Determinism

Reciprocal determinism represents a comprehensive and complex theoretical framework for understanding human behavior development. It places particular emphasis on the functional role of the self and the dynamic interplay between internal personal factors and external environmental influences. According to this theory, when examining the origins of behavior, none of the three determinants—personal factors (such as cognition, attitudes, and beliefs), behavior itself, and the environment—should be viewed as inherently superior to the others. While one factor may exert a more prominent influence in specific contexts, Bandura posits that, in general, these three elements operate as interdependent forces within a bidirectional and interactive system. Importantly, the theory does not suggest that each factor contributes equally in all circumstances. Rather, the degree of influence exerted by each determinant varies depending on the nature of the behavior, the characteristics of

the individual, and the environmental context. This nuanced understanding underscores the complexity of human learning and development and reflects the core of Bandura's social cognitive perspective.

This study was conducted to investigate the current situation and influencing factors of primary education students' ICT teaching competencies and provide guidelines for their effective development. The influencing factors examined in this study include individual factors such as attitude and self-efficacy, as well as external environmental factors including facilities, courses, teacher support, practical opportunities, and school culture. Together, these factors form a multidimensional framework affecting the growth of ICT teaching competencies. Bandura's Social Learning Theory, particularly the concept of reciprocal determinism, highlights the dynamic, bidirectional interactions among personal factors, behavior, and environment. This theoretical perspective provides a solid foundation for analyzing the interplay among internal and external influences in the development of students' ICT teaching competencies.

Background of Undergraduate Primary Education Students at Weifang University

The primary education program at Weifang University is recognized as a first-class undergraduate program construction site in Shandong Province. The program began enrolling students in 2005, started admitting government-funded teacher education students in 2016, and passed the Ministry of Education's secondary teacher education program accreditation in 2022. Currently, the program has 25 full-time teacher educators, including 6 professors, 12 associate professors, and 2 provincial-level teaching masters. As of 2025, the primary education program has a total of 404 students, including 72 first-year students, 98 second-year students, 89 third-year students, and 145 fourth-year students.

Undergraduate primary education students at Weifang University have four academic years, with two semesters per year, making a total of eight semesters. The undergraduate primary education program at Weifang University is structured into three

course categories: general education courses, professional education courses, practical education courses. General education courses are divided into compulsory and elective options, while professional education courses encompass foundational courses, core courses, and elective courses, the core courses include Basic Psychology, Basic Chinese language, Chinese Literature, Principles of Education, Elementary Algebra Research, Principles of Moral Education, Primary Chinese Curriculum and Teaching Theory, Primary Mathematics Curriculum and Teaching Theory, Primary English Curriculum and Teaching Theory. Practical education courses include education novitiate, educational practice and educational seminars. education novitiate is scheduled in the third semester, while educational practice and seminars take place in the sixth semester.

The program includes courses specifically designed to enhance students' ICT teaching competencies, such as University Information Technology, Application and Training on Modern Educational Technology, and Teaching Methodology of Information Technology. University The purpose of the University Information Technology is to provide students with a foundational understanding of IT concepts, while also developing their basic computer operation skills, information processing abilities, and application capabilities. This course serves as a foundation for subsequent related courses. The goal of the Application and Training on Modern Educational Technology is to offer students a systematic understanding of the theories behind modern educational technology, as well as to teach them the techniques and methods for multimedia production and its application in teaching. The Teaching Methodology of Information Technology aims to equip students with a solid understanding of the principles and features of emerging information technologies, along with corresponding instructional design cases to enhance their ability to apply these technologies in educational practice. The other details of these courses are as follows.

TABLE 3 Courses to Improve ICT Teaching Competencies at Weifang University

Classification	Courses	Semester	Credit Hours	
			Theoretical	Practical
General Education Courses	University Information Technology	1	16	16
Professional Education Courses	Application and Training on Morden Educational Technology	3	20	12
Professional Education Courses	Teaching Methodology of Information Technology	4	22	10

The primary education program at Weifang University has developed a range of experimental and training platforms, including smart classrooms, micro-course creation rooms, audio-visual media laboratories, teaching and learning behavior research training rooms, and teacher skills training rooms. These facilities are equipped with advanced technologies such as recording and broadcasting interactive systems and smart blackboards. The university makes substantial investments in primary school textbooks, reference materials, and online teaching resources to support the program. Each year, the latest editions of primary school subject textbooks and teacher guides are purchased, ensuring both teachers and students have access to the essential resources for practical training and academic studies. In addition, Weifang University has established cooperative partnerships with ten primary schools in Weicheng District, regularly sending students for educational internships. The university also collaborates

closely with Dongming School, Dongfang School, engaging in educational research, curriculum reform projects, and various forms of educational internships. Through these partnerships, the university actively explores new models for the joint development of teacher education students, creating an integrated community for teacher cultivation, training, research and service.

Related Research

Yang et al. (2022) investigated the factors affecting the digital competence of pre-service and in-service teachers in primary and secondary education in China. Using a quantitative methodology, the study focused on participants' perceptions of their digital competencies. The findings revealed the following: 1) Both pre-service and in-service teachers demonstrated strong awareness and attitudes toward digital literacy, particularly in areas like information ethics and security. However, both groups identified deficiencies in applying technology to support teaching and learning practices; 2) In-service teachers generally exhibited higher levels of digital competence than teacher education students, likely due to professional experiences encouraging reflection on technological education; 3) Significant differences in digital competence levels were observed among in-service teachers based on factors such as age, teaching experience, and educational background; 4) Current ICT courses were found to have no impact on in-service teachers' digital competence, suggesting issues with the existing ICT training system. The study highlights the need to enhance pre-service teacher education on digital competencies and to design more effective ICT training programs for in-service teachers.

Wang et al. (2023) reveals that the support from normal universities and colleges in terms of personnel, facilities, curriculum, mechanisms, and environment is not fully effective in enhancing the ICT teaching competencies of teacher education students, with notable differences across institutions of varying levels. Personnel and curriculum support require significant improvement, while facility support has a more limiting impact. To address these challenges, the study recommends creating a

dynamic mechanism for integrating technology into teaching, strengthening the role of teachers as demonstrators, and refining the PT-ICT curriculum system according to standards. Additionally, fostering informal learning pathways and improving ICT teaching competencies through evaluation reform is essential. Promoting balanced development of ICT training at different university levels, by sharing quality curricula, and enhancing technology learning and application scenarios for teacher education students, particularly through mobile and autonomous learning, are also crucial steps to improve the situation.

Li and Liu (2020) explored how to enhance the ICT-based instructional design capabilities of teacher education students. They argued that there are disconnects between theoretical knowledge and technical knowledge, theoretical knowledge and practice. To solve these problems, they proposed two strategies. First, they recommended the creation of integrated courses that combine both theory and technology. These courses should focus on developing teacher education students' adaptability to the information society, as well as their ability to learn new theories and acquire new technologies. The curriculum should not only include the latest ICT tools and technical skills but also offer a strong theoretical foundation to guide their application in educational contexts. This integrated training model would enable teacher education students to not only master ICT tools but also understand the educational theories that underpin their use. Second, Li and Liu emphasized the importance of bridging the gap between theory and practice by integrating case analysis with practical teaching. This approach allows students to actively participate in real teaching design and implementation, helping them better understand how ICT can be applied in the classroom. Through hands-on practice, students gain valuable experience, which not only enhances their technical application abilities but also deepens their understanding of teaching methods and strategies.

Liu and Sun (2019) investigated the ICT teaching competencies of fourth-year teacher education students at normal universities in Shanxi Province. The results indicated that these students were generally able to design, plan, and manage ICT

resources reasonably well. However, they had significant weaknesses in ICT teaching design, recording and analyzing teaching processes, and organizing and implementing ICT-based teaching activities. To solve these problems, the researchers proposed the following strategies. First, they suggested increasing ICT-based teaching practice opportunities so that students can apply what they've learned in real teaching practices. Second, both on-campus and off-campus internships, as well as extracurricular activities, should be used to help students gain more ICT teaching experience, particularly in areas such as using information technology for classroom management, teaching assessment, and teaching reflection. Third, the researchers recommended incorporating more case studies and simulated teaching activities into teacher education courses, enabling students to engage in ICT teaching design and activity organization in a simulated environment, helping them face potential challenges in real teaching scenarios. Finally, the researchers suggested that teacher education courses should emphasize interdisciplinary teaching methods, encouraging students to apply ICT in multiple subject areas to enhance their ability to use technology across various teaching contexts.

Aslan and Zhu (2016) found that teaching knowledge, ICT-related courses, and perceived ICT competence are significant predictors of the integration of ICT into teaching practices. Their study emphasizes that pre-service teacher training programs, particularly those focused on teaching knowledge and ICT-related courses, are crucial in enhancing the use of ICT in teaching. The research suggests that universities should implement specific strategies to improve teacher education students' competence in ICT integration. These strategies include addressing external barriers to ICT within teacher training programs, improving human and physical resources, reducing disparities among universities regarding the development of ICT competence, tailoring ICT-related courses to fit the curricula of various subject programs, and prioritizing hands-on experience to build ICT skills.

CHAPTER 3

METHODOLOGY

Research Design

This study is a mixed-method study: a combination of qualitative research and quantitative research. It was conducted as a case study of undergraduate primary education students at Weifang University. In the quantitative research, 252 students were surveyed through a questionnaire to collect empirical data to investigate the current status and influencing factors of ICT teaching competencies. The quantitative phase of this study primarily utilizes a Likert-scale questionnaire as its research tool, as it effectively captures respondents' personal preferences and levels of agreement. In the qualitative research, expert interviews were conducted with five educational experts to gather their suggestions for improving the ICT teaching competencies of undergraduate primary education students.

Population and Sample

1 The population and sample of primary education students

The population for quantitative research consists of 404 undergraduate primary education at Weifang University. According to the formula proposed by Krejcie and Morgan (1970), the appropriate sample size based on the population size is calculated as follows:

$$S = \frac{X^2 NP(1-P)}{d^2(N-1) + X^2 P(1-P)}$$

(S is required sample size, X^2 is the table value for the desired confidence level, N is population size, P is the population proportion, d is the desired level of precision)

With a 99% confidence level and a 5% margin of error, the required sample size is 252.

To ensure that the sample reflects the diversity of the population, this study divided the population into several strata based on their grades, including 72 first-year students, 98 second-year students, 89 third-year students, and 145 fourth-year students. A random sample was then drawn from each stratum, with the number of students selected from each group being proportional to its representation in the overall population. According to the basic formula for stratified sampling:

$$n_h = \frac{N_h}{N} \times n$$

(n_h is the number of samples to be selected from stratum h, N_h is the population size of stratum h, N is the total population size, n is the total sample size). The sample size to be taken from each grade is shown in TABLE 4.

TABLE 4 Stratified Sampling Allocation

Grade	Population	Proportion	Sample Size
First-year	72	17.82%	45
Second-year	98	24.26%	61
Third-year	89	22.03%	56
Fourth-year	145	35.89%	90
Total	404	100%	252

2. The sample of educational experts

This study invited five educational experts to provide suggestions for improving ICT teaching competencies, based on the findings from the investigation into the current status and influencing factors of ICT teaching competencies among undergraduate primary education at Weifang University.

Research Instruments

The research instruments for this study consisted of questionnaires and semi-structured interviews.

1. Questionnaire

The questionnaire was used to investigate the current status and influencing factors of ICT teaching competencies among 252 undergraduate primary education students at Weifang University. It consisted of three sections: personal information, self-evaluation, and influencing factors. The first section collected demographic information, including gender, grade, academic performance, and additional internship experiences beyond the university's standard arrangements. The second section was a self-evaluation designed for students to assess their ICT teaching competencies using a Likert scale. This five-point scale ranged from one (strongly disagree) to five (strongly agree). For each statement, students were required to select the level that best represented their self-perception of ICT teaching competencies. A total of 27 items were included in this section: 8 items assessed basic technological literacy, 8 items focused on technology-supported learning, and 11 items evaluated technology-supported teaching. The third section examined the factors that may influence the development of ICT teaching competencies. Like the second section, this part also employed a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) to assess students' perceptions of various internal and external factors affecting their ICT teaching competencies development. This section contained a total of 42 items, covering internal factors such as attitude and self-efficacy, as well as external factors including facilities, courses, teacher support, practical opportunities, and school culture.

2. Semi-Structured Interviews

The Semi-structured interviews were conducted with five educational experts to gather their suggestions for improving ICT teaching competencies.

