EFFICIENCY IN ONLINE TEACHING AND LEARNING IN VOCATIONAL EDUCATION COMPUTER PROGRAMMING STRATEGY

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ABSTRACT

The objectives of this research were: 1) To study the current situation problems of online teaching and learning in vocational education computer programming, 2) To develop the efficiency in online teaching and learning in vocational education computer programming strategy, 3) To implement and readjustment the efficiency in online teaching and learning in vocational education computer programming strategy. The sample were 21 experts with qualified Delphi Method requirements and 9 experts with qualified Focus Group method from high vocational colleges in Guangxi, as well as 60 computer program students in the second year of study. Research instruments include: 1) Open-Ended Interview Form, 2) Likert Scale Questionnaire, 3) Focus Group. Data analysis by using Median, Mode, Inter-Quartile Range, Percentage, and Frequency, Qualitative Analysis and Descriptive Analysis.

The results were found that:

1. Online teaching and learning in vocational education computer programming in aspects were at a medium-high level.

2. The efficiency in online teaching and learning in vocational education computer programming strategy include 9 aspects: 1) Teachers' Informatization Teaching Ability, 2) Students' Autonomous Learning Ability, 3) Online Teaching and Learning Interaction, 4) Course Content, 5) Teaching Resource, 6) Teaching Design, 7) Learning Engagement, 8) School Policy Support, 9) Online Teaching and Learning

Platform. The research results summarized 80 strategies and suggestions for online teaching and learning in vocational education computer programming.

3. After implementing and readjustment the strategies, the efficiency of online classes was comparable to that of traditional classes.

Keywords: Education Strategies, Online Teaching and Learning, Vocational Education Computer Programming, Delphi Method, Focus Group

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Introduction

Rationale

Online teaching evolved from 20th-century distance education. In the 1970s and 1980s, institutions started using computer networks for educational exchange. The Internet's emergence in the 1990s led to online platforms, enabling real-time teacher-student interaction. Today, more adopt online teaching for flexibility and efficiency.

China's Ministry of Education issued the “Action Plan for Quality Vocational Education. (2020-2023),” focusing on merging IT with education. The goal is better talent training through tech-driven curriculum, transforming teaching with tools like network learning spaces, data analysis, and digital resources. It promotes info-based methods like remote collaboration and flipped classrooms for interactive skill development.

Vocational education is in the midst of a transformative shift, with online teaching emerging as an unavoidable trend. In Guangxi, certain colleges have proactively embraced online instruction, yielding promising outcomes in enhancing educators' tech proficiency and establishing robust e-learning platforms. Computer programming courses require students to have a high degree of abstract thinking and practical skills; however, higher vocational students are usually relatively weak in these areas, while their self-learning ability, self-discipline, and endurance also need to be improved. Therefore, the problems facing computer programming teaching in vocational education lie in how to integrate online education, how to design courses to meet the characteristics and needs of higher vocational students, and how to stimulate students' interest and improve their learning outcomes. Solving these problems requires innovative online teaching and learning strategy to adapt to the changing educational environment.

Based on the above, I decided to carry out the “Efficiency in Online Teaching and Learning in Vocational Education Computer Programming Strategy”. This study will employ contemporary educational technology and online education theories to assess

the present state of online instruction through surveys, interviews, and statistical analyses. Subsequently, I will formulate practical strategy for advancing online teaching in vocational education computer programming in Guangxi, evaluating their viability. The research aims to offer valuable insights for the digital transformation of higher vocational institutions and the progression of online pedagogy in this educational domain.

Research Questions

How to develop the efficiency in online teaching and learning in vocational education computer programming strategy?

Objectives

1. To study the current situation problems of online teaching and learning in vocational education computer programming.

2. To develop the efficiency in online teaching and learning in vocational education computer programming strategy.

3. To implement and readjustment the efficiency in online teaching and learning in vocational education computer programming strategy.

Scope of the Research

Population

21 experts with qualified Delphi requirements and 9 experts with qualified Focus Group method from high vocational colleges in Guangxi, as well as 60 computer program students in the second year of study.

The Variable

According to the analysis of relevant concepts, theories and research, the factors of efficiency in online teaching and learning in vocational education computer programming strategy are as follows:

1. Teachers' informatization teaching ability

2. Students' autonomous learning ability

3. Online teaching and learning interaction

4. Course Content

5. Teaching Resource

6. Teaching Design

7. Learning Engagement

8. School Policy Support

9. Online Teaching and Learning Platform

10.Efficiency in online teaching and learning in vocational education computer programming strategy.

Advantages

1. To use establish the college's leading position in the field of educational information, and provide other colleges with advanced experience and successful cases that can be used for reference.

2. To provide strategies for online teaching and learning in vocational education computer programming with improve the quality of teaching and promote online education.

3. To provide strategies for online teaching and learning in vocational education computer programming adapted to the local region, and to promote the development of online education in Guangxi.

Definition of Terms

1. Online teaching refers to the process of education and learning through the Internet and related technologies. Teachers utilize the Internet to deliver educational content, interact with students, and assess their learning outcomes. Online teaching leverages multimedia resources, real-time or asynchronous communication, and online assessment methods to create a flexible and convenient learning environment.

2. Online learning refers to the process of acquiring knowledge and skills through an online platform using the Internet and related technologies. Learners have access to educational resources, participate in courses, engage with teachers and peers, and evaluate their progress, all through the Internet. The various forms of online

learning encompass real-time virtual classrooms, self-paced course modules, video-based instruction, online discussions, and assignment submission.

3. Teachers' informatization teaching ability refers to the ability of teachers in the context of online education to efficiently use information technology and online educational tools. This includes mastering and utilizing online teaching resources, interactive teaching platforms, and virtual classrooms. It also encompasses teachers' online communication skills, such as how they engage with students through online discussions, real-time chat, video conferencing, and email. Teachers' informatization teaching ability also includes how they design online courses to cater to the needs of computer programming students and provide timely feedback and guidance to support student learning.

4. Students' autonomous learning ability refers to students in the context of online teaching and learning in vocational education computer programming must possess a high degree of autonomous learning ability. This includes how students independently set learning goals, create study plans, manage their study time, and actively engage in online discussions, independent problem-solving, and self-assessment of their learning progress. Students need to be self-motivated, disciplined, and capable of self-management to ensure efficient learning. Furthermore, they need to actively participate in projects, experiments, and programming tasks to develop programming skills and problem-solving abilities. Autonomous learning ability also encompasses how students proactively seek out online learning resources, engage in peer collaboration and interaction, and communicate efficiently with teachers

5. Online teaching and learning interaction refers to various forms of online teaching and learning interaction in vocational education computer programming. This includes real-time interaction between teachers and students, such as online lectures, Q&A sessions, discussions, and video conferences. It also includes asynchronous interactions, where students engage with one another in online discussions, collaborate on projects, and communicate via email. It also involves the interaction between students and the course content, such as through multimedia resources, online quizzes, and programming tasks. Online teaching and learning interactions promote collaboration, critical thinking, and independent learning skills among

students. Teachers play a role in providing timely guidance, feedback, and support to ensure active student engagement and learning.

6. Course content refers to the content and materials of online courses in high vocational education computer programming. The course content must align with the learning objectives in computer programming, covering topics such as programming languages, algorithms, data structures, software engineering principles, and practical projects. These contents should be up-to-date, practical, reflecting the latest developments and demands in the field of computer programming. The course content should provide diverse learning resources, including textbooks, multimedia resources, programming examples, case studies, and practical programming projects.

7. Teaching resource refers to crucial for students to master programming skills in vocational education computer programming. Teaching resources include textbooks, multimedia resources, programming environments, online laboratories, reference materials, case studies, and project templates. These resources should support students' learning, helping them practice and apply their programming knowledge in practical tasks.

8. Teaching design refers to the design of online teaching and learning course in vocational education computer programming. This includes course structure, learning activities, assessment methods, and learning pathways. Teaching design should be diverse to meet the different learning needs and styles of students. It should encourage active participation, deep learning, and practical programming practice. This may include project-based learning, team collaboration, programming challenges, problem-solving tasks, and programming experiments. Additionally, teaching design should consider student feedback and assessment to provide targeted guidance and support, helping students achieve success.

9. Learning engagement refers to the amount of time and effort students must invest in online teaching and learning in vocational education computer programming. Students need to manage their study time efficiently, ensuring they can grasp programming skills. Learning Engagement includes solving programming problems, completing programming tasks, independent study, and participation in

programming projects. Students need to manage their study time efficiently to make the most of online educational resources and tools.

10. School policy support refers to the policies and resource support provided by schools or educational institutions to promote the development of online teaching and learning in vocational education computer programming. This includes resource allocation, such as providing sufficient technology equipment and online education tools to support teaching and learning. Furthermore, school policies should encourage teacher participation in online education training and development to enhance their informatization teaching abilities. Policies should also support the safety and privacy of online learning, ensuring a secure and reliable online learning environment for students and teachers.

11. Online teaching and learning platform refers to the educational platform used for the implementation of online teaching and learning in vocational education computer programming. These platforms include online learning management systems, integrated development environments for programming, collaboration tools, and more. Online teaching and learning platforms should be user-friendly, offer technical support, maintain stability, provide a variety of online educational tools and functionalities, and meet the specific needs of computer programming. These platforms must protect the data and privacy of both students and teachers, ensuring easy access to online programming courses and materials, and delivering a seamless user experience.

12. Vocational education refers to a part of higher education and offers training for specific occupational fields. Its goal is to equip students with practical skills for the job market. It combines theory and practice to prepare students for specific roles and responsibilities. Key features include career orientation, practical teaching, mentoring, accreditation, and ongoing professional development. Students gain skills and knowledge needed for their chosen field, improving their employability.

13. Computer programming refers to Higher vocational computer programming courses, in higher vocational computer majors, is an important part of the computer knowledge structure system. This kind of course is not only the basis for

learning other computer courses, but also a carrier for cultivating students' computer programming way of thinking.

14. Teaching and learning Strategy refers to the methods, tools, and techniques used by teachers to achieve instructional goals and promote student learning. It includes goal setting, method selection, resource design, and personalized learning support. Feedback and assessment aid progress understanding and guide improvement. Strategies showcase teachers' wisdom and experience for efficient teaching and learning.

15. Delphi method refers to rely on Experts answer a series of questions by filling out a questionnaire. After three rounds of questionnaires and feedback, a consensus view can be developed. The main advantage of this method is that the experts can capitalize on their knowledge and experience, while at the same time being independent and avoiding the group pressures that can arise from face-to-face group interactions.

16. Focus Group refers to a structured discussion to gather information and opinions about the topic of this study. This method is usually guided by a researcher who directs the focus group members to share their views and experiences by asking questions and leading the discussion. The focus group method is a common tool for understanding needs, evaluating models, or gaining insight into a problem.

Research Framework

The research framework is based on Community of Inquiry. (Garrison et al., 2000), which integrates the definitions and suggestions of online teaching strategies put forward by many experts and scholars, as shown in the following figure:

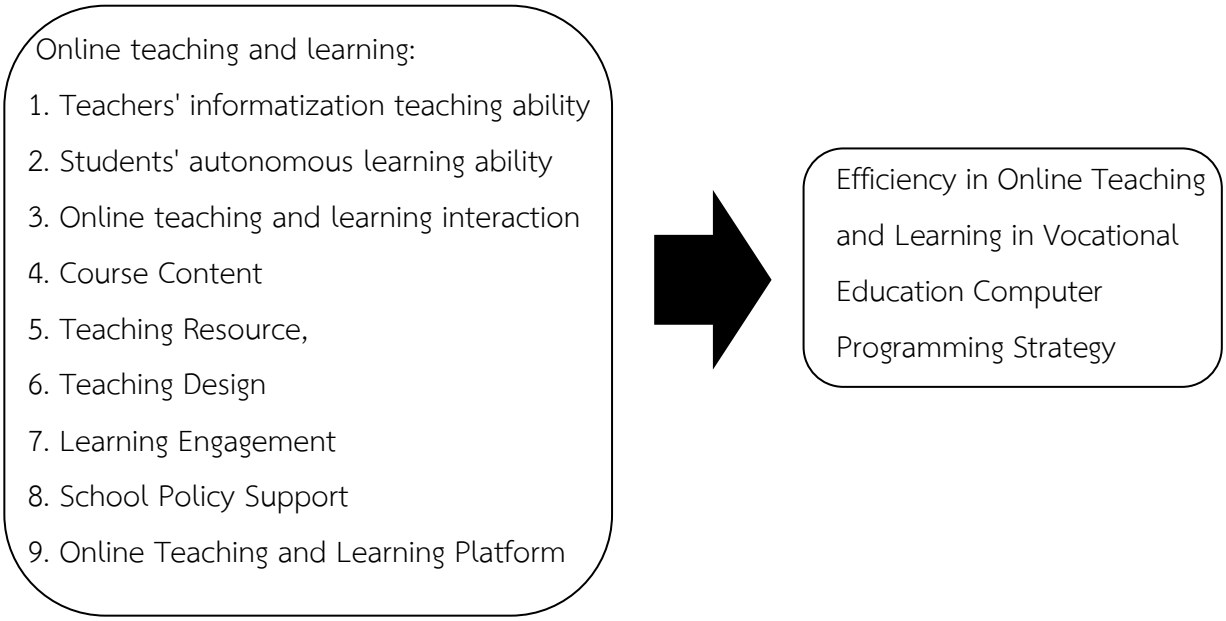

Figure 1.1 Research Framework

Chapter 2

Literature Review

This chapter will focus on the research questions raised in Chapter 1 and summarize the main theoretical basis and relevant researchers involved in this research, and clarify the relationship between this research and the theoretical inheritance, improvement and expansion of existing achievements. In order to explore the theoretical basis of online teaching and learning in vocational education computer programming, this chapter sets out the theories as follow:

1. Theoretical Framework
2. Current situation of online teaching and learning
3. Concept of online teaching and learning
4. Concept of efficiency in online teaching and learning
5. Context of vocational education in Guangxi
6. Delphi Method
7. Focus Group
8. Related research

The detail are as follows:

Theoretical Framework

Community of Inquiry (CoI) is a theoretical framework developed by educational philosophers and researchers, notably by Garrison et al. (2000), Swan et al. (2009), Anderson et al. (2001), to understand and facilitate deep and meaningful learning in online and technology-mediated educational environments. The CoI model proposes that when the three interdependent elements of social presence, teaching presence, and cognitive presence work in tandem efficient learning occurs. Figure2.1 is an adaptation of Garrison et al.'s (2000) model illustrating the interdependence among the three essential elements in a community of inquiry.