3. Item-Objective Congruence

The questionnaire was reviewed by three experts to ensure the accuracy of content and clarity of language. The experts rated the items for each objective as 1 (clearly relevant), -1 (clearly irrelevant), or 0 (unclear). Next, content validity was assessed by using the Item-Objective Congruence (IOC) formula:

$$IOC = \frac{\sum R}{N}$$

($\sum R$ is the total score for each item assigned by all the experts, N is the total number of experts.).

Items with an IOC score of 0.5 or higher were retained, while those scoring below 0.5 were revised or discarded. The IOC result of the questionnaire was 0.996, indicating strong content validity.

4. Pretest and Reliability Analysis

Before the formal distribution of the questionnaire, a pretest was conducted with a sample of 30 students to examine the reliability of the research instrument. To assess the internal consistency reliability, Cronbach's alpha coefficient was calculated for each sub-dimension as well as for the overall scale. The Cronbach's alpha values from the pretest exceeded 0.70 for all dimensions, indicating that the instrument was reliable and appropriate for measuring the ICT teaching competencies of undergraduate primary teacher education students. Based on these satisfactory pretest results, the formal study was subsequently carried out. The Cronbach's alpha coefficients obtained from the full sample also demonstrated high internal consistency, as shown in TABLE 5.

TABLE 5 Reliability Analysis of the Self-assessment Scale

Dimension	Number of items	Cronbach's Alpha
Basic Technological Literacy	8	0.762
Technology-supported Learning	8	0.753
Technology-supported Teaching	11	0.824

TABLE 5 (continued)

Dimension	Number of items	Cronbach's Alpha
Overall	27	0.864

TABLE 6 Reliability Analysis of the Influencing Factors Scale

Dimension	Number of items	Cronbach's Alpha
Attitude	6	0.727
Self-efficacy	6	0.742
Facilities	6	0.755
Courses	6	0.744
Teacher Support	6	0.738
Practical Opportunities	6	0.735
School Culture	6	0.739
Overall	42	0.825

The overall Cronbach's alpha value for the ICT teaching competencies scale was 0.864. The Cronbach's Alpha values for the three sub-dimensions were 0.762, 0.753, and 0.824, respectively. The overall Cronbach's alpha value for the influencing factors scale was 0.825, and all sub-dimensions exceeded 0.70. According to Cronbach (1951), a Cronbach's alpha value above 0.70 is generally considered acceptable for research purposes. Therefore, the reliability of the questionnaire is sufficient to support further statistical analyses in this study.

Data Collection

The quantitative data were collected through an online questionnaire distributed to undergraduate primary education students at Weifang University. The questionnaire

was administered via a secure online platform, and participants accessed the survey through a link shared in class groups and university communication channels. Before starting the questionnaire, students were informed about the purpose of the study, assured of confidentiality and anonymity, and asked to participate voluntarily.

In the qualitative phase, semi-structured interviews were conducted with five educational experts, including university lecturers and researchers in the field of education. The interview questions were designed to gather expert opinions and suggestions on how to improve ICT teaching competencies among undergraduate teacher education students. All interviews were conducted with the consent of the participants and later transcribed for analysis.

Data Analysis

1. The demographic data of the participants was reported in the form of a percentage (%).

2. The Five-point Likert scale was used to score the level of ICT teaching competencies, the score range with its verbal interpretation as shown below:

TABLE 7 Score Range of ICT Teaching Competencies

Score Range	ICT Teaching Competencies
4.21-5.00	proficient
3.41-4.20	advanced
2.61-3.40	Intermediate
1.81-2.60	faint
1.00-1.80	unskilled

3. Research question one: What is the current status of ICT teaching competencies among undergraduate primary education students at Weifang University?

For this question, the statistical procedures used to analyze the ICT teaching competencies of students included frequency (f), percentage (%), mean score ($\bar{x}$), and standard deviation (S.D.). An independent samples t-test was conducted to analyze gender differences in ICT teaching competencies and to examine whether significant differences existed based on participation in internship experiences beyond the university's standard arrangements. One-way ANOVA was applied to determine whether significant differences existed in ICT teaching competencies across different grade levels and academic performance groups.

4. Research question two: What are the factors influencing the development of ICT teaching competencies among undergraduate primary education students at Weifang University? For this question, correlation analysis using Pearson's coefficient was conducted to examine the strength and direction of the relationships between internal factors (attitude, self-efficacy), external factors (facilities, courses, teacher support, practical opportunities, school culture), and ICT teaching competencies. Additionally, Multiple linear regression analysis was used to explore and validate the relationships between the influencing factors and ICT teaching competencies, as well as to assess the strength of the impact of each factor on ICT teaching competencies.

5. Research question three: What are the guidelines for improving the ICT competencies among undergraduate primary education students at Weifang University? For this question, content analysis was used to summarize the educational experts' suggestions.

CHAPTER 4

RESULTS OF THE STUDY

This study was conducted to investigate the current status and influencing factors of ICT teaching competencies among undergraduate primary education students at Weifang University, with the goal of providing guidelines to better support the improvement of their ICT teaching competencies.

This chapter presents the findings based on the data collected to address the research questions. The first section provides demographic data of the participants along with their scores on ICT teaching competencies and sub-dimensions. The second section offers a descriptive statistical analysis of ICT teaching competencies and sub-dimensions. The third section examines ICT teaching competencies and sub-dimensions across different genders, grade levels, academic performances, and participation in internship experiences beyond the university's standard arrangements. The fourth section explores the relationships between variables through correlation analysis and investigates the influencing factors of ICT teaching competencies and sub-dimensions using multiple linear regression analysis. The fifth section discusses the results from the semi-structured interviews, and the final section summarizes the chapter.

Demographic Data

The first part of the questionnaire collected demographic data, including gender, grade level, academic performance, and whether participants had engaged in internship experiences beyond the university's standard arrangements. The results are presented in terms of frequency and percentage of the participants as follows:

TABLE 8 Demographic Features of the Participants

Category		Frequency	Percentage
Gender	Male	92	36.51
	Female	160	63.49
Grade	First-year	45	17.86
	Second-year	61	24.21
	Third-year	56	22.22
	Fourth-year	90	35.71
Class Ranking	Top 30%	53	21.03
	30%–70%	153	60.72
	Bottom 30%	46	18.25
Additional Internship Experience	Yes	109	43.25
	No	143	56.75

According to TABLE 8, a total of 252 participants took part in this study. The number of participants in the study included 92 males (36.51%) and 160 females (63.49%). Regarding grade levels, 45 students (17.86%) are in the first year, 61 students (24.21%) are in the second year, 56 students (22.22%) are in the third year, and 90 students (35.71%) are in the fourth year. For class ranking, 53 students (21.03%) are in the top 30% of their class, 153 students (60.72%) are in the 30%-70% range, and 46 students (18.25%) are in the bottom 30%. In terms of whether they have additional internship experiences beyond those provided by the university, 109 students (43.25%) have participated, while 143 students (56.75%) have not.

Descriptive Statistical Analysis of ICT Teaching Competencies

The second part of the questionnaire was designed to investigate the status of ICT teaching competencies among undergraduate primary education students at Weifang University. It consisted of 27 items distributed across three dimensions: basic technological literacy, technology-supported learning, and technology-supported teaching. All items were rated using a 5-point Likert scale. Descriptive statistics, including the mean ($\bar{x}$) and standard deviation (S.D.), were used to analyze the data.

Research Question 1: What is the current status of ICT teaching competencies among undergraduate primary education students at Weifang University?

TABLE 9 The Status of ICT Teaching Competencies

Dimension	$\bar{x}$	S.D.	Level
Basic Technological Literacy	3.26	0.743	Intermediate
Technology-supported Learning	3.24	0.819	Intermediate
Technology-supported Teaching	3.17	0.728	Intermediate
Overall ICT Teaching Competencies	3.22	0.590	Intermediate

The ICT teaching competencies of undergraduate primary education students at Weifang University were evaluated using the Comprehensive Index (CI), which reflects the average score of all participants. The statistical analysis revealed that the mean ICT teaching competencies score is 3.22, with a standard deviation of 0.590, indicating that the overall ICT teaching competencies of undergraduate primary education students fall within the “Intermediate” level. Regarding the three sub-dimensions, basic technological literacy recorded the highest mean score ($\bar{x}$= 3.26, S.D. = 0.743) and was classified as “Intermediate,” while technology-supported learning ($\bar{x}$= 3.24, S.D. = 0.819) and technology-supported teaching ($\bar{x}$= 3.17, S.D. = 0.728)

were both categorized at the “Intermediate” level. The relative rankings of these dimensions suggest the following relationship: basic technological literacy > technology-supported learning > ICT teaching competencies > technology-supported teaching.

Comparison of ICT Teaching Competencies of Different Demographic Factors

1. Comparison of Different Genders

An independent samples t-test was conducted to examine potential gender differences in ICT teaching competencies and its sub-dimensions. The results are presented in TABLE 10.

TABLE 10 The Comparison of ICT Teaching Competencies Between Genders

Dimension	Gender	N	$\bar{x}$	S.D.	t	p-value
Basic Technological Literacy	Male	92	3.28	0.771	0.325	0.746
	Female	160	3.25	0.729		
Technology-supported Learning	Male	92	3.12	0.838	-1.780	0.076
	Female	160	3.31	0.803		
Technology-supported Teaching	Male	92	3.07	0.800	-1.606	0.110
	Female	160	3.23	0.680		
ICT Teaching Competencies	Male	92	3.15	0.649	-1.390	0.166
	Female	160	3.26	0.551		

The results indicate no statistically significant differences between male and female participants in ICT teaching competencies (p-value > 0.05 for all comparisons). Although males reported slightly higher scores in basic technological literacy ($\bar{x}$ = 3.28, S.D. = 0.771) compared to females ($\bar{x}$= 3.25, S.D. = 0.729), this difference did not reach statistical significance (t = 0.325, p-value = 0.746). Similarly, there were no

significant gender differences in technology-supported learning (t = -1.780, p-value = 0.076) or technology-supported teaching (t = -1.606, p-value = 0.110). For overall ICT teaching competencies, the mean scores for male ($\bar{x}$= 3.15, S.D. = 0.649) and female ($\bar{x}$= 3.26, S.D. = 0.551) participants were nearly identical, with no significant difference observed (t = -1.390, p-value = 0.166). These findings suggest that gender does not play a significant role in determining ICT teaching competencies levels among the participants in this study.

2. Comparison of Different Grades

A one-way ANOVA was conducted to examine differences in ICT teaching competencies across different grades. The results are presented in TABLE 11.

TABLE 11 The Comparison of ICT Teaching Competencies Across Grades

Dimension	Grade	N	$\bar{x}$	S.D.	F	p-value
Basic Technological Literacy	First-year	72	3.07	0.895	1.527	0.208
	Second-year	98	3.24	0.705		
	Third-year	89	3.28	0.689		
	Fourth-year	145	3.35	0.712		
Technology-supported Learning	First-year	72	2.95	0.909	3.328	0.020
	Second-year	98	3.16	0.849		
	Third-year	89	3.32	0.783		
	Fourth-year	145	3.39	0.740		
Technology-supported Teaching	First-year	72	2.99	0.671	3.430	0.018
	Second-year	98	3.01	0.766		
	Third-year	89	3.24	0.735		
	Fourth-year	145	3.32	0.696		

TABLE 11 (continued)

Dimension	Grade	N	$\bar{x}$	S.D.	F	p-value
ICT Teaching Competencies	First-year	72	3.00	0.662	4.411	0.005
	Second-year	98	3.12	0.601		
	Third-year	89	3.28	0.546		
	Fourth-year	145	3.35	0.536		

From the basic technological literacy dimension, the mean scores for the first, second, third, and fourth years were 3.07, 3.24, 3.28, and 3.35, respectively. The results of the analysis showed F = 1.527, P-value = 0.208, indicating no statistically significant differences among the groups (p-value > 0.05). Although the mean scores tend to increase progressively across grade levels, the differences were not found to be statistically significant.

In contrast, significant differences were found in the technology-supported learning dimension. The mean scores were 2.95 for first-year students, 3.16 for second-year students, 3.32 for third-year students, and 3.39 for fourth-year students. The results of the ANOVA analysis revealed an F value of 3.328 with a p-value of 0.020, which is below 0.05, indicating a statistically significant difference in technology-supported learning competencies across the four grade levels. The observed upward trend suggests that students' competencies in this dimension tend to enhance as they progress through their academic studies.