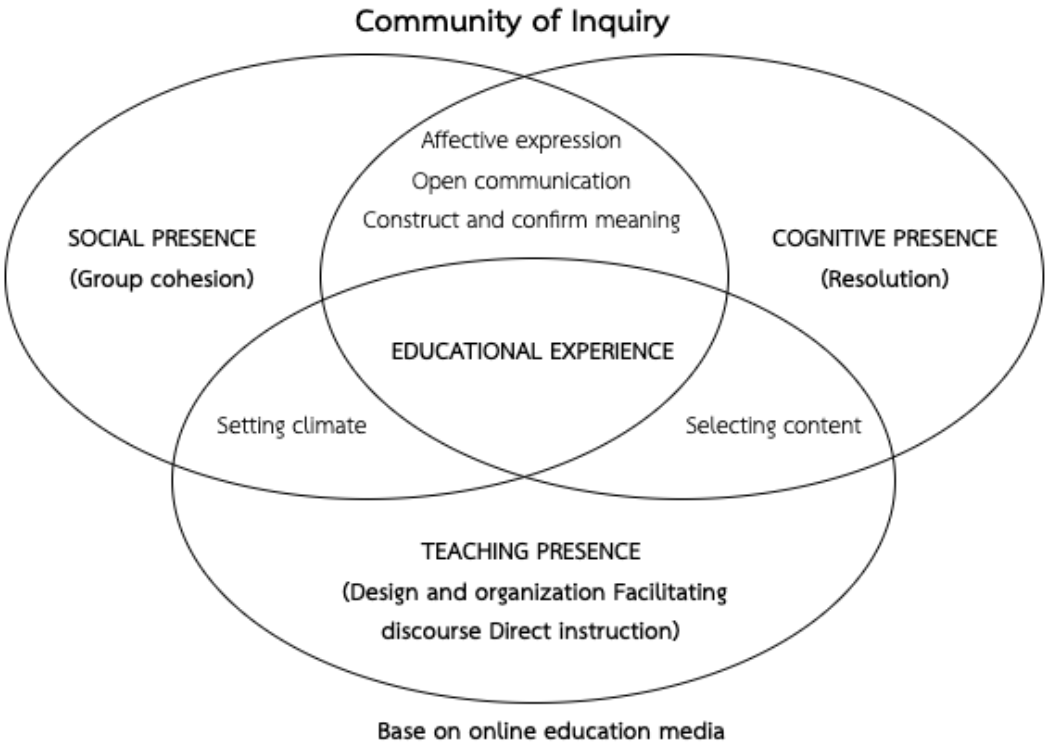

Figure 2.1 Elements of an Online Educational Experience. (Adapted from Garrison et al., 2000)

Social Presence refers to the learner's ability to demonstrate personal characteristics, emotions, and identity in an e-learning environment, thereby building a sense of community and mutual trust. (Anderson et al., 2001) Social presence encourages open communication, collaboration and mutual support so that learners feel connected and valued. It humanizes the online space and promotes a sense of belonging. (Garrison et al., 2000).

Teaching presence encompasses the design, direction and management of the educational experience. This covers course organization, setting learning objectives, managing the learning process, and providing feedback. An efficient pedagogical presence ensures that learners are guided through the learning journey, questions are answered, and learning remains on track toward the desired goals. Swan et al. (2009).

Cognitive presence concerned with the process of constructing meaning and knowledge through reflective thinking, inquiry and discussion. It involves how learners interact with content, ask questions, explore ideas, challenge assumptions and co-

construct new knowledge. Cognitive presence is critical for promoting deep learning, critical thinking, and problem-solving skills. Anderson et al. (2001).

The Community Inquiry Model emphasizes that these three aspects of presence are not isolated, but dynamically interact with each other to create a rich learning environment. (Garrison et al., 2000). When all three presences are efficiently established and maintained, they form a supportive ecosystem that promotes active participation, critical reflection, and deep understanding among learners. Swan et al. (2009). Anderson et al. (2001). The framework has been widely used in the design, implementation, and evaluation of online and blended learning environments because it provides a comprehensive approach to understanding and enhancing the quality of educational experiences beyond traditional classroom settings, and how the presences helped improve online teaching and learning in vocational education computer programming.

Current situation of online teaching and learning

Definition and characteristics of online education

Online education, or “e-learning” or “e-learning”, is a “fifth generation” form of distance education (Taylor, 2001). Driven by modern web-based technologies and rich online resources (applications such as audio-video streaming, learning management systems, three-dimensional simulation visuals, and multiplayer online games) and emerging collaborative communication technologies (e.g., Voice over Internet Protocol (VoIP), instant messaging, screen-sharing, and graphic-sharing whiteboards), today's online learning scenario is a far cry from the previous distance education scenario, which relied on televised and rudimentary videoconferencing.

There have long been conflicting definitions of online education, and a universally accepted definition has yet to be agreed upon. It is important to note that distance education is a broader concept that encompasses all teaching and learning situations where educators and learners are geographically separated and incorporate a variety of technological tools and approaches. Understanding online education as “a specific branch within distance education, which is related but not equivalent” and defining it broadly as “the use of the Internet by learners to interact with content and

others for learning purposes, which may be an integral part of a course or educational program", is a perspective that is not unanimous. "Such a perspective highlights the role of the Internet as the central medium in online learning interactions.

The term "online teaching" used in this study is a general term that refers to teaching and learning that occurs when students are physically separated from teachers but through the use of computers, networks or Internet connections.

Scholars in China have meticulously examined the essence and attributes of online pedagogy, highlighting its function in bridging geographical and temporal gaps via digital platforms. This framework fosters learner autonomy indirectly by supplementing organized teaching efforts, giving rise to a dynamic, bidirectional flow of educational exchange in the digital sphere. (Ding, 2000) Capitalizing on the advancements of the internet, this learning paradigm introduces an innovative, learner-centric methodology that aligns with the progressive trajectory of education. (Yun, 2011) Departing from the norms of traditional classroom settings, online education, through its unique asynchronous communication, grants students the flexibility to tailor their learning paths and pursue specific areas of interest, thereby markedly boosting learning productivity. (Xu, 2014)

When juxtaposed with traditional pedagogy, online education stands out not solely due to its embrace of cutting-edge internet technology, but also through its emphasis on intensified teacher-student collaboration and the cultivation of self-directed learning abilities. (Guo, 2016) Practically, this translates to instructors integrating mobile devices and web technologies—such as live lectures and video conferencing—into their repertoire, enabling learners to promptly seek guidance on academic hurdles, fostering a vibrant two-way dialogue. Moreover, the meteoric advancements in internet technology empower learners with ubiquitous access to learning materials, positioning them as the drivers of their educational journey and thereby augmenting their intrinsic motivation to learn. (Guo, 2016) In essence, online teaching pivots around the learner, underscoring the imperative for educators to embrace novel instructional paradigms and recalibrate their roles to efficiently champion a learner-centric educational agenda. (Liu, 2016)

Current problems of online teaching and learning

At the present stage, colleges and universities in China regard classroom teaching as the main training object, do not pay enough attention to online teaching, and lack of complete organization and management, which makes the quality of online teaching decline. (Weng, 2012) Some teachers are not familiar with the actual operation of online teaching, information technology literacy is low, and online teaching courseware still uses the traditional teaching section, the teaching content is single, can not meet the needs of modern students for high-quality knowledge. (Lv, 2015) At the same time, in reality, there is a very fierce competition between colleges and universities, their teaching resources are not shared, and they need to spend a certain price to buy audio-visual rights, resulting in a lot of waste of educational resources. (Li, 2016) Although the development of new media technology can promote online teaching to a certain extent, the overall teaching resources, teaching planning and teaching quality still need to be improved. (Li, 2017).

The emergence of radio and television in the 20th century and the development of distance education activities have changed the teaching mode of traditional education, broke through the shackles of time and space, and promoted the popularization of education. At present, it is an era of global intelligent interconnection, full of variability, uncertainty, complexity and fuzziness. The rapid development of Internet technology has set off a subversive digital revolution and pushed mankind into the “online” society. Big data, cloud computing, artificial intelligence, blockchain, VR and other emerging technologies promote ubiquitous learning, distance learning and virtual collaborative learning from ideal to reality. The sudden outbreak of COVID-19 in early 2020 has promoted online education to become the new focus and new normal of national concern, social concern and people's concern. According to the 45th Statistical report on the Development of the Internet in China, as of May 8, 2020, network teaching has been carried out in 1454 colleges and universities across the country. 1.03 million teachers offered 1.07 million online courses, a total of 12.26 million courses; a total of 17.75 million college students participated in online learning, a total of 2.3 billion person-times.

Over the past two decades, the number of colleges and universities offering online courses has increased dramatically, and the growth rate of online education enrollment far exceeds that of higher education as a whole. At present, most Chinese higher education institutions offer online courses or programs to provide millions of students with access to higher education, otherwise they may be rejected because of time, geography or other restrictions. Web-based technology has significantly changed the teaching and learning environment. Today, millions of students are taking online courses, which fully proves that this approach is meeting the clear needs of students. Proponents of online learning believe that compared with the traditional face-to-face teaching, it can efficiently eliminate time, distance and other obstacles, while providing more convenience, flexibility, rich materials, customized learning and feedback.

In conclusion, to a certain extent, scholars in China and abroad have expounded the definition, characteristics, development and current situation and problems of online teaching and learning, which deepens the research on online teaching and learning. However, strategies of online teaching and learning is a complex and dynamic system, and there is still a lot of research space on how to integrate into higher education. At present, there is almost no complete set of efficiency in online teaching and learning in vocational education computer programming strategy in China. Therefore, it is urgent to construct feasible efficiency in online teaching and learning in vocational education computer programming strategy in China.

Concept of online teaching and learning

Based on the Internet and modern technology, the online teaching concept aims to provide a flexible, personalized and high-quality educational experience. It synthesizes various educational theories and principles such as constructivist learning theory, social cognitive theory, individualized learning theory, cognitive load theory, and autonomous learning theory. Through the virtual learning environment and flexible learning methods, students can choose courses according to their own needs and interests, independently formulate study plans, and jointly build knowledge through interaction and cooperation. Personalized learning, interactive cooperation, and lifelong learning concepts promote the development of students' deep learning, autonomous learning ability and social communication ability. The theoretical support and guidance of online teaching provides a basis for online education design and practice, provides students with more flexible, autonomous, and diverse learning opportunities, and promotes educational innovation and progress.

Online teaching and learning expand the boundaries of the education market, breaks geographical and time constraints through Internet technology, enables educational resources to be disseminated and shared more widely, promotes the expansion and diversification of the education market, and promotes the transformation and innovation of traditional educational institutions. Traditional schools and training institutions have gradually introduced the online education model. By building online learning platforms and providing online courses, the scope of educational services has been expanded, more flexible and personalized learning methods have been provided, and teaching effects have been improved. Educators can provide more diverse teaching resources and learning content according to the needs and interests of students. At the same time, through the analysis of learning data and the personalized recommendation system, it can tailor the learning path for students, provide personalized learning support, and meet the individual differences and learning needs of students. Teachers are not only the imparters of knowledge, but also the instructors of students' learning, the screeners of learning resources and the supervisors of the learning process. Teachers need to have online teaching skills, be proficient in using educational technology tools, and better interact and cooperate

with students. Online teaching and learning have driven the development and adoption of educational technology. In order to meet the needs of online learning, educational technology continues to innovate, and various online learning platforms, teaching tools and learning applications have emerged. This promotes the prosperity of the education technology industry and provides impetus for the innovation and development of the education industry.

Different scholars have different understandings of the influencing factors of online teaching and learning. Through the review and analysis of relevant literature, the researchers found that the research content mainly has the following points of view:

Wang et al. (2020) proposed that the potential factors affecting the development of online education, including the guarantee and supply of online education, the literacy and abilities of teachers and students, the service level and quality of educational informatization enterprises, and family-school co-education.

Xiang et al. (2021) proposed that students' autonomous learning abilities, online teaching interactions between teachers and students, teachers' proficiency in online teaching, and teaching content arrangements, which have positive impacts on satisfaction.

Zhu et al. (2022) proposed that online teaching are students' learning motivation and willpower, online learning environment, and resources on online learning platforms. They also proposed strategies to improve the quality of online teaching in colleges and universities.

Fang (2018) proposed that four aspects including the intensity of school support for online courses, the completeness of online learning management platforms, learners' basic learning skills, and teachers' instructional design. They explored the factors affecting online learning engagement and finally summarized relevant strategies to enhance learners' engagement.

Cheng (2018) proposed that the key factors affecting satisfaction with online open course learning are students' overall expectations throughout the entire online open course learning process, perceived quality. (from three measurement indicators of teaching content, teaching design, and teaching competence), perceived value.

(usefulness of learned knowledge, improvement of learning abilities, and value of time and effort devoted as three measurement indicators), and teaching interaction. (student-student interaction, teacher-student interaction, and platform interaction as three indicators).

Yang (2019) proposed that the quality of teaching video resources, teaching design and evaluation, well-established informatized learning platforms, students' autonomous learning abilities, and teachers' classroom organization abilities. They provided suggestions on enhancing students' autonomous learning abilities, providing policy and hardware support from schools, and strengthening teachers' and students' information literacy.

Liu (2020) proposed that students' autonomy has become a key factor affecting teaching quality and results. Giving full play to students' learning initiative will comprehensively improve the teaching efficiency and quality of blended teaching.

Zhou et al. (2020) proposed that the key factors affecting undergraduates' learning engagement are the level of online learning engagement, length of extra online time beyond study, network quality during online learning, fondness for online teaching and face-to-face classroom teaching, physical discomfort. (e.g. dry eyes, dizziness, neck and shoulder pain) during online learning, positive coping methods, and professional identity.

Liu (2020) proposed that the influencing factors of online teaching satisfaction in descending order are: richness of network learning resources, teachers' online teaching skills, and students' abilities to use networks for self-study and office work.

Gong et al. (2020) proposed that the low efficiency of online teaching may be related to the influence of other factors around students during online course learning, insufficient home study time, and network congestion. They believed the key factor affecting teaching efficiency was that “online teaching cannot achieve full concentration”.

Qiao (2023) proposed that students' satisfaction with online teaching is greatly affected by factors such as students' autonomous learning abilities, teachers' teaching abilities, software services, and external constraints. They provided specific

construction ideas on aspects like improving students' autonomous learning efficacy, optimizing teaching, and improving online platform services.

Liu et al. (2022) proposed that the top 3 factors are network conditions, students' awareness and self-discipline of autonomous learning, and frequency of teacher-student and student-student interactions.

Wang et al. (2022) proposed that teachers' informatized teaching abilities, choices of different teaching platforms, and students' online learning behaviors are all key factors affecting the effects of online English learning.

Huang (2022) proposed that the influencing factors of online teaching communication effects are teachers' informatized teaching abilities, online teaching platforms, online teaching content, and students' online autonomous learning abilities.

He (2022) proposed that 6 influencing factors including teaching resources, classroom teaching, teacher-student interaction, learning motivation, self-efficacy, and environmental support positively affect the satisfaction of online calligraphy teaching. They provided improvement suggestions from these 6 perspectives.