Similarly, in the technology-supported teaching dimension, the mean scores for first- to fourth-year students were 2.99, 3.01, 3.24, and 3.32, respectively. The analysis reported F = 3.430, p-value = 0.018, again indicating a statistically significant difference (p-value < 0.05). As in the previous dimension, students in higher years performed better.

Regarding overall ICT teaching competencies, the scores progressed from 3.00 (first year) to 3.12 (second year), 3.28 (third year), and 3.35 (fourth year). The ANOVA revealed F = 4.411, p-value < 0.005, indicating significant differences in overall ICT competencies among grade levels.

In summary, the analysis revealed that basic technological literacy did not differ significantly across academic years. However, technology-supported learning, technology-supported teaching, and overall ICT teaching competencies showed statistically significant differences among students in different grades.

3. Comparison of Different Academic Performances

A one-way ANOVA was conducted to examine differences in ICT teaching competencies and its sub-dimensions across different academic performances. The results are presented in TABLE 12.

TABLE 12 The Comparison of ICT Teaching Competencies in Different Academic Performances

Dimension	Class Ranking	N	$\bar{x}$	S.D.	F	p-value
Basic Technological Literacy	Top 30%	53	3.39	0.718	7.355	<0.001
	30%-70%	153	3.32	0.708		
	Bottom 30%	46	2.89	0.789		
Technology-supported Learning	Top 30%	53	3.56	0.639	6.706	0.001
	30%-70%	153	3.21	0.820		
	Bottom 30%	46	2.98	0.902		
Technology-supported Teaching	Top 30%	53	3.52	0.633	9.872	<0.001
	30%-70%	153	3.12	0.700		
	Bottom 30%	46	2.92	0.790		

TABLE 12 (continued)

Dimension	Class Ranking	N	$\bar{x}$	S.D.	F	p-value
ICT Teaching Competencies	Top 30%	53	3.49	0.492	12.272	<0.001
	30%-70%	153	3.21	0.560		
	Bottom 30%	46	2.93	0.654		

In the basic technological literacy dimension, the mean scores for the top 30%, middle 30%-70%, and bottom 30% of students were 3.39, 3.32, and 2.89, respectively. The analysis showed F = 7.355, p-value < 0.001, with a p-value less than 0.05, indicating significant differences in basic technological literacy across class rankings. Students in the top 30% performed significantly better than those in the bottom 30%, with the middle group also outperforming the bottom group.

In the technology-supported learning dimension, the mean scores for the top 30%, middle 30%-70%, and bottom 30% were 3.56, 3.21, and 2.98, respectively. The analysis showed F = 6.706, p-value = 0.001, with a p-value much smaller than 0.05, suggesting significant differences in technology-supported learning abilities across class rankings. The top 30% outperformed both the middle and bottom groups, with the bottom 30% showing the lowest mean score.

For the technology-supported teaching dimension, the mean scores were 3.52 for the top 30%, 3.12 for the middle 30%-70%, and 2.92 for the bottom 30%. The analysis revealed F = 9.872, p-value < 0.001, with a p-value less than 0.05, indicating significant differences in technology-supported teaching abilities across class rankings. Again, students in the top 30% demonstrated higher competency compared to the middle and bottom groups, with the bottom 30% showing the lowest scores.

Regarding the overall ICT teaching competencies, the mean scores for the top 30%, middle 30%-70%, and bottom 30% were 3.49, 3.21, and 2.93, respectively. The analysis showed F = 12.272, p-value < 0.001, with a p-value less than 0.05,

indicating significant differences in overall ICT teaching competencies among different class rankings. Students in the top 30% demonstrated significantly higher ICT teaching competencies compared to the middle and bottom groups, with the bottom 30% exhibiting the lowest overall scores.

In conclusion, significant differences exist in ICT teaching competencies among students in the top 30%, middle 30%-70%, and bottom 30% across all four dimensions: basic technological literacy, technology-supported learning, technology-supported teaching, and overall ICT teaching competencies. The top 30% consistently outperformed the other groups in all dimensions.

4. Comparison of ICT Teaching Competencies Based on Additional Internship Experiences Beyond Those Provided by the University

An independent samples t-test was conducted to examine whether significant differences existed in ICT teaching competencies and their sub-dimensions between students who participated in additional internship experiences beyond the university's standard requirements and those who did not. The results are presented in TABLE 13.

TABLE 13 The Comparison of ICT Teaching Competencies Based on Participation in Additional Internship Experiences Beyond the University's Standard Requirements

Dimension	Internship/Practical Experience	$\bar{x}$	S.D.	t	p-value
Basic Technological Literacy	Yes	3.29	0.722	0.526	0.599
	No	3.24	0.761		
Technology-supported Learning	Yes	3.33	0.774	1.445	0.150
	No	3.18	0.850		
Technology-supported Teaching	Yes	3.26	0.678	1.679	0.094
	No	3.10	0.760		

TABLE 13 (continued)

Dimension	Internship/Practical Experience	$\bar{x}$	S.D.	t	p-value
ICT Teaching Competencies	Yes	3.29	0.530	1.638	0.103
	No	3.16	0.629		

The results revealed no statistically significant difference in basic technological literacy between students who participated in additional internship experiences beyond the university's standard requirements and those who did not (t = 0.526, p-value = 0.599). In the technology-supported learning dimension, students with additional off-campus internship or practical experience showed higher mean scores, though the difference was not statistically significant (t = 1.445, p-value = 0.150). In the technology-supported teaching dimension, the difference approached statistical significance (t = 1.679, p-value = 0.094), again favoring those with additional experience. Similarly, the overall ICT teaching competencies score was higher among students with extra internship participation, but the difference remained statistically non-significant (t = 1.638, p-value = 0.103).

Analysis of Factors Influencing ICT Teaching Competencies

To investigate the extent to which different factors influenced ICT teaching competencies, correlation analysis was first conducted to assess the relationships between variables. Subsequently, multiple linear regression analysis was used to identify the significant predictors of students' ICT teaching competencies and sub-dimensions.

Research Question 2: What are the factors influencing the development of ICT teaching competencies among undergraduate primary education students at Weifang University?

1. Correlation Analysis Between ICT Teaching Competencies and Influencing Factors

TABLE 14 Correlation Analysis of Factors Influencing ICT Teaching Competencies

Dimension	Basic Technological Literacy	Technology-supported Learning	Technology-supported Teaching	ICT Teaching Competencies
Attitude	.306**	.442**	.360**	.478**
Self-efficacy	.174**	.217**	.359**	.335**
Facilities	.105	.103	.054	.109
Courses	.238**	.310**	.172**	.303**
Teacher support	.127*	.200**	.016	.138*
Practical opportunities	.276**	.417**	.385**	.469**
School culture	.079	.131*	.077	.122

*,$p<0.05$; **, $p<0.01$

TABLE 14 presents the correlations between various factors and ICT teaching competencies, along with its sub-dimensions (basic technological literacy, technology-supported learning, and technology-supported teaching). The data reveal that self-efficacy and attitude are the most influential factors, showing strong positive correlations across all dimensions. The results indicate significant positive correlations between attitude, self-efficacy, courses, teacher support, and practical opportunities with basic technological literacy, with correlation coefficients of 0.306, 0.174, 0.238, 0.127, and 0.276, respectively, all significant at the p-value < 0.05 level. Similarly, attitude, self-efficacy, courses, teacher support, practical opportunities, and school

culture showed significant positive correlations with technology-supported learning, with correlation coefficients of 0.442, 0.217, 0.310, 0.200, 0.417, and 0.131, respectively, all significant at the p-value < 0.05 level. Furthermore, attitude, self-efficacy, courses, and practical opportunities were significantly positively correlated with technology-supported teaching, with correlation coefficients of 0.360, 0.359, 0.172, and 0.385, respectively, all significant at the p-value < 0.05 level. Finally, attitude, self-efficacy, courses, teacher support, and practical opportunities demonstrated significant positive correlations with overall ICT teaching competencies, with correlation coefficients of 0.478, 0.335, 0.303, 0.138, and 0.469, respectively, all significant at the p-value < 0.05 level.

2. Regression Analysis of Factors Influencing ICT Teaching Competencies

2.1 Regression Analysis of Various Influencing Factors on Basic Technological Literacy

TABLE 15 ANOVA for the Regression Model of Basic Technological Literacy

Model	Sum of Squares	df	Mean Square	F	p-value
Regression	24.317	7	3.474	7.409	<.001
Residual	114.400	244	.469		
Total	138.716	251			

TABLE 15 presents the results of the ANOVA test for the regression model analyzing factors influencing basic technological literacy. The F-value is 7.409, and the p-value is <0.001, which is significant at the 0.001 level, indicating that the overall regression model is statistically significant

TABLE 16 Regression Coefficients for the Basic Technological Literacy Model

Model	Unstandardized coefficients		Standardized coefficient	t	Sig	Collinearity Statistics	
	B	Standard Error	Beta			Tolerance	VIF
(Constant)	1.486	.301		4.930	<.001		
Attitude	.193	.052	.234	3.744	<.001	.866	1.154
Self-efficacy	.018	.055	.021	.321	.749	.822	1.216
Facilities	.028	.060	.031	.472	.637	.778	1.285
Courses	.142	.055	.172	2.591	.010	.765	1.307
Teacher Support	-.021	.060	-.025	-.354	.724	.701	1.426
Practical Opportunities	.164	.050	.201	3.292	.001	.907	1.102
School Culture	.040	.053	.046	.760	.448	.932	1.073

TABLE 16 shows that the Variance Inflation Factor (VIF) values for all predictors are below 10, indicating that there is no multicollinearity among the independent variables. The significance levels for self-efficacy, facilities, teacher support, and school culture are 0.749, 0.637, 0.724, and 0.448, respectively, all of which are greater than 0.05. This suggests that these four factors do not have a significant impact on basic technological literacy. On the other hand, the regression coefficients for attitude (B = 0.193), courses (B = 0.142), and practical opportunities (B = 0.164) are statistically significant, as their p-values are all less than 0.05. According to the

regression coefficients, the impact of these factors on basic technological literacy, in descending order of influence, is attitude, practical opportunities, and courses.

2.2 Regression Analysis of Various Influencing Factors on Technology-Supported Learning

TABLE 17 ANOVA for the Regression Model of Technology-Supported Learning

Model	Sum of Squares	df	Mean Square	F	p-value
Regression	60.917	7	8.702	19.726	<.001
Residual	107.643	244	.441		
Total	168.560	251			

TABLE 17 presents the results of the ANOVA test for the regression model analyzing factors influencing technology-supported learning. The F-value is 19.720, and the p-value<0.001, indicating that the overall regression model is statistically significant.

TABLE 18 Regression Coefficients for the Technology-Supported Learning Model

Model	Unstandardized coefficients		Standardized coefficient	t	Sig	Collinearity Statistics	
	B	Standard Error	Beta			Tolerance	VIF
(Constant)	.456	.292		1.559	.120		
Attitude	.308	.050	.338	6.154	<.001	.866	1.154
Self-efficacy	.008	.053	.008	.149	.881	.822	1.216
Facilities	-.016	.058	-.016	-.274	.784	.778	1.285
Courses	.189	.053	.208	3.554	<.001	.765	1.307

TABLE 18 (continued)

Model	Unstandardized coefficients		Standardized coefficient	t	Sig	Collinearity Statistics	
	B	Standard Error	Beta			Tolerance	VIF
Teacher Support	.017	.058	.017	.286	.775	.701	1.426
Practical Opportunities	.283	.048	.315	5.872	<.001	.907	1.102
School Culture	.090	.051	.093	1.753	.081	.932	1.073

TABLE 18 shows that the Variance Inflation Factor (VIF) values for all predictors are below 10, indicating that there is no multicollinearity among the independent variables. The significance levels for self-efficacy, facilities, teacher support, and school culture are 0.881, 0.784, 0.775, and 0.081, respectively, all of which are greater than 0.05. This suggests that these three factors do not have a significant impact on technology-supported learning. On the other hand, the regression coefficients for attitude (B = 0.308), courses (B = 0.189), and practical opportunities (B = 0.283) are statistically significant, as their p-values are all less than 0.05. According to the regression coefficients, the impact of these factors on technology-supported learning, in descending order of influence, is attitude, practical opportunities, and courses.

2.3 Regression Analysis of Various Influencing Factors on Technology-Supported Teaching

TABLE 19 ANOVA for the Regression Model of Technology-Supported Teaching

Model	Sum of Squares	df	Mean Square	F	p-value
Regression	39.246	7	5.607	14.561	<.001

TABLE 19 (continued)

Model	Sum of Squares	df	Mean Square	F	p-value
Residual	93.947	244	.385		
Total	133.192	251			

TABLE 19 presents the results of the ANOVA test for the regression model analyzing factors influencing technology-supported teaching. The F-value is 14.561, and the p-value<0.001, indicating that the overall regression model is statistically significant.

TABLE 20 Regression Coefficients for the Technology-Supported Teaching Model

Model	Unstandardized coefficients		Standardized coefficient	t	Sig	Collinearity Statistics	
	B	Standard Error	Beta			Tolerance	VIF
(Constant)	1.211	.273		4.470	<.001		
Attitude	.212	.047	.262	4.535	<.001	.866	1.154
Self-efficacy	.181	.050	.216	3.646	<.001	.822	1.216
Facilities	-.007	.054	-.008	-.131	.896	.778	1.285
Courses	.063	.050	.077	1.260	.209	.765	1.307
Teacher Support	-.091	.054	-.108	-1.678	.095	.701	1.426
Practical Opportunities	.220	.045	.276	4.886	<.001	.907	1.102
School Culture	.060	.048	.070	1.264	.207	.932	1.073

TABLE 20 shows that the Variance Inflation Factor (VIF) values for all predictors are below 10, indicating that there is no multicollinearity among the independent variables. The significance levels for facilities, courses, teacher support, and school culture are 0.896, 0.209, 0.095, and 0.207, respectively, all of which are greater than 0.05. This suggests that these three factors do not have a significant impact on technology-supported teaching. On the other hand, the regression coefficients for attitude (B = 0.212), self-efficacy (B = 0.181), and practical opportunities (B = 0.220) are statistically significant, as their p-values are all less than 0.05. According to the regression coefficients, the impact of these factors on technology-supported teaching, in descending order of influence, is practical opportunities, attitude, and self-efficacy.

2.4 Regression Analysis of Various Influencing Factors on ICT Teaching Competencies

TABLE 21 ANOVA for the Regression Model of ICT Teaching Competencies

Model	Sum of Squares	df	Mean Square	F	p-value
Regression	37.807	7	5.401	26.635	<.001
Residual	49.477	244	.203		
Total	87.284	251			

TABLE 21 presents the results of the ANOVA test for the regression model analyzing factors influencing ICT teaching competencies. The F-value is 26.635, and the p-value<0.001, indicating that the overall regression model is statistically significant.

TABLE 22 Regression Coefficients for the ICT Teaching Competencies Model

Model	Unstandardized coefficients		Standardized coefficient	t	Sig	Collinearity Statistics	
	B	Standard Error	Beta			Tolerance	VIF

(Constant)	1.073	.198		5.412	<.001		
Attitude	.235	.034	.358	6.922	<.001	.866	1.154
Self-efficacy	.081	.036	.120	2.256	.025	.822	1.216
Facilities	.001	.040	.001	.019	.985	.778	1.285
Courses	.123	.036	.189	3.428	<.001	.765	1.307
Teacher Support	-.038	.039	-.056	-.976	.330	.701	1.426
Practical Opportunities	.222	.033	.344	6.793	<.001	.907	1.102
School Culture	.063	.035	.091	1.818	.070	.932	1.073

TABLE 22 shows that the Variance Inflation Factor (VIF) values for all predictors are below 10, indicating that there is no multicollinearity among the independent variables. The significance levels for facilities, teacher support, and school culture are 0.985, 0.330, and 0.070, respectively, all of which are greater than 0.05. This suggests that these three factors do not have a significant impact on ICT teaching competencies. On the other hand, the regression coefficients for attitude (B = 0.235), self-efficacy (B = 0.081), courses (B = 0.123), and practical opportunities (B = 0.222) are statistically significant, as their p-values are all less than 0.05. According to the regression coefficients, the impact of these factors on ICT teaching competencies, in descending order of influence, is attitude, practical opportunities, courses, and self-efficacy.

Semi-Structured Interviews

The data from the semi-structured interviews were analyzed by content analysis.

TABLE 23 The Background Information of Educational Experts

Interviewee Code	Current Position	Institution Type	Years of Experience
E1	Associate Professor	Regional College	21 years
E2l	Director	Regional College	9 years
E3	Director	Regional College	12 years
E4	Associate Professor	Regional College	25 years
E5	Associate Professor	Regional College	23 years

Table 23 presents the background information of the five educational experts interviewed for this study. Each interviewee was assigned a code (E1–E5) to maintain confidentiality

Research Question 3: What are the guidelines for improving the ICT teaching competencies of undergraduate primary education students at Weifang University?

The first interview question was “How do you evaluate the overall level of ICT teaching ability of primary education students at Weifang University?” The results showed that their ICT teaching competencies were at a moderate level.

The second question was “What are the main factors that significantly contribute to enhancing the ICT teaching competencies of undergraduate primary education students?” When discussing this question, all five interviewees emphasized that improving ICT teaching competencies requires a comprehensive and systematic approach. Several recurring themes emerged in their responses: One expert highlighted the importance of course design, stating, “If the course objectives, content, and activities are not well-structured, it’s difficult for students to develop meaningful ICT teaching skills. The curriculum should integrate real classroom scenarios and emphasize hands-on practice.” Another interviewee stressed the role of teacher support, mentioning that, “Teacher educators need to guide students closely, especially when they encounter difficulties during micro-teaching or internships. Providing feedback and

up-to-date resources makes a big difference." Several experts also pointed out the value of practical teaching opportunities. One said, "Students need more chances to actually use ICT tools in real or simulated classrooms. Whether through school internships or online teaching platforms, practice is key to transforming theory into competence." In addition, the availability of learning resources and a supportive learning environment was frequently mentioned. An expert remarked, "When students have access to quality literature, videos, and online learning tools, and when the campus has a strong digital atmosphere, they become more motivated to explore and apply ICT in teaching." Finally, many agreed that institutional support and culture also play an important role. "Policies like offering scholarships for ICT excellence or recognizing students who earn ICT-related certificates can greatly encourage active learning," one participant noted. In summary, the interviewees collectively agreed that enhancing ICT teaching competencies is not the result of a single factor but the outcome of multiple interrelated elements, including curriculum structure, instructional guidance, practical experience, resource access, and institutional culture and policy support.

The third question was "In terms of attitudes, what suggestions do you have for improving ICT teaching competencies of undergraduate primary education students?" The responses from the five experts revealed several strategies to foster a more positive attitude among students. One commonly suggested strategy was role modeling through experienced teachers. Three experts emphasized that inviting excellent in-service primary school teachers to share their successful ICT-integrated teaching experiences would be beneficial. For instance, one expert commented, "When students see how a real teacher uses tools such as Classin to improve writing performance, they realize that ICT can be a tool to make learning more engaging and effective, not just a burden." Another key recommendation was immersive practice through simulated teaching. Two experts suggested incorporating VR-based or real-time classroom simulations. One expert explained, "By using smart boards in mock lessons and then analyzing their performance afterward, students feel a stronger connection to future teaching scenarios,

which can improve their emotional acceptance of ICT use." The third strategy proposed was peer influence and collaboration. Some experts highlighted that assigning ICT-skilled student leaders or creating student-led sharing sessions could help normalize ICT usage. As one expert noted, "Students are more open when learning from their peers. When one shows how to make interactive games using PowerPoint, others feel encouraged and confident to try." Another interesting idea was emotional reinforcement through successful experience. One expert mentioned, "When a student successfully helps a struggling student by using digital tools, this small success brings a sense of accomplishment that directly strengthens their willingness to use ICT again." Finally, some experts emphasized the importance of institutional culture building. One expert stated, "Organizing 'ICT + subject' innovation weeks or public showcases where students present how they integrate ICT into lessons can help build a positive attitude collectively." In conclusion, the interviews showed that to enhance students' attitudes toward ICT use, it is important to provide emotional support through authentic teaching models, create immersive and rewarding practice experiences, and build a peer-supported, innovation-friendly learning environment. These strategies work together to reduce anxiety, increase interest, and shape positive professional beliefs about ICT in education.

The fourth question was "In terms of self-efficacy, what suggestions do you have for improving ICT teaching competencies of undergraduate primary education students?" The responses from the five experts revealed a strong focus on differentiated instruction, hands-on projects, and effective feedback mechanisms. One common theme that emerged was the importance of differentiated instruction. Experts pointed out that students come with varying levels of technological proficiency, and learning tasks should reflect this diversity. For example, a less experienced student might begin with basic tasks such as designing a simple PowerPoint to teach a math concept, which helps build foundational confidence. In contrast, more proficient students could be encouraged to tackle complex assignments—like designing full ICT-integrated lesson plans rooted in project-based learning. As one expert explained, "The sense of

accomplishment from completing tasks at one's own level is the foundation of self-efficacy." The idea of hands-on, collaborative projects also received strong support. ICT instruction, according to several experts, becomes significantly more effective when students are engaged in real or simulated teaching projects. One interviewee shared a successful case where students developed a VR-based science lesson and presented their work publicly. "That moment of showcasing their product in front of peers and instructors gave them a huge confidence boost," the expert noted. The combination of teamwork, applied skills, and peer recognition was seen as a powerful driver of self-belief in ICT integration. Another important recommendation was the use of formative assessment paired with timely, constructive feedback. Instead of relying heavily on summative exams, ICT courses should incorporate continuous evaluation methods that help students track their progress. "When teachers give feedback not just on the content but also on the student's creative use of technology, it shows that their effort is recognized," one expert remarked. Frequent and specific comments on improvement and innovation were seen as instrumental in enhancing students' belief in their own capabilities. In summary, strengthening students' self-efficacy in ICT teaching hinges on adaptable learning pathways, meaningful project experiences, and continuous encouragement. Rather than focusing solely on skill acquisition, these approaches aim to nurture a deeper sense of competence, agency, and readiness for future classroom applications.

The fifth question was "In terms of facilities, what suggestions do you have for improving ICT teaching competencies of undergraduate primary education students?" The responses from the five interviewed experts centered on two main themes: the development of digital infrastructure and the enhancement of hands-on learning environments. One frequently mentioned suggestion was the establishment and active utilization of a campus-wide cloud platform to support teaching and learning. Several experts highlighted that such a platform could serve as a central hub for teacher education students to store, organize, and share their digital teaching materials. As one expert explained, "Teacher education students need a digital space where they can

save their lesson plans, instructional videos, and reflections. If they can also receive comments from peers or instructors through the same system, their learning becomes more interactive and dynamic." Another interviewee noted the value of curating exemplary ICT-integrated teaching resources within the platform, observing that access to high-quality models could deepen students' understanding of effective technology-enhanced instruction. In this way, the platform was not only seen as a storage tool but also as a collaborative, reflective learning environment that fosters professional dialogue and peer feedback. The need to modernize ICT laboratories was also a key concern. A number of experts remarked that many existing labs fall short in equipping students with the tools required for innovative and subject-specific technology use. One expert emphasized that, "Modern ICT instruction requires more than Word and PowerPoint. Students should have access to multimedia editing tools like Photoshop, After Effects, and even subject-specific software." Another proposed incorporating emerging technologies such as 3D printing, digital drawing tablets, or VR tools, which would allow students to explore creative approaches to classroom instruction using technology. Such facilities would not only enhance students' technical proficiency but also encourage them to think critically and imaginatively about how ICT can enrich their future teaching practice. In summary, the experts consistently stressed that access to well-designed facilities is fundamental to developing ICT teaching competencies. The implementation of an interactive cloud platform and the upgrading of digital labs with advanced educational technologies were viewed as essential measures to create a practical, future-oriented, and innovation-driven learning environment for teacher education students.