Wang (2022) proposed that influencing factors of university students' online learning. Regression analysis based on the OLS model showed that internal factors like difficulties in adapting to online courses and lack of interaction in online courses have much greater impacts than external factors like online learning environment. He believed improving university teachers' online teaching abilities and students' online autonomous learning abilities are efficient ways to address internal factors.

Zhang (2022) proposed that teacher professionalism, teacher-student interaction, and investment in online learning platforms are fundamental guarantees of online learning quality in vocational colleges. Combined with the characteristics of vocational colleges, solutions should be proposed to address factors affecting students' online learning engagement.

Table 2.1 Literature on the factors influencing online teaching and learning

Scholar	Factors of online teaching and learning								
	Teachers' Informatization Teaching Ability	Students' Autonomous Learning Ability	Online Teaching and Learning Interaction	Course Content	Teaching Resource	Teaching Design	Learning Engagement	School Policy Support	Online Teaching and Learning Platform
Wang et al. (2020)	√	√						√	√
Xiang et al. (2021)	√	√	√	√					
Zhu et al. (2022)		√			√				√
Fang (2018)		√				√		√	√
Cheng (2018)	√	√	√	√		√	√		√
Yang (2019)	√	√			√	√		√	√
Liu (2020)		√							
Zhou et al. (2020)		√	√				√		√
Liu (2020)	√	√			√				
Gong et al. (2020)			√				√		
Qiao (2023)	√	√							√
Liu et al. (2022)		√	√						√
Wang et al. (2022)	√	√							√
Huang (2022)	√	√		√					√
He (2022)		√	√	√	√			√	
Wang (2022)	√	√							
Zhang (2022)	√		√					√	
Total	10	15	7	4	4	3	3	5	10

According to Table 2.1, Account the features of online teaching and learning in vocational education computer programming, Base on Community of Inquiry. (Garrison et al., 2000) the researcher considered the above 9 features as the framework for this study, including:

1. Teachers' Informatization Teaching Ability
2. Students' Autonomous Learning Ability
3. Online Teaching and Learning Interaction
4. Course Content
5. Teaching Resource
6. Teaching Design
7. Learning Engagement
8. School Policy Support
9. Online Teaching and Learning Platform

These factors will form the core framework of the study to help researcher gain a deeper understanding of the current situation problems and challenges of online teaching and learning in vocational education computer programming, and develop relevant strategies and solutions.

Teachers' informatization teaching ability

Zhang et al. (2022) proposed that teachers' informatization teaching ability means encompass three key facets: online teaching identity, online teaching awareness and norms, and online teaching design and implementation prowess. They established a comprehensive index system for evaluating such ability in the context of online teaching. By employing descriptive statistics and conducting a comparative analysis of questionnaire responses, it becomes evident that college educators exhibit a commendable level of online teaching competence, thereby efficiently meeting the demands of the present online teaching landscape.

Jin (2021) proposed that teachers' informatization teaching ability means the capacity to efficiently integrate technology into pedagogical practices. The author analyzed factors influencing this ability and presented strategies for its enhancement across four dimensions: enhancing the evaluation and incentive structure, cultivating

an environment conducive to technology-driven education, implementing tiered training protocols, and fostering a collaborative learning community. These insights offer valuable guidance for the advancement and reformation of technology-infused teaching within higher vocational institutions.

Yue (2021) proposed that teachers' informatization teaching ability means enhancing awareness and reshaping concepts through deep introspection. They suggested that college educators should seamlessly integrate knowledge, skills, and methods into their daily instructional practices. Additionally, they emphasized the significance of actively engaging in research at the intersection of information technology and subject-based teaching, fostering a symbiotic relationship between pedagogical exploration and scholarly investigation. The authors underscored the vital role that both teachers and higher education institutions play in advancing this competence. To facilitate the growth of college teachers' informatization teaching ability, institutions should establish a comprehensive system of rewards and consequences, implement efficient faculty development programs, and provide robust technical support services, all contributing to the sustained evolution of educators' information-driven pedagogical prowess.

Wang (2021) proposed that teachers' informatization teaching ability means encompass enhancing teachers' awareness and commitment to information-based teaching, augmenting teachers' expertise and proficiency in information-based teaching, refining teachers' capacity for designing and developing information-based teaching materials, enhancing teachers' approaches to implementing and evaluating information-based teaching, and fostering teachers' inclination for reflective practices and innovative techniques in information-based teaching.

Zeng (2021) proposed that teachers' informatization teaching ability means encompass six key dimensions, as follows: information-based teaching resource integration ability, teaching design ability, teaching implementation ability, teaching research ability, teaching evaluation and diagnosis ability, and teaching service awareness.

Su (2021) proposed that teachers' informatization teaching ability means encompass the cultivation of subjectivity and role identity awareness, the

enhancement of information technology knowledge awareness, the promotion of collaborative innovation in information technology education, the optimization of the information resource environment, the construction of an information-based teaching platform, and the establishment of a teacher development incentive and evaluation system. These elements, including technology perception ability, internal motivation, technology and task adaptation, convenience conditions, enabling conditions, and social influence, collectively contribute to the positive transformation of college teachers' information-based teaching proficiency.

Xu (2021) proposed that teachers' informatization teaching ability means encompass enhancing their capacity in information-based teaching design, implementation, and evaluation. Drawing from the TPCK framework, the authors constructed a comprehensive system for higher vocational teachers' information-based teaching ability. Their strategic model for the development of this ability integrates resource construction, teaching design, classroom teaching, and diagnosis and improvement into a cohesive four-in-one approach.

Ma (2021) proposed that teachers' informatization teaching ability means entail focusing on two dimensions: firstly, reshaping teaching paradigms and enhancing awareness of information-based instruction at both individual teacher and institutional levels; secondly, enhancing the training system for nurturing teachers' information-based teaching ability, thereby ensuring the efficiency of such training. Additionally, they recommended utilizing information-based teaching ability competitions as a catalyst for fostering advancements in innovative information-based teaching skills. Furthermore, they advocated for optimizing the information-based teaching environment to solidify the groundwork for the cultivation of robust information-based teaching capabilities.

Su et al. (2021) proposed that teachers' informatization teaching ability means entail identifying individual needs and variations across diverse professional courses. They advocated for the creation of a three-dimensional training framework catering to various groups and career phases, encompassing entry-level, proficient, and master-level stages. Additionally, they recommended implementing impactful measures to enhance teachers' capacity for information-based teaching. These measures

encompass the introduction of incentivizing mechanisms that foster the growth of informational resources, facilitate teaching execution, and promote pedagogical research.

Lu (2021) proposed that teachers' informatization teaching ability means encompass the enhancement of normal students' educational technology skills, achieved through a four-fold approach: analyzing learning motivation, devising motivational strategies, executing these strategies, and evaluating learning outcomes. Lu Xia's study further demonstrated that the integration of the ARCS motivation model efficiently stimulates learning enthusiasm among normal students, ultimately bolstering their capacity for information-based instruction.

Yang (2021) proposed that teachers' informatization teaching ability means encompass enhancing their understanding of education informatization policies, leveraging information technology to foster students' cognitive and interpersonal proficiencies, forming project-based learning communities, utilizing digital resources for pervasive learning, nurturing teachers' leadership in the realm of informatization, and evolving into inventive educators in the era of information.

Zeng (2021) proposed that teachers' informatization teaching ability means encompass the practice of teaching reflection, the reinforcement of informatization teaching concepts, the establishment of resource banks, and the facilitation of teachers' acquisition of information technology skills. It is imperative for educational institutions to make substantial investments in training activities focused on enhancing teachers' proficiency in informatization. Additionally, various departments within schools should consistently engage in informatization teaching and research endeavors to foster the sharing of valuable experiences.

Xu (2022) proposed that teachers' informatization teaching ability means can be conceptualized through an internal developmental pathway. Their perspective emphasizes four distinct stages: the technology awareness stage, the emulation stage, the practical application stage, and finally, the innovation stage. Additionally, the authors delineated an external developmental trajectory for teacher growth, addressing external requirements. This encompassed components such as the institutional training system, policy and administrative frameworks, the enriched digital

teaching milieu, and comprehensive resource backing. These insights are poised to serve as valuable guidance and benchmarks for university administrators and educators seeking to advance their individual prowess in information-based pedagogy.

Liang et al. (2022) proposed that teachers' informatization teaching ability means could be enhanced through the concept of “standard-oriented, precise policy implementation, and mechanism innovation.” Drawing inspiration from international standards, they developed a comprehensive standard system for the informatization teaching of vocational college educators, encompassing areas such as “teaching proficiency, curriculum development, and performance assessment.”

Dai (2022) proposed that teachers' informatization teaching ability means encompass various dimensions. They illustrated this through the case study of Arizona State University, wherein they proposed optimizing the training trajectory of pre-service teachers' informatization teaching ability. This optimization focused on four key aspects: reshaping the conceptual framework of pre-service teachers' informatization teaching ability training, establishing a cohesive “course group” dedicated to pre-service teachers' informatization teaching ability development, investigating the efficacy of a “double teacher system” in enhancing pre-service teachers' informatization teaching ability, and formulating comprehensive standards for teacher educators' technical proficiency to guide efficient teacher training practices.

In conclusion, Teachers' informatization teaching ability means the process in which teachers create a learning environment, collect and integrate learning resources, efficiently carry out teaching design, teaching implementation, teaching evaluation and other activities in an information-based environment, relying on advanced information technologies such as cloud computing, the Internet, the Internet of Things, and artificial intelligence, so as to cultivate students' learning ability and realize the process of lifelong learning for teachers and students. The basic components of information-based teaching ability include: teachers' information-based teaching awareness and attitude, teachers' information-based teaching knowledge and skills, teachers' information-based teaching design and development, and teachers' information-based teaching implementation and evaluation. Faced with the problems of teachers' weak awareness of information-based teaching, insufficient information-based teaching

innovation ability, lack of school information-based teaching ability training system, and imperfect environmental construction, teachers need to cooperate with the school to solve them. On the one hand, as far as individual teachers are concerned, they should increase their awareness of informatization teaching, enhance their learning initiative, and focus on practical reflection, so as to provide internal guarantees for improving teachers' informatization teaching capabilities; These two guarantees constitute a “combined boxing” to jointly improve teachers' information-based teaching capabilities, improve the teaching effect of vocational education and the quality of talent training. Under the background of the concept of online teaching and learning, “information-based teaching ability improvement training system” and “information-based teaching awareness” have received widespread attention from scholars.

Students' autonomous learning ability

Liu (2021) proposed that students' autonomous learning ability can be enhanced and motivated through information-based teaching technology. This approach involves utilizing information technology for resource integration, learning diagnosis, analysis, creation of conducive learning environments, and performance evaluation. By leveraging information technology, students' autonomous learning ability can be nurtured and cultivated. Moreover, this strategy not only enhances teachers' information literacy but also ignites students' enthusiasm for learning. It efficiently directs students towards personalized independent learning and efficient study methods, fostering the development of their innovative and problem-solving skills through independent thinking.

Cao et al. (2019) proposed that students' autonomous learning ability encompasses various aspects, including online learning, literature research, systematic knowledge acquisition, summarizing presentations, and flipped classroom narration. In their study, they implemented a flipped classroom teaching approach in conjunction with online learning on a network teaching platform, resulting in significant enhancements in students' self-directed learning skills and knowledge mastery.

Liang (2021) proposed that students' autonomous learning ability encompasses several stages, including knowledge screening, difficulty decomposition, and key memory, within the self-study process. Fostering the practice of organizing the learning environment can alleviate students' frustration and reluctance during the learning journey. Furthermore, encouraging students to consistently assess the influences on their learning progress and acquire self-motivation skills can efficiently nurture their capacity for autonomous learning.

Yang (2021) proposed that students' autonomous learning ability can be enhanced through the application of metacognitive strategies in the context of higher vocational English. These strategies enable efficient management and oversight of students' learning journeys, fostering the refinement of self-monitoring and self-evaluation skills. Moreover, they facilitate the development of personalized learning plans, enabling students to adeptly manage their learning habits and ultimately augment their proficiency in higher vocational English through autonomous learning.

Cai (2014) proposed that students' autonomous learning ability in the network environment encompasses the adeptness to delineate learning tasks and objectives, proficiently employ learning resources, exhibit self-discipline and self-regulation. By fostering an immersive learning ambiance within the digital sphere, students' intrinsic enthusiasm for self-directed study can be nurtured, thereby invigorating their motivation for autonomous learning. Moreover, this approach facilitates the acquisition of skills such as discerning pertinent information and honing information-filtering prowess, thus augmenting the cultivation of self-directed learning proficiency amongst college students.

Duan (2023) proposed that students' autonomous learning ability encompasses the examination of social, school, and individual factors influencing collegiate autonomous learning. Moreover, recommended strategies for collegiate counselors to facilitate autonomous learning among students. These strategies include fostering an educational atmosphere conducive to enhancing the supportive context for independent learning, implementing institutional frameworks to promote standardized learning autonomy, offering guidance in developing a strong sense of autonomous learning awareness, and stimulating intrinsic motivation for learning.

Yang (2022) proposed that students' autonomous learning ability can be efficiently stimulated through pre-class teacher assignment preview tasks. They suggested that in-class teacher PPT design, incorporation of suitable small videos, and teachers' explanations of key core knowledge points, coupled with guidance to engage students in interactive activities, can significantly augment the overall learning outcome. In the context of science and engineering education, they advocated for the use of well-designed online classroom quizzes to facilitate the timely digestion and mastery of subject matter. Furthermore, they emphasized that post-class teacher support, including prompt question resolution and a grading system encompassing “paper grades + regular assessments. (Based on online classroom participation and homework completion)”, serves to further cultivate students' sense of academic inquiry and reinforce their learning autonomy.

Ma et al. (2023) proposed that students' autonomous learning ability means facing a significant hurdle due to the predominant challenge of lacking motivation in autonomous learning. They emphasized that learning motivation intricately connects to the establishment of learning objectives, the crafting of learning strategies, and the execution of strategic actions. Furthermore, they highlighted metacognition and self-efficacy as pivotal internal elements influencing autonomous learning. Simultaneously, external influences such as external pressure, role models among peers, and the physical surroundings also play significant roles. To efficiently enhance college students' self-directed learning, the authors suggest a three-fold approach encompassing the enhancement of self-efficacy, cultivation of psychological dimensions, and the creation of an enabling learning environment.

Li (2022) proposed that students' autonomous learning ability can be enhanced through various strategies under the mixed teaching mode. They proposed adopting a “student-centered” educational concept to promote college students' awareness of autonomous learning. Additionally, they emphasized the importance of implementing an “interest-oriented” learning model to foster students' self-management skills. Furthermore, they advocated utilizing technology as a central component of the teaching medium to further develop college students' autonomous learning capabilities.