The sixth question was "In terms of courses, what suggestions do you have for improving ICT teaching competencies of undergraduate primary education students?" The interviewed experts offered comprehensive suggestions focused on updating course content, enhancing interdisciplinary integration, improving teaching methods, and increasing practical training opportunities. A prominent recommendation was the urgent need to update course content in line with the rapid advancement of digital

technologies. Several experts stressed the importance of introducing teacher education students to emerging tools such as artificial intelligence, educational data mining, and blockchain. One expert remarked, “Our ICT courses should go beyond PowerPoint and Excel. Future teachers need to know how AI can personalize learning or how data can inform instructional decisions.” Another added, “Even a conceptual understanding of technologies like blockchain can prepare students for future trends in managing learning resources or student data.” These insights reflect a shared conviction that keeping pace with technological innovation is crucial for cultivating forward-thinking educators. In addition, integrating ICT instruction with disciplinary content was seen as essential for contextualized learning. Rather than treating ICT as a standalone subject, some experts advocated for embedding it directly into the teaching of core curriculum areas. For example, one interviewee suggested, “Students should learn how to use reading apps like Ximalaya and speech recognition tools such as iFlytek Voice Input in Chinese language classes; tools like Duolingo and BoldVioce in English classes.” Equally important was the recommendation to diversify teaching methods within ICT-related courses. Experts advocated instructional models such as Problem-Based Learning (PBL) and Project-Based Learning (PjBL), which encourage learners to tackle real-world teaching challenges through the use of digital tools. One expert explained, “By designing ICT-based projects, students gain hands-on experience in how technology can solve actual problems in the classroom.” Lastly, all five experts agreed that practical training must be significantly strengthened throughout the program. “Practical courses need to be present in every academic year,” one expert emphasized. “Students can’t just learn theory—they must repeatedly experience how to apply technology in realistic teaching scenarios.” This incremental structure was viewed as essential for building both competence and confidence over time. In summary, the experts advocated for a dynamic, practice-oriented, and integrative curriculum to effectively enhance ICT teaching competencies. By modernizing course content, connecting ICT to disciplinary instruction, incorporating active learning models, and

embedding sustained practical experiences, teacher education students will be better equipped to meet the demands of digital-age classrooms.

The seventh question was “In terms of teacher support, what suggestions do you have for improving ICT teaching competencies of undergraduate primary education students?” The responses from the interviewed experts revealed a range of insightful recommendations, emphasizing curriculum enrichment, instructional guidance, internship supervision, and access to quality resources. A key suggestion that emerged was the integration of cutting-edge knowledge and exemplary case studies into ICT-related teaching. Several experts highlighted the importance of exposing students to the latest trends in educational technology, such as artificial intelligence, virtual reality (VR), and augmented reality (AR). One expert commented, “Introducing advanced technologies not only broadens students’ horizons but also prepares them to use these tools meaningfully in their future classrooms.” Another expert emphasized the practical value of international and domestic ICT teaching case studies, suggesting, “Analyzing real-life cases can help students understand how innovative tools are being used effectively in authentic primary school settings.” Organizing classroom discussions around these cases was also recommended to deepen reflection and critical thinking. The experts also emphasized the value of instructional process guidance during teaching simulations. Rather than merely observing, instructors should actively support teacher education students by offering timely advice and corrective feedback. One interviewee pointed out, “It’s important that instructors guide students not just on content delivery, but on how to effectively integrate technology to enhance learning.” Where students face difficulties using ICT tools, instructors should demonstrate correct techniques and provide hands-on coaching. Moreover, post-teaching debrief sessions were considered essential, as another expert noted, “Feedback after practice teaching should be thorough—acknowledging what the student did well, but also identifying areas for growth and giving clear suggestions.” Ongoing support during the internship period was another widely shared recommendation. Some experts advocated for regular visits to placement schools and open communication with mentor teachers to

ensure teacher education students receive timely help. One expert stated, “Instructors need to follow up consistently during internships and collaborate with school mentors to support student progress.” Others suggested organizing regular reflection seminars, where interns can share their teaching experiences and discuss how they’re applying ICT in real classrooms. One participant remarked, “Peer discussions during the internship help student teachers realize that they’re not alone in facing challenges—and they can learn a lot from each other.” Reviewing and providing feedback on internship reports was also seen as a critical component of this support process. Finally, ensuring access to high-quality learning resources was regarded as essential. Teachers should recommend well-selected academic materials—books, journals, and practical guides—related to ICT in education. As one expert explained, “A carefully structured reading list helps students connect theoretical understanding with real-world practice.” Others encouraged the use of online learning platforms such as MOOCs and national education repositories, noting that, “Platforms like the National Public Service Platform for Educational Resources or Xueke.com offer a wealth of teaching materials that students can use to develop their instructional plans.” Regular literature discussions and guided self-learning were also recommended as effective strategies for cultivating academic literacy and professional competence. In conclusion, the experts agreed that enhancing teacher support requires a multifaceted approach: updating course content with the latest technological developments, providing hands-on instructional guidance, offering consistent mentorship throughout internships, and recommending valuable resources for continued learning. These support mechanisms work together to foster the development of strong ICT teaching competencies among undergraduate primary education students.

The eighth question was “In terms of practice opportunities, what suggestions do you have for improving ICT teaching competencies of undergraduate primary education students?” Interview participants highlighted a range of strategies to expand and optimize hands-on ICT teaching experiences for teacher education students. These recommendations emphasize partnership-building, experiential learning, virtual

engagement, and systematic practice management. One of the most emphasized strategies was the establishment of long-term and stable internship partnerships between universities and primary schools. Several interviewees stressed the importance of selecting schools that are not only technologically well-equipped but also open to innovative teaching practices. One expert suggested, “Internship schools should serve not just as teaching grounds, but as training fields for ICT integration.” Through joint development of training programs and clearly defined roles, both universities and schools can work collaboratively to provide meaningful, structured experiences. Assigning experienced primary school teachers as one-on-one mentors was also noted as essential for supporting students’ growth throughout the internship. By engaging in authentic classroom teaching under expert guidance, teacher education students can put their ICT knowledge into real practice, bridging the gap between academic theory and teaching reality. The experts also underscored the value of collaborative teaching practices involving joint lesson design and implementation. In this model, university faculty and primary school teachers co-develop lessons that incorporate ICT tools, with teacher education students participating in lesson delivery and classroom observation. One interviewee described this approach as “a real-time laboratory for learning from seasoned teachers while contributing to the teaching process.” These sessions enable teacher education students to observe how ICT tools are selected and applied in response to learners’ needs and classroom dynamics. Additionally, feedback collected from student participants can inform future lesson improvements, creating a mutually beneficial learning environment for all involved. In response to the digitalization of education, the idea of expanding virtual teaching opportunities through online platforms was also brought forward. With the growing availability of online teaching platforms and educational resources, teacher education students can now gain practical experience by designing and delivering virtual lessons. One expert noted that “virtual teaching environments offer a flexible, scalable alternative to traditional practicums.” In these settings, teacher education students are encouraged to use a range of ICT tools—for lesson planning, instructional delivery, student engagement, and learning assessment.

Moreover, integrated analytics tools on online platforms allow them to monitor student performance and adjust teaching strategies accordingly. This virtual approach not only complements in-person teaching but also familiarizes students with blended and remote teaching formats that are increasingly common in modern education. Another important recommendation was the creation of a robust practice opportunities management system. Participants proposed that universities establish dedicated departments responsible for coordinating all aspects of practical teaching, including internship base management, scheduling, project implementation, and quality assurance. As one expert pointed out, “Without a clear management framework, even good practice opportunities can fall short of their potential.” To maximize the effectiveness of practical training, detailed teaching plans should be developed, outlining specific objectives, procedures, and expected outcomes. Ongoing monitoring and feedback mechanisms were also recommended to ensure that practice programs are aligned with learning goals and continuously improving. In sum, the interview responses emphasize that improving practice opportunities requires a systemic and multifaceted strategy. Establishing authentic teaching contexts, fostering collaborative and virtual experiences, ensuring effective coordination are all seen as essential steps toward cultivating strong ICT teaching competencies in teacher education teachers.

The ninth question was “In terms of school culture, what suggestions do you have for improving ICT teaching competencies of undergraduate primary education students?” Participants emphasized that cultivating a positive, digitally enriched school culture plays a foundational role in shaping teacher education students’ attitudes, awareness, and behaviors regarding ICT use in education. Suggestions centered around enhancing the digital atmosphere on campus, establishing robust evaluation systems, and offering targeted incentives and support. A frequently mentioned recommendation was the creation of a digitally enriched campus environment that organically integrates ICT into the daily experiences of students. Several participants noted that the presence of digital installations in public spaces—such as electronic bulletin boards, smart displays, and interactive touchscreens—can help normalize the

presence of educational technology in the university setting. These displays might feature the latest developments in ICT for education, outstanding examples of digital teaching, or student innovations in technology integration. One expert shared, “A visually immersive and interactive campus environment helps embed ICT into students’ consciousness and encourages everyday exploration.” This immersive atmosphere not only raises digital awareness but also helps teacher education students internalize the idea that technology is an integral part of modern teaching practice. In addition to the physical environment, interviewees emphasized the importance of building a comprehensive evaluation and feedback mechanism focused on ICT teaching competencies. It was noted that regular assessments—spanning theoretical understanding, technical operation skills, and classroom integration abilities—can provide critical insight into students’ developmental progress. A range of evaluation formats was recommended, including exams, teaching demonstrations, peer reviews, and reflective portfolios. According to one participant, “Multiple forms of evaluation give a more accurate and holistic picture of student capabilities, which is essential for guiding growth.” Timely feedback, based on assessment results, should be personalized to help students identify areas of strength and weakness. Furthermore, students can be encouraged to formulate individualized improvement plans, making the development of ICT teaching competencies a self-directed, reflective process. From an institutional perspective, feedback data can also be used to refine cultural initiatives and ensure that campus-wide programs are aligned with students’ actual needs. Another critical theme that emerged from the interviews was the development of incentive and support policies aimed at fostering a proactive learning atmosphere. Participants suggested implementing scholarship programs specifically designed to recognize students who demonstrate excellence in ICT-related coursework or teaching practice. Financial support for participation in ICT-focused projects, competitions, or training activities was also viewed as a key motivator. As one interviewee put it, “Incentives signal that ICT competencies are valued and worth investing effort in.” From a policy standpoint, institutions can further support this development by adjusting curriculum

credit systems to give greater weight to ICT-related subjects and recognizing external certifications or training achievements. These measures not only validate students' engagement with ICT but also provide tangible academic and professional rewards, reinforcing their commitment to continuous improvement. Collectively, these suggestions underscore that school culture is more than a backdrop—it is an active force in shaping how teacher education students perceive and pursue ICT integration. By cultivating an environment that is rich in digital resources, supportive of ongoing assessment, and driven by clear incentives, institutions can create a powerful cultural foundation for the development of future educators' ICT teaching competencies.

Summary of the Chapter

This chapter presents the findings of both the quantitative and qualitative data collected to investigate the current status and influencing factors of ICT teaching competencies among undergraduate primary education students at Weifang University. The results of the questionnaire survey indicated that students demonstrated intermediate-level ICT teaching competencies. Among the three sub-dimensions, basic technological literacy ranked the highest and reached the advanced level, whereas technology-supported learning and technology-supported teaching remained at the intermediate level.

The analysis further revealed that, while basic technological literacy did not differ significantly across academic years, statistically significant differences were found in technology-supported learning, technology-supported teaching, and overall ICT teaching competencies among students at different academic levels. Significant differences were also observed among students with varying levels of academic performance. These findings suggest that both academic progression and academic achievement are strongly associated with the development of ICT teaching competencies.

In contrast, no significant differences were found based on gender. Although students who participated in additional internship experiences beyond the university's

standard requirements consistently exhibited higher mean scores across all dimensions, including overall ICT teaching competencies, the differences were not statistically significant. This indicates that, despite the positive trend, extended internship experiences did not result in a measurable improvement in ICT teaching competencies within the scope of this study.

In terms of influencing factors, the study found that attitude, course, and practical opportunities had significant positive effects on basic technological literacy. Similarly, attitude, courses, and practical opportunities also positively influenced technology-supported learning. For technology-supported teaching, significant positive effects were observed in attitude, self-efficacy, and practical opportunities. As for overall ICT teaching competencies, it was positively influenced by attitude, self-efficacy, courses, and practical opportunities.

In addition to the statistical results, expert interviews provided in-depth insights and practical recommendations based on seven core influencing factors: attitudes, self-efficacy, courses, facilities, teacher support, practical opportunities, and school culture.

Based on these findings, the next chapter will provide an in-depth discussion of the results, along with their implications for teacher education. It will also address the limitations of the study and offer recommendations for future research to further explore and enhance ICT teaching competencies among undergraduate primary education students at Weifang University.

CHAPTER 5

CONCLUSION AND DISCUSSION

This study investigated the ICT teaching competencies of primary education students at Weifang University and the factors influencing these competencies through a questionnaire survey. In addition, guidelines for improving these students' ICT teaching competencies were summarized through a semi-structured interview. This chapter provides a summary of the study, an overview of the main findings, and a discussion of the results. Furthermore, the significance and limitations of the research are presented, along with recommendations for future studies.