Li et al. (2023) proposed that students' autonomous learning ability signifies the pivotal skill for college students to acclimate to the swift advancements of contemporary society. Drawing upon the staged autonomous learning model, transformation process model, and autonomous learning theoretical model, in conjunction with the distinctive attributes of the object-oriented programming course, a triphasic learning framework termed “self-directed prelude + in-class learning + self-regulated revision” is formulated, accompanied by tailored autonomous learning resources. This innovative approach holds the potential to significantly enhance students' self-directed learning proficiency and overall learning outcomes.

Xue (2022) proposed that students' autonomous learning ability encompasses challenges such as ambiguous learning objectives, diminished enthusiasm for learning, non-systematic learning approaches, and inadequate learning assessments in the realm of collegiate online autonomous learning. The proposition involves the establishment of an immersive learning environment through the implementation of the “mining” developmental paradigm, the enhancement of motivation for self-directed online learning via the integration of a point-based incentive system, and the instigation of a sense of camaraderie among peers and within academic disciplines through the introduction of innovative models and strategies, including the incorporation of a group competitive mechanism. These endeavors collectively aim to prompt university students towards fortifying their personal educational journey and ameliorating their aptitude for self-guided learning.

Bu et al. (2023) proposed that students' autonomous learning ability encompasses a deficiency in enthusiasm towards specialized courses, a prevalence of passive learning practices, and unsatisfactory academic outcomes. They advocate for an approach centered around interest-driven and task-oriented autonomous learning. This approach encourages students to commence their educational journey with subjects that captivate their curiosity, independently construct learning objectives, judiciously leverage educational resources, assemble requisite materials, and proficiently execute learning assignments under the mentorship of educators. The authors further dissect the pedagogical paradigm across phases encompassing instructional design and execution, educational assessment, and contemplative

analysis, aiming to furnish a blueprint for fostering self-directed learning proficiency among university students.

Wang (2023) proposed that students' autonomous learning ability encompasses the core of smart teaching through approaches like introducing research topics, teaching efficient learning methods, enhancing teaching resources, facilitating autonomous research, and assessing outcomes. These measures aim to activate students' learning drive, enhance the efficiency and caliber of coursework, and establish a cornerstone for nurturing pioneering individuals endowed with robust learning and investigative proficiencies.

Zheng (2023) proposed that students' autonomous learning ability can be enhanced and refined through the utilization of digital interaction technology, smart virtual communities, and digital thinking. This approach offers a promising avenue for efficiently nurturing engineering students in the context of the digital era.

In conclusion, students' autonomous learning ability means the ability of students to actively plan, monitor, and adjust the learning process, independently obtain, analyze, and synthesize information, solve problems, and complete tasks under the guidance of teachers, according to their own learning needs and interests. Cultivating this kind of ability is extremely important to the development of college students. It needs to start with learning motivation, methods, resources, and environment. It can adopt flipped classroom, inquiry-based, and project-based organizational forms, combined online and offline learning teaching modes, discuss, display, evaluate, reflect, and other teaching methods; build network platforms, databases, and virtual communities.

Online teaching and learning interaction

Zhang et al. (2022) believe that when learners have emotional or cognitive needs, teaching interaction can provide emotional support and cognitive assistance. Emotional support can help learners get rid of negative emotions and make online learning more durable. Cognitive assistance can help learners solve cognitive difficulties and make online learning smoother. When learners do not have the above-mentioned needs, teaching interaction will bring attention interference and negative

effects that affect students' deep thinking. Therefore, in online teaching, one should not blindly use text communication such as barrage interactive technology, and the object and timing of application should be considered. Only in this way can it be possible to give full play to the role of teaching interaction in online learning, and then better promote online learning of college students.

Xin (2020) pointed out that interactive teaching is a teaching method in which teachers use students' exploration activities as the main body and teachers' instruction as the main body in order to achieve certain teaching goals, and carry out teaching activities through interactive links such as exchanges, discussions, and questions between teachers and students, and guide students to explore and discover knowledge by themselves. Interactive teaching enlivens the classroom atmosphere, improves students' learning interest and enthusiasm; changes the way teachers spread knowledge one-way, enables students to learn from mechanical imitation learning to active learning, maximizes students' learning potential, and cultivates students' innovative thinking.

Sun et al. (2021) proposed that multi-dimensional online interaction strategies consist of daily interaction strategies based on social software, online interaction strategies based on live lectures, and other interaction strategies based on online learning platforms. Online interaction based on social software should not overemphasize the synchronization of interaction, so as to create opportunities for more students to explore freely. The online interaction of the live course includes the preview evaluation interaction based on the online learning platform and the teaching interaction based on the live platform to lay the foundation, expand the breadth and seek depth. Other interactions based on the online learning platform mainly focus on promoting multi-person interaction through peer evaluation and activating self-interaction through mind mapping.

Chen et al. (2020) believe that online teaching interaction has a positive impact on student learning, but there are also negative effects, which require system optimization design. Human-computer interaction is the foundation, but excessive reliance on technology will affect the learning effect; content interaction is conducive to independent learning, but it should not be the center; teacher-student interaction

is especially important for the social development of some student groups. Generally speaking, online teaching interaction is a complex system engineering, which needs to consider the synergistic effect of human-computer, content, and teacher-student interaction. On the premise of ensuring the basic human-computer interaction experience, appropriately strengthen content interaction to promote independent learning, and give full play to the guiding role of teacher-student interaction, especially pay attention to some student groups that need more attention, and provide personalized guidance. At the same time, it is also necessary to be alert to the problem of excessive recognition of technology, pay attention to the overall development of students, and avoid one-sided interaction. This requires teachers to continuously improve online teaching capabilities, optimize interaction design, achieve good interaction with students, content, and technology, and create a reasonable and efficient online learning environment to achieve learning effects that promote students' cognition, skills, and overall development.

Lin (2022) pointed out that online teaching is restricted by external conditions and lacks the sense of presence in offline teaching, and the problem of online interaction between teachers and students is prominent. As a key element of efficient teaching, interaction determines the efficiency of online teaching. Transforming the concept of online teaching, building a SPOC learning environment guided by interaction types, and constructing group cooperative interaction with the “core-edge” structure of the network can provide efficient interactive support for online teaching.

Wang et al. (2021) believe that the development of interactive teaching is the key to the reintegration of teaching and learning behaviors in online teaching. It is proposed that the use of mobile phones and other teacher-student interaction tools can efficiently improve the level of interaction and solve the problems of single form, low efficiency and unbalanced direction in the existing online interactive teaching. Use teaching concepts such as peer interaction, layered interaction and gamification interaction to guide online teaching design, drive teaching with questions, organize efficiently according to the online teaching process, and establish a mobile feedback system to support online interaction, optimize online interactive teaching, and improve the effect of teaching and learning.

In conclusion, Online teaching and learning interaction means in the network environment, teachers and students, students and students around the learning content and activities, using information technology to carry out various communication, discussion, collaboration, feedback and other teaching behaviors. It is the key link to realize the goal of network teaching, through different forms of human-machine, teacher-student, and student-student interactions to promote the learning process, stimulate learning motivation, and improve learning effects. Online teaching interaction should give full play to the guiding role of teachers, pay attention to the needs of different students, provide emotional support and cognitive assistance; organize rich teacher-student and student-student communication activities, activate the classroom atmosphere, and cultivate teamwork ability; rationally use technical means to avoid information overload and single interaction forms; and continuously evaluate and optimize the interaction design to make it pertinent, timely and efficient, so as to play the positive role of interaction and ultimately promote students' learning and development.

Course Content

Shi et al. (2023) believed that reconstructing the course content is threading the knowledge points to reflect the process of continuous innovation; at the same time, the knowledge is energized, and for each knowledge point, the corresponding practical application is added, especially focusing on increasing the application cases that are closely related to the specialty and the frontier of the discipline, and dispersing the students' thinking for the innovation points in the process of classroom teaching. Improve the traditional teaching mode of lecturing into an exploratory teaching mode. Design a chain of questions to guide students to think in groups or independently, and continuously discuss between teachers and students to mobilize the flexibility of students' thinking. Characters and events involved in the course content are introduced to cultivate students' creative personality in terms of willpower, observation, independence, cooperation, optimism and social responsibility. In addition, in the part of knowledge vitalization, when applying the knowledge learned to solve the practical problems of the specialties studied, it can

be elaborated with the teachers' personal scientific research experience, so that the students can deeply appreciate the importance of willpower, observation power, cooperation spirit, etc. in innovation.

Lin (2023) pointed out that although the existing course content of Warehouse and Distribution Management adopts the integrated teaching of science and practice, and adds a lot of practical operation links to improve the hands-on ability of students, students still need to listen to a lot of theoretical knowledge through multimedia courseware and videos in the classroom, and now the students have different levels of hierarchy levels, and there is a big difference in the depth and breadth of the knowledge points grasped by the students from different sources, which leads to not only theoretical learning Students feel boring, in the practical part of the teacher is also deeply time-consuming and laborious. Most of the equipment in the training room belongs to the teaching version, and cannot fully keep up with the changes of the times, the logistics industry is realizing the leapfrog development from modern logistics to intelligent logistics, and students are also in urgent need to go to the enterprise to learn new knowledge, new skills, and contact with the latest equipment. It is proposed that by reconstructing the content of the warehousing and distribution course, the course content can be docked with the “1 + X” vocational skills level examination of logistics management, improve the students' working ability and practical hands-on ability through the integration of job internships with the course content, update the teaching module in a timely manner to connect with the direction of the development of skills competitions, and help to cultivate more high-quality technical skill talents. Technical skills talents, the real situation of the typical tasks of the post into the curriculum, the interesting skills competition into the case and situation training, the gold vocational certificate into the evaluation of learning outcomes, to achieve efficient articulation and organic integration between each other, so that the curriculum teaching of the physical and practical integration of dynamic, the formation of moral and technical and cultivation, the physical and practical, the hands and brains and the combination of work and study of the technical skills personnel training model. By the process evaluation, results evaluation and value-added evaluation of three parts of the composition of the student's performance assessment method, the

results are also more reasonable, and the students are more involved in the course of study.

Wen (2016) believed that the project-based transformation of the course content of Software Engineering: First, in accordance with the principle of sufficiency, the more theoretical content is deleted, and the practical content is increased; second, the main knowledge points are set to be combined with the actual professional practice of a single task or comprehensive task, which is conducive to the use of task-driven method of teaching; third, the content related to the affiliated professions such as discipline-specific surveys, feasibility analysis, engineering system design, etc., so that software engineering is no longer an abstract theoretical course outside the development of specific software projects, but more closely integrated with the engineering content of the course. Third, add the content related to the specialty, such as discipline-specific survey, feasibility analysis, engineering system design, etc., so that software engineering is no longer a theoretical course abstracted from the development of specific software projects, but tends to be more closely integrated with the engineering content of the course.

Su (2019) believed that e-commerce courses in the original teaching, mostly using classroom lectures as the main, multimedia teaching methods, single teaching means, teaching methods old-fashioned, has not adapted to the learning needs of modern students. The authors point out that, first of all, combined with the e-commerce vocational competition and the needs of industry and enterprises, the content of the practical part of the e-commerce course is abstracted, and more practical operations are given to the students in practice and space to realize the characteristics of the student as the main body; once again, based on this foundation, with the modern informatization technology, such as microclasses, video animation, cell phone APPs, virtual technology, simulation software, etc., so as to make the learning process of the students more graphic Vivid and concrete, improve students' learning autonomy while cultivating their ability to think about problems, solve problems independently, and the awareness of innovation and entrepreneurship, so as to better realize employment and entrepreneurship.

Wang (2018) aiming at the actual situation that students lack the initiative to seek knowledge, are addicted to games, and are not happy to learn, we have formulated a game-based task-driven, “game + competition” mode of course content design, highlighting the knowledge, practice, fun, and efficiency, and will determine the teaching objectives of the course from the three dimensions of knowledge, competence, and quality, and formulate teaching and learning priorities and difficulties. The course content is designed as 10 games. The course content is designed as 10 game tasks, creating a relaxed and harmonious learning environment. Set up four teaching sessions: students' problem solving, teachers' basic knowledge teaching and demonstration, students' simulation experience, group confrontation, communication and sharing. In the teaching process, we are good at cultivating students' sense of problem, guiding them to complete the game tasks with group collaboration, and transforming from leading to guiding students' main experience. After class, the subject competition as a driver, the project studio to undertake the agency business and entrepreneurial practice to expand knowledge, highlighting the student's subjectivity, to achieve the practical sublimation and expansion of the teaching content of this class, and then improve the quality of classroom teaching, and comprehensively enhance the entrepreneurial ability of college students.

In conclusion, Course Content means the integration of theoretical knowledge with practical applications, the introduction of exploratory teaching methods, the inclusion of hands-on experiences and project-based elements, the incorporation of modern information technology, and alignment with industry demands. This approach not only enhances the practical relevance of the curriculum but also fosters students' practical work abilities, improves their problem-solving skills, and nurtures their innovation and entrepreneurial capabilities, ensuring their preparedness for future challenges. This transformative process revitalizes education and better equips students to adapt to the demands of the modern society and the workplace.

Teaching Resource

Lei (2018) believes that the construction of the curriculum teaching resource follows the principles of service, education, construction, professionalism, scientificity and systematicness; the construction content of the teaching resource database includes industry resources, professional resources, course resources, vocational training resources and characteristic resources. The construction idea of the project-driven course teaching resource library is to carry out project design according to the circular or segmented method; “student-centered” and “problem-oriented”, and project resource materials are built according to the idea of “asking questions-self-learning-troubleshooting-consolidating and improving”.

Wang (2023) put forward the policy of “integrated design, structured curriculum, and granular resources” for the construction of a teaching resource library for vocational education majors. The professional teaching resource library construction plan mainly includes the following aspects: Restructuring the curriculum system to realize “integration of post-course competition certificate + real project orientation”. Establish a modular and progressive course system, and cooperate with industry companies to develop course content. Integrate the requirements of skill level certificates, vocational qualification certificates, and skill competitions to build a comprehensive curriculum system. Establish professional construction standards to serve industry needs. According to policy requirements, international standards, industry needs, etc., establish professional construction standards and personnel training specifications. Continuously improve the professional personnel training program. Build a teaching resource complex, build a shared resource library with the government, colleges and enterprises, and form a three-level teaching resource library. Expand functional modules, establish functional modules such as vocational skill level certificates, enterprise cooperation, practical training promotion, employment services, etc., and continuously enrich the resource base. A resource library operating platform that provides teaching functions, resource functions, and management functions. Realize teaching functions such as self-study, online communication, and lesson preparation; establish course sub-databases, realize resource upload and management functions; realize multi-level management functions of users and resources.

Kang (2019) put forward suggestions to promote the joint construction and sharing of the teaching resource of vocational education specialty: improve the top-level design and strengthen the role of policy guidance. Formulate relevant policies and guiding opinions, incorporate resource sharing into the evaluation system, and provide an incentive mechanism for resource co-construction. Formulate construction standards and realize resource co-construction throughout the process. Establish quality standards and monitoring mechanisms, form a co-construction thinking, and ensure construction quality. Build a team of teachers and carry out team training. Strengthen teachers' systematic study of resource library construction and improve their understanding of unified construction standards. Organize exchanges and sharing to promote capacity improvement. Improve the service concept and create a good user experience. Design customized learning experience according to different user needs, provide humanized design and resource recommendation.

Xiong (2018) proposed a teaching resource of vocational education specialty construction path based on the concept of the Internet, that is, to build a first-class team that organically integrates “government-school-enterprise associations”, integrate the achievements of national model colleges and specialty specialty construction, and gather the support of the national Internet financial system.

Zhang (2021) put forward the strategies of integrating production and education to build a teaching resource of vocational education specialty: build a school-enterprise cooperation community, and enterprises participate in the construction of resource databases; set up a resource database construction team, and implement the leader responsibility system; develop and construct digital teaching resources, complete resource collection and integration; apply resource database courses to teaching practice, and constantly update and optimize courses based on user feedback to make resources meet needs. It has important reference value for promoting the integration of production and education to build a professional teaching resource library.

Zhang et al.(2020) clarified the construction logic of the teaching resource of vocational education specialty construction through in-depth research and analysis on the construction of vocational education informatization, and proposed to improve

the guarantee mechanism for informatization construction in colleges and universities, use the resource bank as the starting point for improving the level of informatization, establish a leading organization and support team, supporting funds and system guarantees. Formulate a management system that adapts to “Internet + teaching”, support online and hybrid teaching, and improve credit recognition and mutual recognition mechanisms. Standardize fund management, put an end to irregularities in the use of funds, and ensure the standardization, safety and efficiency of fund use. Formulate a multi-channel promotion plan for the resource library, set user and usage indicators, carry out training, and attract more users. Give full play to the role of the co-construction and sharing alliance, jointly build resources, carry out resource sharing, mutual recognition of credits, teacher training, etc. Promote various long-term application activities, formulate learning programs and incentives, and encourage teachers, students, and social users to widely use resource libraries. The resource bank will play a more important role in promoting the co-construction and sharing of high-quality resources, promoting the informatization process of vocational colleges, accelerating the reform of professional education and teaching, deepening the application of teaching informatization, improving the efficiency and quality of talent training, and serving the expansion of millions of learning groups.

In conclusion, Teaching Resource means the comprehensive and organized collection of educational materials, content, and tools designed to support vocational education and enhance the teaching and learning process. These teaching resources are intended to meet the specific needs of vocational education and can include various elements, such as industry-specific content, modular course materials, skill certification requirements, digital teaching resources, and more. The construction and development of these teaching resources aim to improve the quality and efficiency of vocational education by providing educators and students with valuable, up-to-date, and structured learning materials and tools.

Teaching Design

Zhang (2016) believe that efficient classroom teaching design is the basis for realizing efficient teaching and the prerequisite for realizing the efficiency of classroom teaching. Based on the efficient teaching model of BOPPPS, it is proposed to rationally arrange and design classroom teaching activities from the aspects of classroom composition elements, operating procedures, teaching strategies, etc., and put forward teaching design suggestions from the aspects of highlighting the main body position of students, introducing the idea of flipping the classroom, guiding students to participate in interaction, innovating teaching activity organization strategies, and rationally allocating the teaching process.

Du et al. (2013) believe that instructional design is mainly to promote learners' learning, using systematic methods to transform the principles of learning theory and teaching theory into specific plans for teaching objectives, teaching content, teaching methods, teaching strategies, teaching evaluation, etc., and create a systematic “process” or “program” of teaching and learning. It is proposed that instructional design should focus on thematic reorganization of knowledge, teaching strategies should be student-centered, and use various efficient methods to cultivate students' higher-order thinking abilities such as application, analysis, synthesis, and evaluation. At the same time, information technology, as a cognitive tool, can play the functions of visualization and communication, become students' intelligent partners, and efficiently support the deep learning process. Teaching evaluation should also pay attention to whether students' metacognitive ability has been cultivated.

Wang (2010) pointed out that the teaching design of innovative higher vocational classrooms should firmly establish the concept of being student-centered and cultivating students' professional core abilities. First of all, it is necessary to clarify the teaching content according to the job requirements, design practical teaching content, and realize the efficient combination of knowledge imparting and ability training. Secondly, it is necessary to innovate in teaching methods, adopt task-driven, project-oriented and other methods, so that the learning process and the working process can be seamlessly connected. Thirdly, in terms of teaching rhythm, it is necessary to master the reasonable use of classroom time and resources to achieve a

balance of length, density, depth and moderation. At the same time, it is necessary to create a classroom atmosphere of teacher-student interaction, making it a process of thinking inspiration and emotional exchange. In addition, process evaluation and reflection should be strengthened, and teaching quality should be continuously improved by obtaining feedback and self-reflection.

Chen (2019) pointed out that the integration design of higher vocational MOOC, SPOC and traditional teaching needs to clarify the characteristics of different professional courses, design a multi-dimensional teaching mode according to course knowledge, skill requirements and students' learning characteristics, and rationally configure three teaching methods. Pay attention to the combination of theory and practice, and give full play to the advantages of various teaching methods. It is necessary to design multiple and flexible teaching programs, deepen school-enterprise cooperation, and build a high-quality teaching resource system. It is necessary to design a systematic teaching plan according to the time and space needs of students, and organically integrate network teaching and face-to-face teaching. By starting from the characteristics of professional courses and students' learning needs, we will give full play to the advantages of various teaching methods and form a systematic integration design to meet the needs of the development of higher vocational education under the new situation.

Wang (2020) put forward the idea of the mixed teaching design of vocational education courses oriented by the work process: the mixed curriculum system should be developed through the analysis of positions and work tasks, and the role of information technology in the course design process should be fully considered. In the blended teaching design, it is necessary to analyze the learners and teaching objectives, pay attention to the practice design of complex skills, and the rational use of online and offline resources. It is necessary to reposition the roles of teachers in schools and enterprises, and develop a mixed teaching environment and resources that meet the needs. The implementation and evaluation of blended teaching should focus on the development of students' professional ability. The entire blended teaching design process should be oriented towards the development of professional ability, organically combine knowledge learning and skill training through the working

process, and realize the efficient integration of teaching content, process and evaluation.

Tan et al. (2019) believe that the teaching design of blended courses should follow the design of teaching objectives, which should be clear and specific, consistent with the curriculum standards, and include knowledge, ability and quality goals. The design of teaching tasks should highlight practicality, inquiry and interest, connect with practical work, and stimulate students' interest. The design of teaching methods should consider the characteristics of knowledge and learning situation, and use methods such as questions, projects, and cases to make students willing to learn and able to learn. The design of teaching steps should be pertinent, spiral and complete, and students' ability can be improved through the cycle of doing, learning and doing. The assessment design should emphasize intelligent means, diversified content, diversified subjects, and dynamic process.

In conclusion, Teaching Design means the systematic process for creating efficient learning experiences. It involves setting clear learning objectives, organizing content and resources, selecting appropriate teaching methods, designing engaging activities, and creating assessments. This process should be student-centered, accommodating diverse learning needs and styles. It can employ various teaching methods, from traditional to innovative approaches like blended learning and online instruction. The goal is to enhance education quality, fostering deeper subject understanding, critical thinking, problem-solving, and lifelong learning. Teaching Design is an ongoing, dynamic process that optimizes the learning experience by considering both the content and the best methods for delivery.

Learning Engagement

Liu (2021) A random survey of 2,388 vocational students and their influencing factors on online learning engagement, after descriptive analysis, cluster analysis, and multiple linear regression, found that: vocational students have higher cognitive engagement in learning, but lower interactive engagement in learning; most of the individual factors have no influence on online learning engagement, but have a significant influence on the professional category, and the science and engineering

category is outstanding; the management system and measures of the school will have a significant influence on the learning engagement of college students; online learning psychology has a very significant influence on learning engagement; and the school will have a very significant influence on the learning engagement. The management system and measures of online classes have a significant impact on college students' learning engagement, and the impact of online class learning psychology on learning engagement is very significant.

Liu et al. (2021) believed that students' learning behavioral engagement is an important factor affecting the learning effect. In order to understand the current situation of online learning behavior of higher vocational students during the epidemic prevention and control period, we designed a six-dimension online learning behavior measurement scale for higher vocational students on the basis of the study of learning behavior investment, online learning behavior investment definition and measurement, and based on the back-end data of the online learning system and the questionnaires from the post-course surveys of the learning process, we conducted a descriptive analysis, a stage analysis, and a change analysis with respect to the final outcome of the measurement indexes. Based on the background data of the e-learning system and the questionnaire data of the post-course survey on the learning process, the descriptive analysis of the 20 indicators, the analysis of the changes in the stages, and the correlation analysis with the final online examination scores were conducted. Finally, we propose some practical suggestions to efficiently stimulate students' online learning behavior, including strengthening the process management of online teaching, enriching the online teaching design to stimulate students' motivation, and insisting on the high requirements of online teaching.

Cai (2021) explored the influence factors and mechanism of students' learning engagement in higher vocational colleges and universities. Through the interviews and data analysis of 24 students, it was found that: individual characteristics such as psychological state and institutional characteristics such as dormitory culture circle play a common role in students' learning engagement in higher vocational colleges and universities, and that individual characteristics, institutional characteristics and students' learning engagement in higher vocational colleges and universities form a

“loop” of interactive effects. individual characteristics, institutional characteristics and students' learning engagement in higher vocational colleges form a “circular circle” of interaction. It is proposed that higher vocational colleges and universities should pay attention to professional cognition, reform teaching methods, stimulate students' interest in learning and intrinsic motivation; optimize the learning space, promote habit formation, improve the learning atmosphere and students' self-study ability; pay attention to the emotional support, strengthen the interaction between teachers and students, and boost students' learning expectations and psychological state.

Zhang et al. (2021) explored the instructional design that promotes online learning engagement and break through the bottleneck that restricts the quality of online teaching. Partially flipped classroom teaching is implemented with SPOC. (small-scale restricted online course) as the core, online teaching is guided by time management and building new teacher-student relationship, and the octagonal model is applied to stimulate learning drive. It was found that the design of teaching activities promoting learning engagement enhanced self-efficacy of online learning, and the evaluation of online learning engagement would be continuously improved with the development of big data technology. It is recommended to return to the essence of teaching and learning through the deep integration and regular application of online teaching and information technology to provide teachers and students with the development space for teaching and learning ability enhancement.

In conclusion, Learning Engagement means the degree of cognitive and interactive engagement in learning exhibited by students in an online learning environment, it is influenced by a variety of factors, including students' individual characteristics, school management system, psychological state, and dormitory culture circle. It was found that factors such as major category, online instructional design, learning space, and emotional support significantly affect learning engagement. Therefore, higher vocational colleges and universities need to pay attention to the reform of teaching methods to stimulate students' learning interest and intrinsic motivation, and enhance learning self-efficacy. At the same time, schools should optimize the learning space, improve the learning atmosphere, and strengthen teacher-student interaction in order to enhance students' learning expectations and

psychological state. In terms of instructional design, strategies such as flipped classroom and small-scale online courses should be adopted to stimulate learning drive and promote students' commitment to online learning. By continuously deepening the integration of online teaching and information technology, students' learning and teaching abilities can be improved and the quality of online learning can be promoted.

School Policy Support

Tang (2023) In order to promote the reform of blended teaching in higher vocational institutions, it is necessary to fully recognize the current problems and put forward policy measures to promote the reform, including the following: higher vocational institutions should formulate a policy that requires the establishment of a “Blended Teaching” column on the campus official website, the school newspaper, bulletin boards, and other media, which describes the content, significance, and successful cases of blended teaching in detail. It is also encouraged to hold at least one special lecture every semester, inviting experts to share knowledge about blended teaching to broaden the horizons of teachers and students, and to regularly organize teachers and students to participate in discussions in the form of teaching and research meetings, themed class meetings, etc., to help them realize that blended teaching provides a new direction for higher vocational colleges and universities. The policy should include the establishment of a teaching guidance mechanism for teachers, a feedback mechanism for students, a mechanism for training and selecting school-based experts, a mechanism for monitoring the quality of blended teaching reform and information feedback, and an incentive mechanism to ensure that the blended teaching reform is carried out in an orderly manner. Finally, the policy should also encourage higher vocational colleges and universities to develop constraint and incentive mechanisms to promote teachers to take the initiative to improve their information literacy, as well as to organize regular exchange reports for teachers, invite experts to comment on their work, and set up information technology support departments to support the improvement of information literacy. These policy

measures will help solve the problems faced in blended teaching reform in higher vocational institutions and promote the successful implementation of reform efforts.

Li (2023) believed that higher vocational colleges and universities need to meet the specific requirements of the "Double-High Plan" to improve the level of informatization in the construction of smart campus, informatization education and teaching, teachers and students' informatization literacy, informatization management and services, and to combine the needs and tasks of the high-quality development of higher vocational colleges and universities and strongly support the "Double-High Plan" to promote the construction of smart campus in a coordinated manner. "In order to promote the construction of smart campus, the following policies should be implemented: optimize the overall layout, integrate campus culture and characteristics, support university-enterprise cooperation and integration of industry and education, and build a smart campus. Construct a new paradigm of intelligent education and teaching, expand the supply of quality resources, strengthen the teaching and learning ecosystem, expand intelligent application scenarios, and assist in the "Three Teachings" reform. We will establish a sound information literacy training system for teachers and students, including a mechanism for evaluating and assessing the information literacy of teachers, improving the information competency of teachers and students, and strengthening the information training of "dual-teachers". Innovative and precise digital governance model, fusion-driven intelligent data governance, fusion to create intelligent service supply, continuous support intelligent security protection.

Deng et al. (2023) pointed out that digital transformation is a new stage in the informationization construction of vocational colleges and universities, and is a key link in the construction of digital vocational education system. In order to achieve the transformation goal of using digital technology to innovate business models, trigger organizational changes and reshape the school ecology, vocational colleges and universities should uphold the three core concepts of "demand-driven", "humanities-led" and "integration and collaboration". Vocational institutions should adhere to the three core concepts of "demand-driven", "humanity-led" and "integration and synergy", and form a digital transformation framework of "strategy-driven, goal-driven, scenario-linkage, and condition-prying". In terms of path selection, vocational colleges

and universities should construct a scientific and complete digital transformation plan from the three dimensions of value consensus, holistic strategy and stage advancement; improve the elemental system of vocational colleges and universities' digital transformation through the construction of innovation-driven new infrastructures, new data and new capabilities; and, from the perspective of enhancing the transformation vitality of specialized organizations, stimulating the transformation motivation of all relevant subjects and ensuring the efficiency of the transformation through the ethical regulation, create an efficient and synergistic digital transformation system to guarantee its efficiency. Create an efficient and synergistic digital transformation guarantee system.