Summary of the Research

This study aimed to investigate the current status and the influencing factors of ICT teaching competencies among undergraduate students majoring in primary education at Weifang University, with the objective of offering guidance to enhance their ICT teaching competencies.

The participants consisted of 45 first-year students, 61 second-year students, 56 third-year students, and 90 fourth-year students. This study was conducted during the first semester of the 2025 academic year. A questionnaire consisting of a scale measuring ICT teaching competencies and a scale measuring influencing factors was used as the research instrument to collect data. Before completing the questionnaire, participants were provided with a brief explanation of ICT teaching competencies to ensure a common understanding of the concept. Then, all participants were asked to complete the questionnaire, which consisted of three parts: demographic information and items related to their ICT teaching competencies and influencing factors. A semi-structured interview was conducted with five educational experts to gather their suggestions for improving the ICT teaching competencies of undergraduate primary education students. The questionnaire was analyzed using frequency (f), percentage (%), mean score ($\bar{x}$), standard deviation (S.D.), t-test, one-way ANOVA, correlation

analysis, and multiple linear regression analysis. The data from the interviews were analyzed by content analysis.

The results showed that students' overall ICT teaching competencies were at a moderate level, with a mean score of 3.22. Among the sub-dimensions, basic technological literacy scored the highest ($\bar{x}$ = 3.26), while technology-supported teaching scored the lowest ($\bar{x}$ = 3.17). It also showed that basic technological literacy did not differ significantly across academic years. However, statistically significant differences were found in technology-supported learning, technology-supported teaching, and overall ICT teaching competencies, with higher-year students performing better. Significant differences were also observed among students with different levels of academic performance. Across all four dimensions, students in the top 30% consistently outperformed those in the middle and bottom groups, suggesting a strong association between academic achievement and ICT teaching competencies.

Regarding influencing factors, the regression analysis showed that students' attitude and practical opportunities had significant positive effects across all dimensions of ICT teaching competencies. Courses were also positively associated with basic technological literacy, technology-supported learning, and overall ICT teaching competencies. In addition, self-efficacy had a significant impact on technology-supported teaching and overall ICT teaching competency. In contrast, facilities, teacher support, and school culture did not reach statistical significance in any of the models, suggesting that these external support factors may have a relatively weak direct effect within the context of this study.

Discussion

The study revealed that the overall ICT teaching competencies index of the students was 3.22, indicating a moderate level. Among the specific dimensions, basic technological literacy had the highest mean score ($\bar{x}$ = 3.26), while technology-supported teaching had the lowest ($\bar{x}$= 3.17), suggesting that while students possess basic technical operational skills, their ability to integrate technology

into instructional design still requires improvement. This finding is consistent with Wang et al. (2023), who also reported that the overall ICT teaching competencies of teacher education students in China were at a moderate level. Further analysis showed no statistically significant differences in ICT teaching competencies or their sub-dimensions between male and female students. This result suggests that, within the current educational context and training system, male and female teacher education students at Weifang University exhibit relatively balanced levels of ICT teaching competencies.

In terms of academic progression, statistically significant differences were found in overall ICT teaching competencies as well as in the sub-dimensions of technology-supported learning and technology-supported teaching. The mean scores for all dimensions showed a steady upward trend as students advanced through their academic years. These results suggest that ICT teaching competencies—particularly in applying technology to support teaching and learning—tend to improve with academic progression. This trend may be attributed to the cumulative effects of pedagogical courses, increased exposure to educational technologies, and the practical teaching experiences gained in later stages of the program. Consistent with these findings, previous research also reports significant differences in ICT competencies based on students' grade level, with higher scores favoring those in the fourth year (Demirtaş & Mumcu, 2021).

Moreover, students with different academic performance levels demonstrated statistically significant differences across all ICT teaching competency dimensions. Higher-achieving students consistently outperformed those with lower academic performance, suggesting a strong association between academic achievement and the development of ICT teaching competencies. This may be due to greater learning motivation, deeper engagement with technology-related content, or more effective study strategies among higher-performing students. These findings underscore the importance of providing targeted support to lower-performing students to narrow the competency gap and foster more balanced development of ICT teaching competencies across students.

Finally, the study examined whether students' participation in additional internship experiences beyond the university's standard requirements had any impact on their ICT teaching competencies. The results revealed no statistically significant differences in overall ICT teaching competencies or in any of the sub-dimensions, including basic technological literacy, technology-supported learning, and technology-supported teaching, between students with and without such external experiences. However, students with additional internship experiences consistently scored higher across all dimensions compared to those without such experiences. This suggests that while the differences were not statistically significant, there is a trend indicating that external internship experiences may have a positive, though not decisive, impact on students' ICT teaching competencies.

The findings of this study indicate that multiple factors collectively influence the development of ICT teaching competencies among teacher education students. Consistent with Lan et al. (2024), the integration of digital teaching in Chinese higher education is shaped not only by educators' demographic characteristics and self-efficacy but also by external elements such as institutional policies, infrastructure, and training provision. In the present study, regression analyses revealed that among the seven examined factors——attitude, self-efficacy, facilities, courses, teacher support, practical opportunities, and school culture——attitude and practical opportunities emerged as the most consistent and significant predictors across all competency dimensions. This highlights the pivotal role of students' internal motivation and their engagement with hands-on, technology-enhanced learning experiences. Courses were also found to play a significant role in most models, emphasizing the importance of well-designed curricula that explicitly incorporate ICT-related content and applications. Self-efficacy, though not universally significant across all dimensions, demonstrated a strong influence, particularly in technology-supported teaching and overall competency development, suggesting that students' confidence in their ability to use ICT is closely tied to their instructional integration skills.

Interestingly, factors such as facilities, teacher support, and school culture did not show significant direct effects in any of the models. This finding may point to a disconnect between the existence of institutional resources and their actual impact on students' skill acquisition. Although universities have generally achieved basic compliance in terms of network infrastructure and access to hardware and software, these resources alone appear insufficient for promoting higher-order ICT teaching competencies (Wang et al., 2023). According to competency standards, teacher education students require more than just access——they need meaningful opportunities to experience how technology can support student-centered teaching. However, the current university environment seems to lack adequate support for autonomous, collaborative, and inquiry-based learning, which are crucial for developing deep, transferable digital teaching capabilities. This gap underscores the need for not only improving physical infrastructure but also aligning pedagogical practices and learning environments with the principles of student-centered, technology-integrated instruction.

Guidelines for Improving ICT Teaching Competencies

The results of this study provide the following guidelines for improving ICT teaching competencies of undergraduate primary education students at Weifang University.

1. Attitude

1.1 Inspiring Emotional Engagement Through Role Models

To enhance students' emotional connection with ICT in teaching, experienced primary school teachers could be invited to share real-life stories of how they have successfully integrated ICT into their classrooms. For example, one teacher enhanced student participation through a smart quiz system and leveraged its data analytics features—such as tracking response accuracy and completion time—to identify individual learning difficulties. These authentic examples help teacher education students recognize the relevance of ICT use to their future professional roles. In addition, showcasing successful cases where outstanding student teachers have creatively

applied ICT during their practicum can foster a “peer role model” effect, helping to reduce anxiety and lower perceived barriers to using ICT in teaching.

1.2 Building Positive Emotional Connections Through Experiential Learning

Organizing workshops themed around “Technology-Enhanced Primary Classrooms” allows teacher education students to experience technology from the perspective of primary school learners. For example, by engaging in activities such as AR-based literacy games or using interactive whiteboards, students can personally feel the engaging and dynamic learning environment that ICT tools can provide. This kind of simulated, hands-on experience can spark a strong emotional response, such as the desire to “create this kind of learning experience for my future students.” Compared to traditional theoretical instruction, this emotional resonance can more effectively foster intrinsic motivation to apply technology in teaching.

2. Self-efficacy

2.1 Differentiated Instruction and Task Design

In ICT-related courses, universities should implement differentiated instruction based on the initial competency levels of teacher education students. For students with weaker foundations, simple and achievable tasks should be assigned, such as creating basic PowerPoint presentations or using elementary teaching software. As their skills improve, task difficulty can gradually increase. More complex assignments may be given for students with stronger foundations, such as designing ICT-integrated instructional plans based on project-based learning. By completing tasks that align with their skill levels, all students can experience success, which helps build a stronger sense of self-efficacy.

2.2 Project-Based Learning and Product Presentation

Project-based learning organizes ICT instructional content into practical, hands-on projects that promote teamwork and active participation. For example, a group of students might collaboratively design a primary science lesson using interactive multimedia tools. This process involves creating teaching materials,

developing a detailed lesson plan, and rehearsing the lesson in a simulated teaching environment. After completing the project, students present their work in a showcase, where peers and faculty offer constructive feedback. Such recognition enhances students' self-confidence and supports the comprehensive development of their ICT teaching competencies throughout the project.

2.3 Formative Assessment and Immediate Feedback

Rather than relying solely on final examinations, a multi-dimensional assessment system that emphasizes formative evaluation should be adopted. In ICT courses, students' performance should be evaluated continuously based on classroom participation, the quality of assignments, and involvement in projects throughout the semester. Teachers ought to provide timely and constructive feedback that acknowledges students' strengths and progress while offering specific guidance for improvement. For example, after a student delivers a class presentation, the evaluation should consider not only the content and delivery but also how effectively the student employed ICT tools, including aspects of creativity and technical proficiency. This kind of targeted feedback helps students gain a clearer understanding of their strengths and areas needing development, which in turn fosters their confidence and motivation to improve, thereby enhancing their self-efficacy.

3. Facilities

3.1 Development and Use of a Campus Cloud Platform

A well-developed campus cloud platform should be established to provide teacher education students with convenient access to storage and sharing of teaching resources. The platform should offer ample storage space, allowing students to upload and manage their self-created teaching materials, such as lesson plans, instructional designs, and teaching reflections. It should also support resource categorization, search functions, and comment sections to facilitate easy retrieval and encourage peer-to-peer interaction and feedback. Additionally, the university can integrate exemplary teaching resources into a shared repository on the platform, enabling all students to learn from high-quality examples. This approach promotes

collaborative learning, resource sharing, and the development of a supportive academic atmosphere.

3.2 Construction of Professional Computer Laboratories

Computer laboratories are essential for hands-on ICT skill development among teacher education students. These labs should be equipped with a sufficient number of high-performance computers that are capable of running various advanced teaching software and multimedia applications. In addition to standard office software, a wide range of educational tools should be installed. For example, Adobe Photoshop can assist students in creating visually appealing teaching materials; Adobe After Effects can be used to develop engaging educational animations; and subject-specific software such as Geometer's Sketchpad can support ICT integration in math and science instruction. To further enhance hands-on learning opportunities, the lab should also include equipment such as 3D printers and digital drawing tablets. These tools help broaden students' technical capabilities and encourage the use of emerging technologies in the development of innovative teaching resources.

4. Courses

4.1 Updating Course Content

Course content should keep pace with the latest developments in information technology and incorporate emerging ICT applications in education. For instance, with the growing use of artificial intelligence in education, courses can include content on AI in education, such as the principles and applications of intelligent teaching systems, as well as using AI for personalized learning analysis and tutoring. Additionally, the application of machine learning algorithms in educational data mining can be introduced, allowing teacher education students to understand how to analyze student learning behavior data to inform teaching decisions. The use of blockchain technology in education resource management can also be explored to broaden students' perspectives and equip them with the essential technological knowledge needed for the future development of education.

4.2 Strengthening Interdisciplinary Integration

Primary education emphasizes a comprehensive and interdisciplinary approach to teaching, so ICT courses should focus on integrating with various subject areas in primary education. For example, in the context of elementary Chinese language teaching, the course could include content on how to use ICT tools to enhance reading instruction. This might involve using e-reading software for reading activities, organizing online reading sharing sessions, or using speech recognition technology for reading assessments. In mathematics instruction, the course could introduce the use of educational software to create geometric shapes, simulate mathematical experiments, and incorporate online math games to engage students and stimulate their interest in learning. Additionally, for subjects such as science, ICT can be integrated by introducing digital tools for conducting virtual science experiments, creating interactive simulations, and using multimedia resources to explain complex scientific concepts. In social studies, teachers could explore the use of interactive maps, historical timelines, and online resources to help students develop a deeper understanding of the world. By incorporating interdisciplinary content, teacher education students will learn to effectively combine ICT tools with primary education curriculum goals and subject-specific content. This approach will enhance the relevance and effectiveness of their teaching, fostering a more engaging and comprehensive learning experience for students.