Rao et al. (2023) proposed to clarify the connotation of high quality higher vocational school, analyze the real dilemma of the construction of high quality higher vocational school in China from the aspects of school running concept, social service ability, talent cultivation mode, professional construction quality, digital informationization level, and "dual-teacher" teacher team, etc., and summarize the successful experiences at home and abroad, and propose to improve the social service ability, innovate talent cultivation mode, pay close attention to the quality of professional construction, and create a guarantee system for efficient and collaborative digital transformation. It also summarizes the successful experiences at home and abroad, and puts forward the countermeasures to promote the construction of high-quality higher vocational schools from the aspects of improving social service ability, innovating talent cultivation mode, paying close attention to the quality of professional construction, improving the level of digital informatization, and building a high-level "dual teacher" team.

In conclusion, School Policy Support refers to comprehensive policy measures and strategic frameworks designed to address key issues and drive positive reforms in vocational education, focusing on blended teaching, information enhancement, digital transformation, and elevating the quality of vocational institutions.

Online Teaching and Learning Platform

Yang et al. (2021) believe that based on the online learning space, traditional teaching support service systems, live broadcast platforms, and social software should be fully integrated, and an online learning space including management, teaching, and evaluation should be constructed to form a closed loop of online teaching. In the fields of continuing education, open education, and lifelong learning, the value of distance teaching can be brought into greater play, online teaching can be efficiently supported, and the quality of online teaching can be guaranteed. It also provides a reference for the construction of the next generation of intelligent network learning space and the application of personalized teaching.

Yang (2020) pointed out that the construction and application of online learning space requires the rational allocation of online learning time, the construction of a complete teaching platform, the production of high-quality teaching content, the integration and development of various elements, such as paying attention to educational fairness, and focusing on diversified process evaluations. We should correctly understand the role of online learning space construction and application in high-level undergraduate education, continuously improve the level of online learning space construction and application, continue to improve the quality assurance system for online learning space construction and application, and promote the high-level development of undergraduate education in my country.

Chen (2021) believes that the network teaching platform is the key infrastructure and support system for realizing network teaching. The online teaching platform has important functions such as gathering and sharing high-quality course resources, building an interactive space for teachers and students, recording and analyzing learning process data to improve the evaluation system, etc. Platform construction should be oriented to meet the needs of teaching, and maintain good interaction with teaching practice. The use of artificial intelligence technology can promote the platform to realize intelligent and personalized services. A fully functional and easy-to-use online teaching platform not only facilitates the development of teaching and learning, but also expands resource space, constructs a communication environment, and optimizes the evaluation mechanism, thereby efficiently improving

teaching methods and improving teaching quality. Therefore, the construction and development of the network teaching platform has a significant positive impact on the promotion of network teaching, and is a powerful guarantee for the realization of network teaching goals.

Chen (2021) believes that the Peppe R platform of the University of Toronto is a powerful and easy-to-use online teaching platform. The platform builds a virtual learning community to support knowledge sharing, emotional communication and intelligent learning. The platform provides various tools to help knowledge management, classification and construction, and also supports multiple forms of communication to enhance the sense of social reality. The platform can support educational research, optimize teaching practice, provide learning analysis reports, and help teachers understand student dynamics. The platform supports teachers to design and edit personalized teaching, which optimizes the workflow and improves user experience.

Yang et al. (2015) believe that the awareness of the application of the network teaching platform should be improved, the management should change the concept, the teachers should study the application, and the students should adapt to the network teaching; the application research and development of the platform should be strengthened, the structure should be optimized, and the students' learning situation should be paid attention to; a management mechanism should be established to provide software and hardware guarantee. The application of network teaching platform is the basis of realizing network teaching, which should serve the teaching function and pay attention to the actual teaching. The application effect of the platform directly affects the effect of online teaching, and all parties need to pay attention and make efforts to improve the quality of online teaching.

Qi (2021) pointed out that the construction of online teaching platform requires systematic planning and design through the practice of Wuhan University's online teaching platform. It should strengthen the top-level system construction, improve the management system, and establish relevant standards and incentive mechanisms. Investment should be increased to improve platform performance and experience. The construction of online courses should be carried out extensively to enrich teaching

resources. Teacher training should be strengthened to improve the ability of information-based teaching. It should also realize the data sharing and functional docking of various teaching platforms in the school. The construction and application of the network teaching platform requires the joint efforts of all parties in the school in order to be efficient and efficiently promote the process of network teaching

Shen (2021) believes that the teaching model should be continuously summarized and optimized, and a teaching platform suitable for the needs of disciplines should be built. We should adhere to the openness and sharing of resources, and cooperate in the development of characteristic courses. A safe online teaching environment should be established, and the platform should be incorporated into the construction of a smart campus to play a positive role in corporate culture. The Internet should be used to improve the quality of home-school cooperation and class management. The construction of online teaching platform requires systematic thinking, and requires the joint efforts of teachers, students, administrators and other parties to play a role in teaching.

In conclusion, Online teaching and learning platform means integrates teaching resources, supports teaching activities, builds a communication space, and conducts evaluation through information technology to provide comprehensive support for online teaching and learning. The literature believes that the online teaching and learning platform should be oriented to teaching needs and provide convenient operation experience and personalized services. It is necessary to pay attention to resource construction and support multiple teaching modes; realize the connection with other systems and build a closed-loop teaching management system; use artificial intelligence technology to provide intelligent services. The platform requires systematic planning, teachers, students, managers and other parties to participate and continuously improve. Looking forward to the future, the online teaching and learning platform will develop in a more intelligent and powerful direction, combining virtual simulation, artificial intelligence and other technologies to provide high-quality support for teaching through knowledge recommendation and accurate evaluation. The construction and application of the online teaching and learning platform will promote the reform of teaching concepts and methods, and greatly improve the effect of online

teaching and learning. But we also need to see that technical means are not the end, the core is to stimulate learning interest and cultivate students' spirit of active inquiry. It is necessary to rationally view and use various technologies to meet the needs of educational development.

Concept of efficiency in online teaching and learning

Regarding the efficiency in online teaching and learning, the academic community has not reached a consensus. Numerous studies have compared online education and traditional face-to-face teaching from different angles, using various metrics, and have arrived at different conclusions. Some studies have confirmed that online courses offer a superior learning experience compared to traditional face-to-face courses, while others have reported no significant differences in efficiency between the two teaching modes. Additionally, research has also focused on the efficiency of blended learning models compared to purely online or traditional face-to-face instruction, or a combination of both. However, the results of these studies vary, and there is still a lack of clear consensus on whether online courses or traditional face-to-face courses are equally efficient.

Certain studies have indicated that student performance improves in online education, while others have found that online teaching does not significantly enhance student learning outcomes when compared to other instructional methods. Some research even suggests that there is no significant difference in student performance between traditional face-to-face teaching, purely online learning, and blended learning.

Zhang (2021) proposed an online teaching model that involves efficient instructional goal setting, efficient delivery of instructional content, successful implementation of teaching methods, and impactful teaching interventions based on the accurate identification of learners' states. Leveraging educational platforms, the model utilizes data collection, analysis, and application of online student learning process data. Teachers use this information to perceive and track students' learning statuses, dynamically adjust and optimize teaching strategies, and thereby achieve efficient teaching.

Liu et al. (2019) introduced a comparative analysis of the teaching effects between online and traditional education using systematic evaluation methods. Through meta-analysis, the study statistically analyzed effect sizes and found that, compared to traditional classrooms, students in online education exhibited higher performance in exam scores, understanding of knowledge, application of knowledge, self-learning abilities, self-management skills, and learning motivation. There were no significant differences in pass rates, excellence rates, and collaborative abilities between online and traditional education. Moreover, students displayed higher levels of interest, dedication, participation, and satisfaction in online education.

Hu (2012) put forth that efficient online teaching constitutes a multidimensional and comprehensive structure. It encompasses three levels: the forms of information-based teaching, the design of information-based instruction, and the philosophy of information-based teaching. Each level entails four elements: the goals of information-based teaching, the context of information-based instruction, the strategies of information-based teaching, and the evaluation of information-based instruction. The four characteristics of efficient information-based teaching are scientific and flexible instructional goals, coordinated and seamless instructional contexts, rational and flexible instructional strategies, and diverse and developmental instructional evaluations.

In summary, the academic community's research findings regarding the efficiency of online education are mixed. Despite the in-depth exploration undertaken by many studies, varying viewpoints persist concerning the efficiency of different teaching modalities. This highlights the need for further extensive research and exploration in the field of online education to gain a more comprehensive and accurate understanding of the strengths and weaknesses of various teaching methods.

Context of vocational education in Guangxi

Higher vocational education is an important part of China's education system, and its positioning is to cultivate high-level skilled personnel and serve local economic and social development. It emphasizes the combination of theory and practice, and pays attention to the cultivation of students' professional skills. According to the learning needs of students and social needs, the direction of higher vocational education covers engineering, agronomy, medicine, art and other fields. China's higher vocational education started relatively late, starting in the 1980s and developing rapidly in the 1990s. In order to meet the needs of economic and social development, the state has issued a number of policies to support higher vocational education, such as “Decision of the State Council on Actively Promoting the Reform and Development of Vocational Education”, “Opinions of the Ministry of Education on Actively Promoting the Reform and Development of Higher Vocational Education”, etc. Since the reform and opening up, China's higher vocational education has greatly improved in terms of student size, major setting, and teaching quality.

The state attaches great importance to the supporting role of higher vocational education in economic and social development, and has introduced a number of policies to support it, mainly reflected in: expanding the proportion of higher vocational education in higher education, increasing funding, reforming talent training models, encouraging school-enterprise cooperation, and supporting the internationalization of higher vocational education. The “1+X” certificate system reform of higher vocational education proposed in recent years is also to improve the quality of higher vocational education. At present, online teaching is widely used in higher vocational education, but there are still some problems: 1) Theoretical teaching is out of touch with online teaching content, and does not match the actual work requirements. 2) The construction of online teaching resources lags behind, and some core professional course resources are insufficient. 3) Teachers' information technology application ability is insufficient, and online teaching methods are single. 4) Practical teaching is difficult to be fully realized through online teaching. 5) There is a lack of an online learning evaluation system for the characteristics of higher vocational education. 6) Students have weak awareness of autonomous learning and lack of

initiative. Due to the relative lack of higher education resources in Guangxi and the relatively backward industrial development level compared with the eastern coastal areas, the above problems are particularly prominent in Guangxi, which is located in the southwest.

As of 2023, there are more than 30 public higher vocational colleges in Guangxi, including: Guangxi Mechanical and Electrical Vocational and Technical College, Guangxi Sports College, Nanning Vocational and Technical College, Guangxi Water Conservancy and Electric Power Vocational and Technical College, Guilin Teachers College, Guangxi Vocational and Technical College, Liuzhou Vocational and Technical College, Guangxi Ecological Engineering Vocational and Technical College, Guangxi Communication Vocational and Technical College, Guangxi Industrial Vocational and Technical College, Guangxi International Business Vocational and Technical College, Liuzhou Railway Vocational and Technical College, Guangxi Construction Vocational and Technical College , Guangxi Modern Vocational and Technical College, Beihai Vocational College, Guangxi Economics and Trade Vocational and Technical College, Guangxi Industrial and Commercial Vocational and Technical College, Guangxi Electric Power Vocational and Technical College, Liuzhou City Vocational College, Baise Vocational College, Wuzhou Vocational College, Guangxi Early Childhood Teachers College, Guangxi Health Vocational and Technical College, Guangxi Finance Vocational and Technical College, Guangxi Safety Engineering Vocational and Technical College, Guangxi Natural Resources Vocational and Technical College, Qinzhou Preschool Teachers College, Guangxi Manufacturing Engineering Vocational and Technical College, Guangxi Logistics Vocational and Technical College, Fangchenggang Vocational Technology College. The above-mentioned problems exist to varying degrees in the development of online teaching in these colleges and universities.

In general, online teaching of vocational education in Guangxi still faces some problems and challenges, and it is necessary to further strengthen top-level design, resource construction, teacher training, assessment and evaluation, etc., in order to improve the quality and effect of teaching, and better serve the country and regional economic and social development.

Delphi Method

Originated from the RAND Corporation in 1950 (Okoli, 2004; Skulmoski, 2007), the Delphi method uses an interactive iterative process to seek expert consensus. (Vernon, 2009; Rowe, 1999), in order to make decisions or evaluations, or conduct predictive research.

The Delphi Method is a structured communication technique used to gather and synthesize expert opinions or judgments to make informed decisions or predictions on a particular topic. It aims to achieve convergence of opinions by collecting input from a panel of experts, often anonymously, over multiple rounds of iterative surveys or questionnaires. (Wang et al., 2021).

Here's how the Delphi Method typically works:

1. Panel Selection: A group of experts is selected based on their knowledge and experience in the subject area under investigation. These experts could be from various fields, and they participate voluntarily.

2. Round-Based Questioning: In the first round, the panelists are asked to respond to open-ended questions or statements related to the topic. Their responses are collected and summarized. These responses are then anonymized and shared with the panelists in subsequent rounds.

3. Feedback and Iteration: In each subsequent round, the experts are provided with summaries of the collective opinions from the previous round, along with any statistical or consensus data. They are then asked to reconsider their own opinions in light of the group's responses. They can modify their answers or maintain their initial responses. The process continues for several rounds until a certain level of convergence or consensus is reached.

4. Group Opinion Convergence: Over successive rounds, the experts' opinions tend to converge as they learn from each other's insights, and outliers are often minimized. This convergence helps identify trends, areas of agreement, and key issues within the group.

5. Final Analysis: Once consensus or a predefined stopping criterion is reached, the compiled expert opinions are analyzed to draw conclusions, make predictions, or inform decision-making.

The Delphi Method is commonly used in various fields, including business, healthcare, technology, and policy-making. It is particularly useful in situations where there is a lack of definitive data, and expert opinions can provide valuable insights. The method helps reduce bias, prevents the dominance of a single expert, and allows for diverse perspectives to be considered.

It's important to note that while the Delphi Method has its advantages, it also has limitations, such as potential bias in expert selection, challenges in achieving true consensus, and the time-consuming nature of multiple rounds of surveys.

Focus Group

Focus group is a qualitative research method used to gather insights and opinions from a small, diverse group of participants on a specific topic, product, service, or concept. It involves structured group discussions facilitated by a trained moderator. Focus groups provide in-depth qualitative data by allowing participants to share their thoughts, feelings, and experiences in a group setting, which often leads to valuable insights that might not be obtained through individual interviews or surveys alone. (Chang, 2006).

Here's how a typical focus group process works:

1. Participant Selection: A small group of participants, usually ranging from 6 to 10 individuals, is carefully selected based on specific criteria relevant to the research topic. Participants should represent a diverse range of perspectives and backgrounds related to the subject.

2. Moderator: A skilled moderator facilitates the discussion. Their role is to guide the conversation, ask open-ended questions, keep the discussion on track, and ensure that all participants have an opportunity to contribute.

3. Discussion Guide: The moderator uses a discussion guide, which is a list of open-ended questions and prompts designed to explore various aspects of the research topic. The guide provides structure to the conversation while allowing flexibility for participants to express their opinions.

4. Group Discussion: During the focus group session, participants engage in a guided conversation. The moderator encourages participants to share their thoughts,

listen to others, and respond to each other's comments. The dynamic interaction among participants often leads to a deeper exploration of the topic.

5. Data Collection: The focus group session is typically recorded. (with consent from participants) using audio or video equipment. Detailed notes are also taken by the moderator or an assistant. These recordings and notes serve as the primary sources of data for analysis.

6. Analysis: The recorded discussions and notes are transcribed and analyzed to identify key themes, patterns, and insights. Researchers look for commonalities and differences in participants' responses to extract meaningful information.

7. Reporting: The findings from the focus group are compiled into a report or presentation, often including direct quotes from participants. The report may be used to inform decisions, shape strategies, or generate further research questions.

Focus groups are particularly useful for exploring complex or nuanced topics, understanding participants' attitudes and perceptions, generating hypotheses for further research, and gaining insights into the language and terminology people use to describe a subject. However, it's important to note that focus groups may not always lead to generalizable results due to their small sample size and the potential for group dynamics to influence individual responses. (Chang Mei-Ying & Hsu Li-Ling,2006).

Related Research

This study explores the efficiency in online teaching and learning in vocational education computer programming strategy. Through literature review and analysis of keywords relevant to this study, it is discovered that related research is mainly distributed in aspects such as learning support service in vocational education.

Learning support services in vocational education

Huang (2022) mainly proposed innovative ideas for smart learning support services under the background of industry-education integration from five aspects: resource construction, teaching services, emotional interaction, data applications, and technical support. Adhere to the student-centered approach, build a comprehensive resource system that integrates production and education with characteristics, and develop fragmented micro-resources to meet students' learning needs anytime, anywhere. Innovate teaching support services, implement school-enterprise “dual system” auxiliary teaching, rationally adjust teaching content and practical teaching system, and realize personalized teaching. Provide interactive emotional support services, build a sharing platform, set up a learning community, respond to students' learning feedback in a timely manner, and carry out multiple interactions. Apply big data technology to make student learning portraits and provide students with personalized learning programs. Apply new technologies to realize interactive learning in different places, build a learning space that integrates virtual reality, support multi-terminal access, and provide personalized learning support.

Jiang (2016) proposed that the construction of support service mechanism under the perspective of blended learning needs to grasp the characteristics of system, whole process, intelligence and individualization of support. The construction of learning support services must first start with people, create a convenient, open, orderly, and intelligent learning field, rationally use learning support service technologies, build a big data environment, and build learning support services under the perspective of blended learning through active support, personalized support, and improving the quality of support service personnel. Similarly, the construction of a learning support service mechanism requires technological development, platform construction, and school mechanism construction as guarantee conditions.

Zhu (2016) believes that the construction of a learning support service system is the key to the implementation of online courses. Based on the theory of learning support services, it is proposed that network courses adopt a multi-subject co-implementation system, and a model of network course learning support service system is constructed. In the course implementation, the college has carried out a series of institutional arrangements and resource integration in terms of management, teachers, and services, such as formulating online course management methods, deploying tutors and encouraging flipped classrooms, and providing full-process and diversified learning support services. Through the construction of an efficient learning support service system, students are provided with a comprehensive service guarantee, which is an important support for the implementation of online courses.

Hu (2018) combined the "hybrid characteristics" of teaching support services, and proposed that colleges and universities should grasp the connection between traditional face-to-face classrooms and online learning, and build a targeted teaching support service system based on blended learning. This teaching support service system consists of six categories: institutional support, resource support, environmental support, technical support, team support, and management support. Contribute to the construction of a teaching support service system based on blended learning, from only supporting the development of traditional classroom teaching to a teaching support service system that supports online and offline mixed learning environments.

Ai et al. (2019) proposed that the learning support service system for vocational education professional teaching resource databases includes five major elements: resource support, technical support, environmental support, management support, and interactive support, and elaborated and in-depth analysis of specific measures and methods for carrying out learning support services, which has certain guiding significance for the application and promotion of resource databases.

Feng (2020) proposed that under the background of big data, the higher vocational teaching resource library platform should build personalized portraits of learners, use intelligent resource push, formulate personalized learning strategies, and implement diversified evaluations to provide customized online learning support services for different learners. Through portrait construction, intelligent push, strategy

formulation and multi-evaluation, etc., the advantages of big data technology are fully utilized, and the personalized learning support of the higher vocational teaching resource library platform is efficiently realized, and the level of online learning services is improved.

Wang (2020) systematically expounded the path of building learning support services for higher vocational students from the aspects of meeting different needs, changing learning attitudes, improving support service systems, optimizing academic services and improving non-academic services. The key is to analyze the differences in students' needs, strengthen the construction of service system, assist teaching links, provide diversified resource support, and create a good environment to better stimulate students' endogenous motivation and promote students' all-round development.

Guo et al. (2022) based on constructivism, analyzed the online learning support service content of Chinese vocational college SPOC from the teaching team support, management support, resource support, evaluation support and other online learning support service modules, combined with constructivism theory, centered on the learner, constructed the online learning support service framework from the four perspectives of student assistance, supervision, guidance, and learning promotion, and explained the role of online learning support services: the teaching team provides knowledge construction guidance; management uses data analysis to supervise learning; resource support multiple guidance Self-directed learning; assessment support facilitates the completion of learning tasks. Online support services should consider the characteristics of learners, provide appropriate guidance, supervision, resources and evaluation, so that learners can actively participate in online learning and improve learning effects.

The related research mainly focuses on the following aspects: resource construction, teaching services, emotional interaction, data applications, and technical support. The studies indicate that by building a comprehensive resource system, innovating teaching support services, providing emotional interaction support, and applying big data and new technologies, personalized and intelligent learning support services can be achieved. Additionally, the research emphasizes the importance of

systematic, comprehensive, intelligent, and personalized support service mechanisms, proposing specific measures and methods for constructing learning support service systems. These studies provide comprehensive service guarantees for the implementation of online courses in vocational education and promote the all-round development of students through efficient support service systems.

Chapter 3

Research Methodology

The research procedures consisted of two phases: 1) Using the Delphi Method to study the current situation problems of online teaching and learning in vocational education computer programming, and to develop the efficiency in online teaching and learning in vocational education computer programming strategy. 2) Using the Focus Group and Learning Efficiency Evaluation to implement and readjustment the efficiency in online teaching and learning in vocational education computer programming strategy. The researcher has the following procedures.

1. The population
2. Research Instruments
3. Data Collection
4. Data analysis

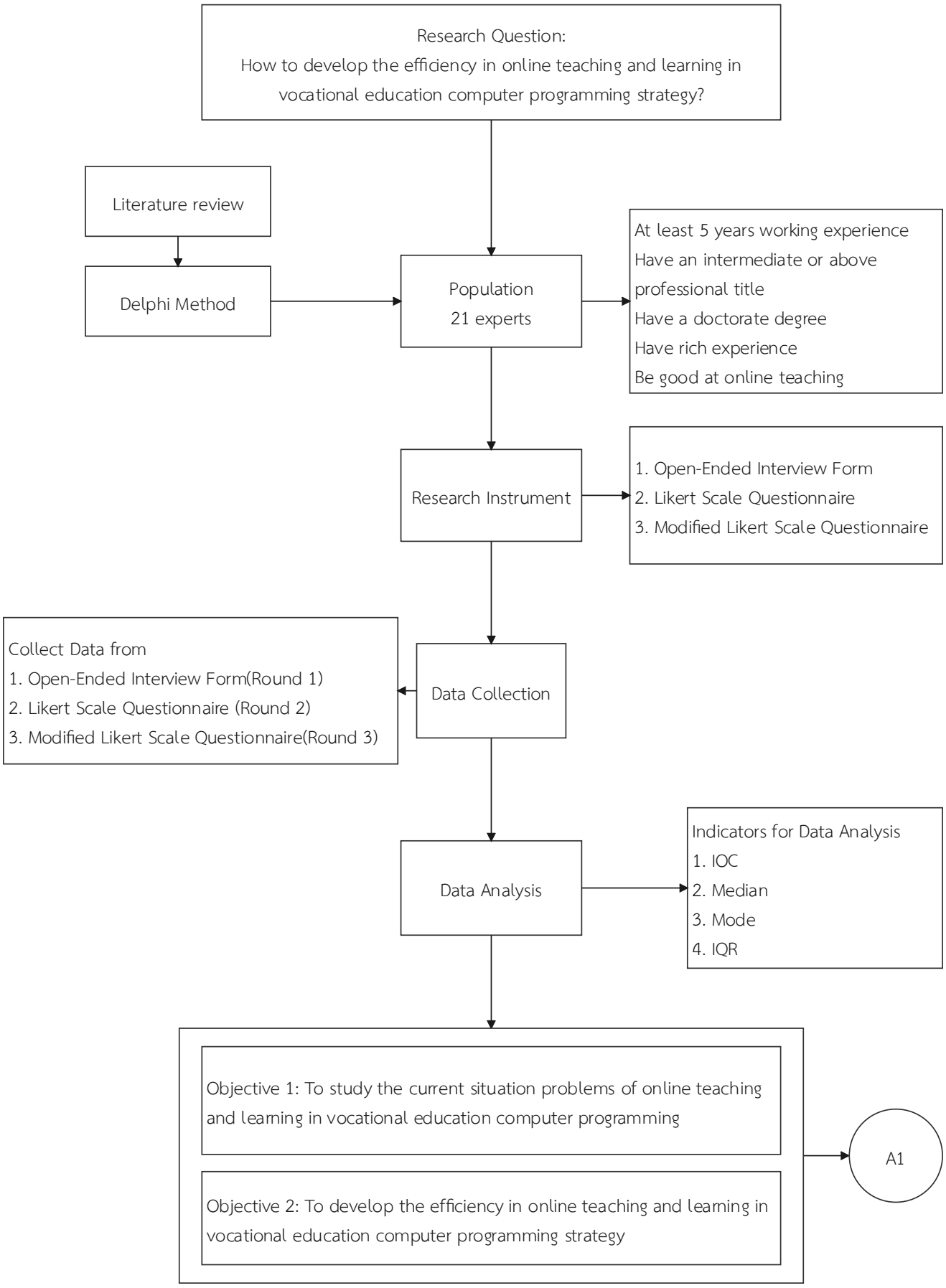

Figure 3.1 Research flow chart (Phase 1)

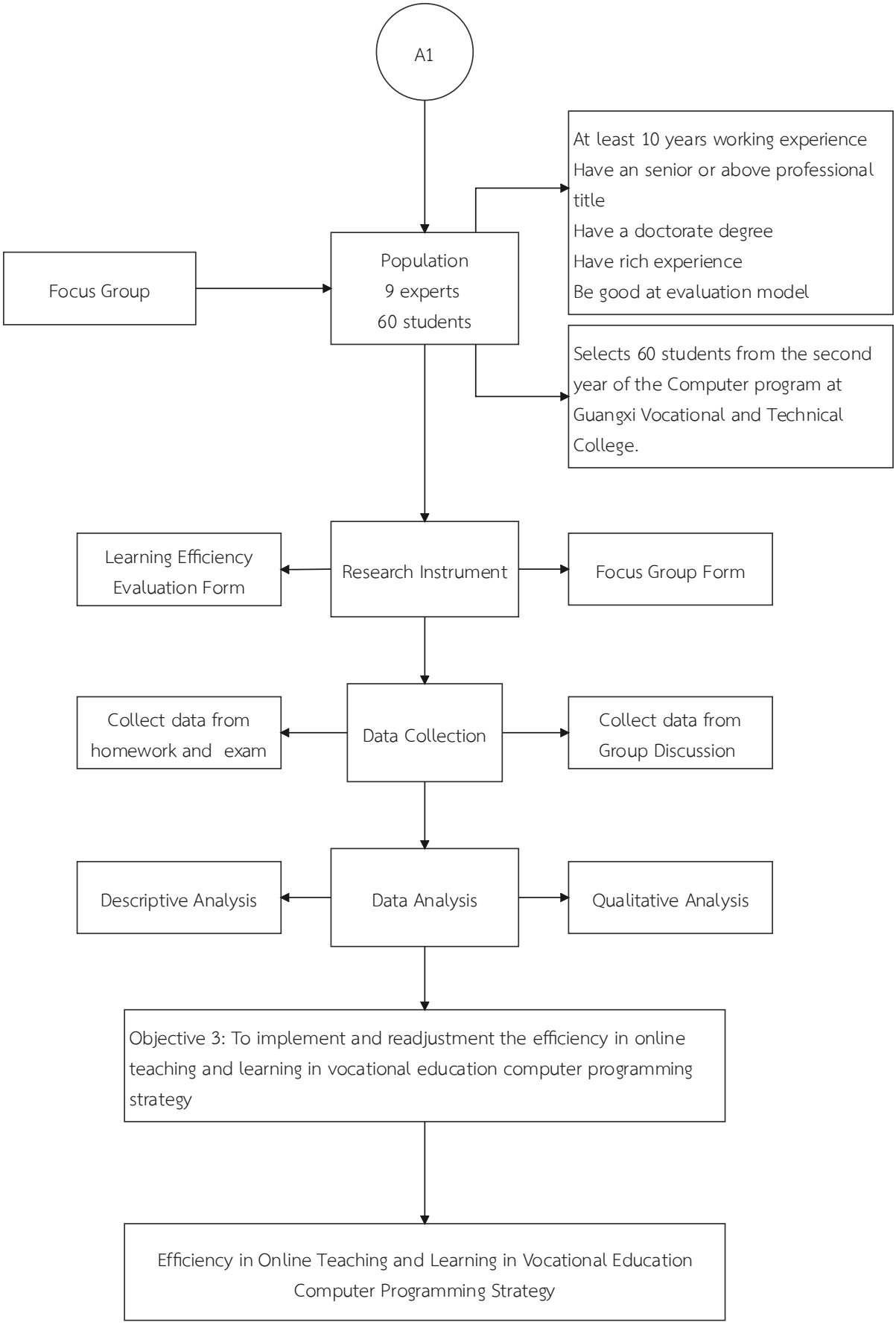

Figure 3.2 Research flow chart (Phase 2)

Phase 1: Employ the Delphi Method to achieve objective 1 and objective 2

The Population

The Population

The researcher uses Purpose Sample and selects 21 experts with the following qualifications:

1. At least of 5 years in online teaching experience;

2. Hold an intermediate or above professional title or a doctor's degree;

3. Possess rich practical experience in online teaching, and have achieved certain accomplishments;

4. Familiar with the educational model of vocational education and have a deep understanding of the theory, practice, and development trends of online education.