4.3 Supplementing Teaching Methods and Case Analysis

The course should include content on ICT teaching methods, such as Problem-Based Learning (PBL) and Project-Based Learning (PjBL), and their application in ICT instruction. Teacher education students will learn how to use problems or projects as drivers to guide students in utilizing ICT tools for independent learning and inquiry. Additionally, a rich variety of teaching case studies should be introduced, covering various subjects in primary education, different teaching scenarios, and age groups. Through case analysis, teacher education students can learn how to design ICT-based teaching plans, select appropriate teaching strategies, and address various

challenges in teaching. This will help develop their practical teaching skills and ability to effectively integrate ICT into diverse teaching contexts.

4.4. Increasing the Proportion of Practical Courses

The curriculum should significantly increase the proportion of practical courses to ensure a proper balance between theory and practice in teacher education. Practical courses should be integrated throughout the entire training process, ranging from basic ICT skills practice to more comprehensive teaching application practice, gradually enhancing the practical abilities of teacher education students. For example, in the lower grades, a foundational course on basic computer operations can be offered, helping students master essential computer skills. In the middle grades, a course on multimedia resource creation can be introduced, focusing on developing their ability to produce high-quality teaching materials. In the higher grades, a course on ICT-based teaching design and implementation should be arranged, requiring students to apply their ICT knowledge comprehensively in teaching design and classroom practice, culminating in complete teaching experiences. This progressive approach ensures that students gain hands-on experience and practical competence, preparing them for effective teaching in real educational settings.

5. Teacher support

5.1 Incorporating Cutting-Edge Knowledge and Case Studies

As information technology evolves rapidly, it is essential for teacher educators to integrate the latest developments and case studies into the classroom. Special attention should be given to emerging applications in the field of education, such as artificial intelligence in teaching, and the application of virtual reality (VR) and augmented reality (AR) in instructional settings. Introducing these advanced topics helps broaden teacher education students' perspectives and stimulates their interest in exploring new technologies. Moreover, exemplary ICT teaching cases from both domestic and international contexts should be introduced to provide practical references. Organizing case study discussions among students can guide them to draw valuable insights from successful examples and understand how to effectively integrate

advanced ICT tools into primary school teaching practices to improve instructional outcomes.

5.2 Instructional Process Guidance

During simulated teaching sessions, instructors should closely observe the entire process, promptly identify issues, and provide targeted guidance. For areas where students struggle with technical operations, teacher educators should offer on-the-spot demonstrations to help them master the correct techniques. Additionally, teacher educators should assess teaching strategies, the pacing of instruction, and classroom management abilities, guiding students on how to integrate ICT with pedagogical methods to enhance instructional effectiveness. After the simulated teaching session, a structured reflection and summary should be conducted. Instructors should offer comprehensive feedback, affirming strengths, identifying areas for improvement, and suggesting specific directions for future development.

5.3 Internship Monitoring and Feedback

During the internship period, teacher educators should regularly visit internship schools to provide ongoing guidance and track the progress of teacher education students. Maintaining close communication with mentor teachers at the internship schools is essential to jointly support the growth and development of the teacher education students. Teacher educators should observe how effectively ICT tools are being integrated into classroom teaching and offer timely assistance and guidance when students encounter challenges or difficulties in their instructional practice. Regular seminars and discussion sessions should be organized for interns to share experiences, reflect on challenges, and collaboratively seek solutions. In addition, teacher education students should be required to submit internship reports regularly. These reports should be carefully reviewed by the teacher educators, who should provide constructive feedback and evaluations to encourage continuous reflection and improvement in the interns' teaching practices.

5.4 Providing Access to High-Quality Learning Resources

To support the development of ICT teaching competencies among teacher education students, teacher educators should actively recommend high-quality learning resources tailored to students' academic needs. This includes professional books and academic literature that cover the fundamental theories, application techniques, and practical cases related to ICT-integrated teaching. By studying these materials, students can systematically enhance their knowledge of ICT in education. In addition, instructors are encouraged to select and share recent academic publications to help students stay informed about emerging trends and research hotspots in the field. Regular book discussions and literature review sessions can be organized to promote critical thinking, reading comprehension, and knowledge exchange. Furthermore, instructors should guide students to make effective use of online learning platforms and educational resource repositories. Platforms such as MOOCs offer a variety of ICT-related courses that teacher education students can explore through self-directed learning. Additionally, access to national educational resource platforms like the National Public Service Platform for Educational Resources and subject-specific repositories such as Xueke.com can provide students with an abundance of teaching materials, including lesson plans, instructional videos, and multimedia content. These resources serve as valuable tools to support students' learning and teaching practice.

6. Practical opportunities

6.1 Establishing Long-Term and Stable Internship Partnerships

Universities should collaborate with multiple primary schools to establish long-term and stable partnerships as internship bases for teacher education students. When selecting internship schools, priority should be given to those with a strong foundation in ICT-integrated teaching and progressive educational philosophies. Internship plans and training programs should be co-developed by the university and the internship schools, with clearly defined responsibilities and tasks for both parties. The internship schools are expected to provide real classroom environments and practical teaching opportunities for student teachers. Experienced primary school teachers should be assigned as mentors to offer one-on-one guidance throughout the

internship period. Meanwhile, universities are responsible for the overall management and supervision of the internship process, maintaining regular communication with the internship schools to address any issues that may arise during the placement. Through these structured internships, student teachers can apply the ICT-related theoretical knowledge they have learned at university in real teaching settings. This hands-on experience helps them build practical teaching skills, bridge the gap between theory and practice, and improve their overall ICT teaching competencies.

6.2 Collaborative Teaching Practice

Universities and primary schools should jointly organize collaborative teaching activities that actively involve teacher education students. For example, teacher educators and primary school teachers can co-design a public lesson that integrates ICT tools. The primary school teacher delivers the lesson, the teacher educator provides technical and pedagogical support, and the teacher education students assist in the classroom while observing the entire teaching process. During these collaborative sessions, students have the opportunities to learn how experienced primary school teachers select and apply ICT tools based on students' needs, manage classroom dynamics, and engage in interactive teaching. Moreover, the teacher educators and primary school teachers can use the feedback from teacher education students to refine the lesson design, further enhancing teaching quality and effectiveness. This model promotes mutual learning and provides students with a practical, guided environment to improve their ICT teaching competencies.

6.3 Expanding Virtual Teaching Practice Through Online Platforms and Educational Resources

With the rapid development of online education, many platforms now offer a wealth of teaching resources and tools for both educators and learners, creating new virtual practice opportunities for teacher education students. Universities can collaborate with these platforms to organize teaching practicums for students in a virtual environment. For instance, students can design and deliver their own courses through online teaching platforms, targeting primary school students or other learners.

Throughout the teaching process, teacher education students are required to utilize ICT tools for course design, instructional delivery, and assessment. Engaging in interactive online teaching allows them to gain practical experience and enhance their teaching competencies. Additionally, many platforms provide data analytics features that help teacher education students monitor students' learning progress and adjust their teaching strategies accordingly. This virtual approach not only complements traditional in-school practicums but also broadens opportunities for practical ICT application in education.

6.4 Establishing a Practice Opportunities Management System

To ensure effective coordination and utilization of various practice opportunities, the university should establish a comprehensive management mechanism for practical teaching. A dedicated department for practice teaching should be set up to oversee the development and administration of practice bases, the organization and implementation of practical projects, and the scheduling and supervision of all practice-related activities. A detailed practical teaching plan and management system should be formulated to clearly define the objectives, tasks, procedures, and requirements of practice-based learning. In addition, stronger monitoring and quality assurance measures should be implemented throughout the practical teaching process. By building a quality assurance system for practical education, institutions can ensure the smooth operation of practice programs and continuously improve the quality of ICT teaching training.

7. School culture

7.1 Creating a Digitally Enriched Campus Environment

The campus environment is a direct reflection of institutional culture. To promote digital awareness, schools should integrate digital elements into the campus landscape. In public areas such as the main halls of teaching buildings, libraries, and student activity centers, electronic display screens can be installed to showcase content related to ICT in education. This includes updates on the latest educational technologies, exemplary ICT-integrated teaching cases, and achievements in educational technology

innovation. These displays not only help teacher education students stay informed about cutting-edge developments in the field but also spark their curiosity and motivation to explore ICT tools. Additionally, interactive digital installations—such as smart sculptures or touch-enabled information boards in gardens—can be set up around campus. Students can scan QR codes or engage via touchscreens to access relevant knowledge and information. These interactive features enhance the enjoyment and engagement of learning, allowing students to experience the appeal of ICT in their everyday campus life and deepening their interest in ICT-based teaching.

7.2 Establishing an Evaluation and Feedback Mechanism

A well-structured evaluation and feedback mechanism for ICT teaching competencies is essential for ensuring that campus culture effectively supports the development of students' ICT teaching competencies. The university should conduct regular assessments of students' ICT teaching competencies, covering areas such as theoretical knowledge, practical operation skills, and the ability to apply ICT in instructional settings. A variety of assessment methods can be used, including written exams, project-based evaluations, classroom observation, as well as self-assessment and peer assessment. These diverse approaches help provide a comprehensive and objective understanding of students' competency levels. Based on the assessment outcomes, timely feedback should be given to students, highlighting areas of weakness and offering targeted guidance and suggestions for improvement. Students should also be encouraged to develop personal improvement plans based on this feedback. In addition, schools should use the evaluation results to review and refine campus cultural initiatives and related activities. By aligning these cultural efforts more closely with students' actual development needs, institutions can build a more supportive environment for enhancing ICT teaching competencies.

7.3 Development of Incentive and Support Policies

The university should establish a series of incentive and support policies to encourage teacher education students to actively improve their ICT teaching competencies. A special scholarship program can be set up to reward students who

excel in ICT learning and teaching practice, motivating them to engage more in their studies. Financial support should also be provided for students participating in ICT-related practical projects and competitions, covering expenses such as equipment, software, and materials, ensuring the smooth implementation of these activities. In terms of curriculum design and credit recognition, priority should be given to courses and practical activities related to improving ICT teaching competencies. For example, increasing the credit weight of practical courses and recognizing credits or offering additional credits for students who participate in external ICT training or earn related certifications can encourage teacher education students to proactively enhance their ICT skills.

Limitations of the Study

This study was conducted with primary education major students at Weifang University, representing a specific and localized group of participants. These students may possess unique educational backgrounds, learning environments, and institutional experiences that differ from those of students at other universities. As such, the findings derived from this research may not be fully generalizable to broader populations, including students from different academic levels, fields of study, or institutions with different educational contexts.

Moreover, the study did not include qualitative data such as interviews with the student participants. As a result, it was not possible to explore their individual perspectives, motivations, or contextual experiences in depth. This limitation may have restricted the interpretation of some findings, particularly those related to the absence of significant differences in off-campus internship effects, where students' own voices could have provided valuable explanations and insights.

Recommendations for Further Studies

The following are some recommendations for further studies:

1. This study explored the ICT teaching competencies and their influencing factors among undergraduate primary education students at Weifang University. The participants represented a small and specific group from a single institution. It would be beneficial if future studies included a larger and more diverse sample of students from different universities or educational backgrounds to increase the generalizability of the findings.

2. In this study, ICT teaching competencies were assessed using a scale structured around three key dimensions: basic technological literacy, technology-supported learning, and technology-supported teaching. Future research could consider adopting alternative theoretical frameworks or employing different measurement models to validate or expand upon the current findings.

3. In this study, the influencing factors of ICT teaching competencies were measured using a scale that included seven dimensions: attitude, self-efficacy, facilities, courses, teacher support, practical opportunities, and school culture. Future research may explore the use of different factor structures or incorporate additional contextual variables to gain a more comprehensive understanding of the influences on ICT teaching competencies.

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APPENDIX

APPENDIX A

Questionnaire

QUESTIONNAIRES

Part I: Personal Data

Instruction: Please answer all the questions below by making a check mark (√)you're your answer or writing your answers in the space provided.

1. Gender:

☐ Male ☐ Female

2. Grade

☐ First year

☐ Second year

☐ Third year

☐ Fourth year

3. Academic performance ranking:

☐ Top 30%

☐ Middle 30%-70%

☐ Bottom 70%

4. Besides the internship opportunities provided by the university, do you have any other internship experiences?

☐ Yes ☐ No

Part II: Self-evaluation questionnaire on ICT teaching competencies

Instruction: Please answer all questions below by making a check mark (√) for each statement that closest to reflect with your ICT teaching competencies.

	Strongly Disagree	Disagree	Average	Agree	Strongly Agree
1. Basic Technological Literacy					
1.1 I know the importance of applying ICT in primary education.					
1.2 I will consciously use ICT tools to study anytime and anywhere.					
1.3 I am willing to share my application experience and new discoveries about ICT with others.					
1.4 I can skillfully operate the ICT tools in the classroom.					
1.5 I can solve common problems in the application of ICT tools.					
1.6 I am proficient in operating and frequently use general online learning platforms and software such as MOOC.					
1.7 I can consciously abide by the relevant information laws and regulations, use information resources correctly, and not illegally steal other people's information.					
1.8 I can impart healthy and progressive ICT concepts to students and cultivate their awareness of information security and norms.					

2. Technology-supported Learning					
2.1 I can actively use ICT tools to collect and organize valuable learning resources and enrich learning content					
2.2 I can use ICT tools to set learning goals and plans and improve the efficiency of independent learning.					
2.3 I can use ICT tools to record my learning outcomes, reflect on them, and adjust my learning methods and progress.					
2.4 I can use ICT tools to communicate and share with teachers and classmates.					
2.5 I can collaborate with others and conduct evaluations on learning tasks and problems in an information-based environment.					
2.6 I can think deeply about the viewpoints and problems in teaching, use the Internet to collect relevant resources, and conduct teaching research.					
2.7 I am good at using ICT tools to collect, process, analyze and summarize data.					
2.8 I have a strong sense of innovation and use information technology to creatively design posters, promotional videos, etc.					
3. Technology-supported Teaching					
3.1 Before teaching, I can obtain appropriate information resources according to the teaching content and preset situations.					
3.2 I can further analyze and evaluate the information resources obtained, and reasonably plan and manage teaching resources.					

3.3 I can use advanced technology to edit, integrate and innovate teaching resources to provide learners with personalized experience.					
3.4 I understand different information-based teaching models and know their usage scenarios and functions.					
3.5 I will choose the appropriate information-based teaching model according to the teaching content and situation and complete the design of teaching process and activities.					
3.6 When designing information-based teaching, I can consider the differences of learners and design diversified learning activities and guidance strategies.					
3.7 I can reasonably select, and design information-based teaching evaluation plans and tools based on student characteristics, learning goals, etc.					
3.8 I can fully understand the teaching implementation strategies, principles and methods of teaching intervention in the ICT-based teaching environment.					
3.9 In simulation or real teaching, I can reasonably and effectively integrate ICT throughout the entire teaching process.					
3.10 I can use ICT tools to collect, analyze, diagnose, and evaluate students' learning progress and performance.					
3.11 I can use ICT tools to record the strengths and weaknesses of my own teaching and others, and conduct analysis, reflection and summary.					

Part III The influencing factors of ICT teaching competencies

	Strongly Disagree	Disagree	Average	Agree	Strongly Agree
1. Attitude					
1.1 I am very interested in the use of ICT tools					
1.2 I believe that improving ICT teaching competence is an important reflection of being responsible for both my learning and future students.					
1.3 I believe that using ICT tools allows me to conduct teaching more effectively.					
1.4 I believe that future teachers will need to possess an increasing amount of ICT teaching competencies.					
1.5 I believe that teachers should continuously enhance their ICT skills to meet the demands of modern education.					
1.6 I believe that incorporating new ICT-based teaching models, such as flipped classrooms and blended teaching, to replace certain traditional teaching methods can lead to positive transformations.					
2. self-efficacy					
2.1 I am confident in exploring and using ICT tools which I have not used before.					
2.2 I am confident in using emerging ICT tools in teaching.					
2.3 Even if I encounter difficulties in applying ICT tools in teaching, I will solve these problems as soon as					

possible instead of giving up.					
2.4 I am confident that I can keep up with the latest developments in educational technology by using ICT tools.					
2.5 When facing difficulties in ICT teaching, I am able to actively seek solutions.					
2.6 I am confident in designing and implementing innovative teaching activities using ICT tools to enhance student learning outcomes.					
3. Facilities					
3.1 The university provides sufficient ICT teaching software facilities (such as campus network, communication and collaboration software).					
3.2 The university provides sufficient ICT teaching hardware facilities (such as electronic whiteboards, cognitive assessment system equipment).					
3.3 The ICT teaching facilities provided by the university can meet the needs of most teaching scenarios.					
3.4 The university regularly updates and maintains its ICT facilities to meet the needs of modern education.					
3.5 The university ensures me have access to up-to-date ICT resources.					
3.6 The university provides a wide range of ICT-based learning platforms (such as Learning Management Systems, E-learning Platforms).					
4. Courses					
4.1 The courses offered by the program to improve ICT teaching competencies are rich in content and					

can enhance my ICT teaching competencies.					
4.2 The class hours of the courses offered by the program to improve ICT teaching competencies meet my learning needs.					
4.3 The distribution of theory and practical hours in the courses offered by the program to improve ICT teaching competencies is reasonable.					
4.4 The courses offered by the program to improve ICT teaching competencies are up to date.					
4.5 The number of courses offered by the program to improve ICT teaching competencies meets my learning needs.					
4.6 The courses content offered by the program to improve ICT teaching competencies related to the use of ICT in teaching different subjects.					
5. Teacher Support					
5.1 The university frequently invites primary school teachers and experts to conduct lectures on ICT teaching competencies training.					
5.2 Multiple teachers collaborate to teach ICT-related courses, which can meet my ability development needs.					
5.3 Teachers possess highly professional and systematic ICT theoretical knowledge and a high level of ICT teaching competencies.					
5.4 Teachers frequently provide useful ICT teaching resources and information.					
5.5 Teachers place great emphasis on the cultivation of ICT teaching competencies, guiding me to actively					

participate and engage in teacher-student interaction.					
5.6 Teachers encourage and support students to experiment with and apply various ICT tools and teaching methods in real classroom settings.					
6. Practical Opportunites					
6.1 The university arranges sufficient off-campus teaching internships, during which I can improve my ICT teaching competencies.					
6.2 The university provides sufficient on-campus opportunities to practice ICT teaching competencies (e.g., micro-teaching or workshops).					
6.3 The university provides sufficient practical activities such as micro-teaching competitions and information technology contests.					
6.4 The university provides sufficient hands-on practice opportunities for using advanced ICT tools in real or simulated classrooms.					
6.5 The university provides sufficient opportunities for collaboration with other students in ICT-related teaching projects.					
6.6 The university provides sufficient opportunities for internships or collaborative projects with schools or educational organizations, allowing me to apply ICT teaching competencies in real-world settings.					
7. School Culture					
7.1 The university places great importance on the development of ICT teaching competencies.					
7.2 I am in a positive learning environment that promotes the enhancement of my ICT teaching					

competencies.					
7.3 The university or college provides relevant incentives for students, which motivates me to improve my ICT teaching competencies.					
7.4 The university uses clear and measurable indicators to assess the ICT teaching competencies of students.					
7.5 The university provides timely and effective feedback on the ICT teaching competencies of students.					
7.6 The university fosters a culture of continuous improvement in ICT teaching competencies by encouraging teachers and students to share best practices and innovative teaching strategies.					

APPENDIX B

Semi-structed Interview Outline

Semi-structed Interview Outline

Interview Time:

Interview Method:

Questions:

1. How do you evaluate the overall level of ICT teaching ability of primary education students at Weifang University?

2. What are the main factors that significantly contribute to enhancing the ICT teaching competencies of undergraduate primary education students?

3. In terms of attitudes, what suggestions do you have for improving ICT teaching competencies of undergraduate primary education students?

4. In terms of self-efficacy, what suggestions do you have for improving ICT teaching competencies of undergraduate primary education students?

5. In terms of facilities, what suggestions do you have for improving ICT teaching competencies of undergraduate primary education students?

6. In terms of courses, what suggestions do you have for improving ICT teaching competencies of undergraduate primary education students?

7. In terms of teacher support, what suggestions do you have for improving ICT teaching competencies of undergraduate primary education students?

8. In terms of practice opportunities, what suggestions do you have for improving ICT teaching competencies of undergraduate primary education students?

9. In terms of school culture, what suggestions do you have for improving ICT teaching competencies of undergraduate primary education students?

APPENDIX C

IOC Rating of Questionnaire

IOC Ratings of Questionnaire

(The Ratings of Each Item by the Three Specialists)

Items No.	Expert 1 Rating	Expert 2 Rating	Expert 3 Rating	Total	IOC	Remarks
1	1	1	1	3	1	Accepted
2	1	1	1	3	1	Accepted
3	1	1	1	3	1	Accepted
4	1	1	1	3	1	Accepted
5	1	1	1	3	1	Accepted
6	1	1	1	3	1	Accepted
7	1	1	1	3	1	Accepted
8	1	1	1	3	1	Accepted
9	1	1	1	3	1	Accepted
10	1	1	1	3	1	Accepted
11	1	1	1	3	1	Accepted
12	1	1	1	3	1	Accepted
13	1	1	1	3	1	Accepted
14	1	1	1	3	1	Accepted
15	1	1	1	3	1	Accepted
16	0	1	1	2	0.67	Accepted
17	1	1	1	3	1	Accepted
18	1	1	1	3	1	Accepted
19	1	1	1	3	1	Accepted
20	1	1	1	3	1	Accepted
21	1	1	1	3	1	Accepted
22	1	1	1	3	1	Accepted
23	1	1	1	3	1	Accepted
24	1	1	1	3	1	Accepted

(continued)

Items No.	Expert 1 Rating	Expert 2 Rating	Expert 3 Rating	Total	IOC	Remarks
25	1	1	1	3	1	Accepted
26	1	1	1	3	1	Accepted
27	1	1	1	3	1	Accepted
28	1	1	1	3	1	Accepted
29	1	1	1	3	1	Accepted
30	1	1	1	3	1	Accepted
31	1	1	1	3	1	Accepted
32	1	1	1	3	1	Accepted
33	1	1	1	3	1	Accepted
34	1	1	1	3	1	Accepted
35	1	1	1	3	1	Accepted
36	1	1	1	3	1	Accepted
37	1	1	1	3	1	Accepted
38	1	1	1	3	1	Accepted
39	1	1	1	3	1	Accepted
40	1	1	1	3	1	Accepted
41	1	1	1	3	1	Accepted
42	1	1	1	3	1	Accepted
43	1	1	1	3	1	Accepted
44	1	1	1	3	1	Accepted
45	1	1	1	3	1	Accepted
46	1	1	1	3	1	Accepted
47	1	1	1	3	1	Accepted
48	1	1	1	3	1	Accepted
49	1	1	1	3	1	Accepted
						Accepted

(continued)

Items No.	Expert 1 Rating	Expert 2 Rating	Expert 3 Rating	Total	IOC	Remarks
50	1	1	1	3	1	Accepted
51	1	1	1	3	1	Accepted
52	1	1	1	3	1	Accepted
53	1	1	1	3	1	Accepted
54	1	1	1	3	1	Accepted
55	1	1	1	3	1	Accepted
56	1	1	1	3	1	Accepted
57	1	1	1	3	1	Accepted
58	1	1	1	3	1	Accepted
59	1	1	1	3	1	Accepted
60	1	1	1	3	1	Accepted
61	1	1	1	3	1	Accepted
62	1	1	1	3	1	Accepted
63	1	1	1	3	1	Accepted
64	1	1	1	3	1	Accepted
65	1	1	1	3	1	Accepted
66	1	1	1	3	1	Accepted
67	1	1	1	3	1	Accepted
68	1	1	1	3	1	Accepted
69	1	1	1	3	1	Accepted
70	1	1	1	3	1	Accepted
71	1	1	1	3	1	Accepted
72	1	1	1	3	1	Accepted
73	1	1	1	3	1	Accepted
74	1	1	1	3	1	Accepted

(continued)

Items No.	Expert 1 Rating	Expert 2 Rating	Expert 3 Rating	Total	IOC	Remarks
75	1	1	1	3	1	Accepted
76	1	1	1	3	1	Accepted
77	1	1	1	3	1	Accepted
78	1	1	1	3	1	Accepted
79	1	1	1	3	1	Accepted
Average	0.996					

VITA