Table 3.1 Lists of expert and experience

No	Experts	Experience (Years)	Professional Title/Degree	Achievements	Familiarity
1	interviewee1	8	Doctorate	Rich Experience	Profound
2	interviewee2	10	Assoc. Prof	Significant	Profound
3	interviewee3	11	Assoc. Prof	Significant	Familiar
4	interviewee4	12	Assoc. Prof	Rich Experience	Familiar
5	interviewee5	15	Professor	Significant	Profound
6	interviewee6	10	Assoc. Prof	Rich Experience	Profound
7	interviewee7	13	Assoc. Prof	Significant	Familiar
8	interviewee8	10	Assoc. Prof	Rich Experience	Familiar
9	interviewee9	13	Professor	Rich Experience	Profound

Table 3.1 Lists of expert and experience (Continue)

No	Experts	Experience (Years)	Professional Title/Degree	Achievements	Familiarity
10	interviewee10	15	Professor	Significant	Familiar
11	interviewee11	6	Doctorate	Rich Experience	Profound
12	interviewee12	6	Intermediate	Rich Experience	Familiar
13	interviewee13	5	Doctorate	Significant	Profound
14	interviewee14	5	Doctorate	Rich Experience	Profound
15	interviewee15	10	Assoc. Prof	Significant	Familiar
16	interviewee16	11	Assoc. Prof	Rich Experience	Profound
17	interviewee17	15	Professor	Significant	Familiar
18	interviewee18	15	Professor	Rich Experience	Profound
19	interviewee19	13	Assoc. Prof	Rich Experience	Familiar
20	interviewee20	14	Assoc. Prof	Significant	Profound
21	interviewee21	10	Assoc. Prof	Rich Experience	Familiar

According to table 3.1, it showed that detailed information of the 21 experts participating in the Delphi research is presented. These experts were carefully selected based on rigorous qualification criteria, which encompassed their years of experience in online teaching, professional titles or degrees held, achievements in online education, and their familiarity with educational models. This information is of paramount importance for both expert selection and the subsequent analysis of their opinions. Among these 21 experts, the majority hold positions equivalent to or higher than Associate Professor and possess extensive experience in online education, which underscores the significance and confidence of their opinions and viewpoints in the research. Furthermore, their varying degrees of familiarity with educational models are poised to contribute to a deeper exploration of the online education domain.

Research Instruments

The research instruments used in this study are Open-Ended Interview Form and Likert Scale Questionnaire developed based on Delphi Method:

1. Open-Ended Interview Form

The instrument to collect the data for objective 1, to study the current situation of online teaching and learning in vocational education computer programming, and to collect the problems and challenges of online teaching and learning in vocational education computer programming. The Open-Ended Interview Form designed based on online teaching and learning in vocational education computer programming include 9 following aspects:

1. Teachers' Informatization Teaching Ability
2. Students' Autonomous Learning Ability
3. Online Teaching and Learning Interaction
4. Course Content
5. Teaching Resource
6. Teaching Design
7. Learning Engagement
8. School Policy Support
9. Online Teaching and Learning Platform

Construction process of the Open-Ended Interview Form:

Step 1: Reviewing and analyzing documents, concepts, theories, and researches related to the efficiency in online teaching and learning in vocational education computer programming strategy.

Step 2: Constructing the Open-Ended Interview Form about the current situation of online teaching and learning in vocational education computer programming. Then sending the Open-Ended Interview Form to the thesis advisors to review and revise the contents according to the suggestions.

Step 3: Distribute the Open-Ended Interview Form to 5 experts for try-out.

Step 4: Revise the Interview Form based on the experts' suggestions.

Step 5: Distribute Interview Form to selected 21 experts.

2. Likert Scale Questionnaire

The instrument to collect the data for objective 2, to setup the efficiency in online teaching and learning in vocational education computer programming strategy.

Based on the Community of Inquiry (CoI) theory, this study has revealed a strong correlation between its central components, namely pedagogical presence, social presence, and cognitive presence, and the 9 key facets related to efficient online teaching and learning in the context of vocational education computer programming. Consequently, the researcher has developed a Likert Scale Questionnaire set of 109 questions covering the following areas: Teachers' Informatization Technology Teaching Ability, Students' Autonomous Learning Ability, Online Teaching and Learning Interaction, Course Content, Teaching Resource, Teaching Design, Learning Engagement, School Policy Support, Online Teaching and Learning Platform.

Each statement was to measure on Likert Scale Questionnaire, as follows:

Table 3.2 Measurement scale of strategy

Level of Agree	Score
Strongly Agree	5
Agree	4
Neutral	3
Disagree	2
Strongly Disagree	1

Construction process of the Likert Scale Questionnaire

Step 1: Reviewing and analyzing concepts, theories, and researches related to Community of Inquiry (CoI).

Step 2: Based on the 21 experts' responses from the Open-Ended Interview Form, constructing the Likert Scale Questionnaire about survey was conducted the strategy of online teaching and learning in vocational education computer programming.

Step 3: The Likert Scale Questionnaire was distributed to 5 experts for try-out.

Step 4: The Index of Item Objective Congruence (IOC) of the questionnaire was examined by 5 experts. The Index of Item Objective Congruence (IOC) was 0.60 to 1.00.

Step 5: Revise the Likert Scale Questionnaire based on the experts' suggestions.

Step 6: Distribute the Modified Likert Scale Questionnaire to the selected 21 experts, requesting experts' responses and opinions, repeat three rounds.

Data Collection

The researchers made a request for cooperation using email or instant messaging tools, contact each expert to be willing to answer the question.

1. Collect the Open-Ended Interview Form in the interview.
2. Collect the Likert Scale Questionnaire of the first, second and third round.

Data Analysis

In the research based on Delphi Method, the concentration of expert advice can usually be analyzed by Median(Md), Mode(Mo), Inter-Quartile Range(IQR) Among them, the larger the Median(Md), the more important this constituent element, while when reflecting the concentration of experts' opinions through Inter-Quartile Range(IQR), the smaller the value is, the higher the concentration of expert opinions is, and the higher the value is, the worse the concentration of expert opinions is, and the meaning represented by the Median is unacceptable.

Median (Md)

The median is the score in the middle of the score data provided by all experts in order. It can describe the concentration trend of expert opinions, and then explain the meaning according to the standards set by Wang et al. (2020), as follows.

Table3.3 Judgement of the degree of agree by Median

Degree of Agree	Median (Md)
Highest	$4.0 < Md \leq 5.0$
High	$3.0 < Md \leq 4.0$
Medium	$2.0 < Md \leq 3.0$
Low	$1.0 < Md \leq 2.0$
Lowest	$0.0 < Md \leq 1.0$

Mode (Mo)

The Mode refers to the number of occurrences or the most frequent value in a set of data, which is a positional average and is not affected by the values of extreme variables. Plurality is primarily used to measure concentration trends in categorical data, but can also be used to measure concentration trends in ordinal and numeric data.

Inter-Quartile Range (IQR)

This study uses the view of Holden (1993) that when the inter-quartile range is less than or equal to 0.6, the item reaches a high consensus; if the inter-quartile range is between 0.6 and 1, the item reaches a moderate consensus; if the inter-quartile range is greater than 1, the item does not reach a consensus. If more than 75% of the questions reach a level above high consensus, the survey can be concluded.

Table 3.4 Judgement of the degree of Consensus by Inter-Quartile Range

Degree of Consensus	Inter-Quartile Range (IQR)
High	$0.0 \leq IQR < 0.6$
Medium	$0.6 \leq IQR < 1.0$
Low	$1.0 \leq IQR$

Index of Item Objective Congruence (IOC)

In order to ensure the validity of the data, the researcher applied the Index of Item Objective Congruence (IOC) test to the questionnaire validity evaluation. Based on the scoring range of - 1 to 1, 5 experts evaluated all items in the questionnaire, giving them a rating of 1. (Conforming to the measurement), - 1. (Non- conforming to the measurement), or 0. (Suspicious. According to this evaluation standard, the evaluation result value of all items in the questionnaire are greater than 0.6, which means that all items in the questionnaire are valid and consistent with the goal.

Phase 2: Employ the Focus Group and Class Comparison to achieve objective 3.

The Population

The researcher uses Purpose Sample and selects 60 students from the second year of the computer program at Guangxi Vocational and Technical College. And selects 9 experts, and the qualifications are as follows:

1. At least of 10 years in online teaching experience;

2. Possesses a senior or higher professional title or a doctoral degree;

3. Familiar with the educational model of vocational education and specializes in the development and evaluation of teaching strategies.

Research Instrument:

1. Focus Group Form

A structured form designed to guide the discussion within the Focus Group. The purpose of this form is to evaluate the efficiency in online teaching and learning in vocational education computer programming strategy.

Construction process of the Focus Group Form

Step 1: Define the objectives and questions of the Focus Group.

Step 2: Conduct the Focus Group meeting, guiding discussions according to the designed agenda. Ensure recording of the meeting content, including members' opinions, viewpoints, and suggestions.

Step 3: Guide Focus Group experts to discuss the proposed the efficiency in online teaching and learning in vocational education computer programming strategy. Ask for expert opinion on whether to “pass” or “modify” or “add” or “delete”.

Step 4: Collect the final results of expert discussions by Focus Group Form.

2. Learning Efficiency Evaluation Form

An educational evaluation tool used to systematically collect and analyze student learning performance and outcomes in a given course or instructional activity, with indicators included in the evaluation form reflecting the efficiency of student learning in terms of knowledge acquisition, skill development, attitudes and behaviors.

Construction process of Learning Efficiency Evaluation Form

Step 1: uses purpose sample and selects 60 students from the second year of the computer program at Guangxi Vocational and Technical College.

Step 2: Randomly assign the selected 60 students into two classes, ensuring balance in terms of student abilities and backgrounds. Ensure that all variables other than teaching strategies (such as curriculum content, class hours) are consistent.

Step 3: Implement traditional face-to-face Teaching Strategies and Online teaching and learning Strategies, Record the course progress and participation in both classes.

Step 4: Compare the grades of both groups in tests, assignments, and projects. Evaluate student performance in programming skills and problem-solving abilities.

Step 5: Use descriptive statistical methods to analyze the learning efficiency data of both groups. Assess which teaching strategy is more efficient and its impact on different types of students.

Data Collection:

The Focus Group discussions are form or video recorded to capture the interactions, opinions, and insights of the participants. And register the final conclusion with Focus Group Form.

Use Learning Efficiency Evaluation Form to collect and record the scores from homework, skill, and examinations taken by students in both classes.

Data Analysis:

Use qualitative analysis to categorize the results of Focus Group discussions and to analyze and summarize expert opinions in order to implement and readjustment the efficiency in online teaching and learning in vocational education computer programming strategy.

In comparing the traditional and online teaching strategies on student scores from homework, skill, and exam, Descriptive statistics are utilized. involving the calculation of Min, Max, Mean, Std. Deviation, Median, IQR.

Timeline

Table 3.5 Timeline of the research methodology and content

Time	Research methodology	Research content
2023.12.1- 2023.12.31	Delphi Method	Selected and contacted 21 eligible experts. Design and review the open-ended interview form Send the interview form to all 21 experts. Designing and reviewing the Likert scale questionnaire Send the Likert scale questionnaire to 5 experts for testing and IOC test. Collected feedback and revised the questionnaire based on experts' suggestions Conduct two rounds of Likert scale questionnaire. Collect and analyze data
2024.1.1- 2024.1.10	Focus Group method	Select and contact 60 students and 9 experts. Design the Focus Group discussion form Conduct Focus Group sessions. Collect the final results of expert discussions by Focus Group Form.
2024.1.1- 2024.1.31	Learning Efficiency Evaluation	Randomly assign 60 students to two classes and implement different instructional strategies. Recorded lesson progress and student participation Collect and compare student performance on tests, assignments, and projects between the two classes Analyze learning efficiency data using descriptive statistical methods.

Summary

This research analyzed the research questions and identified three research objectives. the Delphi and Focus Group methods design was used in the study, including quantitative and qualitative research.

The research was divided into three processes, which were the preparation of the research plan, the research procedure and the research report. Among them, the research procedure was divided into two phases according to the chronological order of the research objectives

Phases 1: Using the Delphi Method to study the current situation problems of online teaching and learning in vocational education computer programming, and to develop the efficiency in online teaching and learning in vocational education computer programming strategy.

Phases 2: Using the Focus Group method to implement and readjustment the efficiency in online teaching and learning in vocational education computer programming strategy. Using the Learning Efficiency Evaluation Form, Compare the grades of both groups in tests, assignments, and projects. Evaluate student performance in programming skills and problem-solving abilities.

Chapter 4
Results of Analysis

This research was to study: 1) To study the current situation problems of online teaching and learning in vocational education computer programming. 2) To develop the efficiency in online teaching and learning in vocational education computer programming strategy. 3) To implement and readjustment the efficiency in online teaching and learning in vocational education computer programming strategy.

The data analysis result can be presented as follows:

1. Symbol and abbreviations
2. Presentation of data analysis
3. Results of data analysis

The details are as follows.

Symbol and Abbreviations

N refers to the Sample

Md refers to the Median

Mo refers to the Mode

IQR refers to the Inter-Quartile Range

Presentation of Data Analysis

Part 1: The analysis results of the personal information of the respondents, classified by gender and educational background. The researcher presented the data by Frequency and Percentage.

Part 2: The analysis results of interview data about the current situation problems of online teaching and learning in vocational education computer programming by Text Statistics.

Part 3: The analysis results of the questionnaire data about the efficiency in online teaching and learning in vocational education computer programming strategy by Median, Mode and Inter-Quartile Range.

Part 4: The analysis results of the Focus Group discussion about the efficiency in online teaching and learning in vocational education computer programming strategy education by Qualitative Analysis

Part 5: The analysis results of the efficiency of the traditional class and online class by Descriptive Analysis.

Results of Data Analysis

The researcher analyzed the data in 5 parts as follows:

Part 1: The analysis results of the personal information of the respondents, classified by gender and educational background. The researcher presented the data by frequency and percentage.

Table 4.1 Personal information of the survey respondents

(n = 21)

Item	Personal Information	Frequency	Percentage
Gender	Male	13	61.90
	Female	8	38.10
	Total	**21**	**100**
Age	Under 30 years	2	9.52
	30-39 years	10	47.62
	40-49 years	6	28.57
	50-59 years	3	14.29
	Total	**21**	**100**
Experience	5-9 years	5	23.81
	10-14 years	12	57.14
	15 years and above	4	19.05
	Total	**21**	**100**

Table 4.1 Personal information of the survey respondents (Continue)

(n = 21)

Item	Personal Information	Frequency	Percentage
	Intermediate	5	23.81
Professional	Associate Professor	11	52.38
Title	Professor	5	23.81
	Total	**21**	**100**
	Bachelor’s degree	2	9.52
Educational	Master’s degree	15	71.43
background	Doctor’s degree	4	19.05
	Total	**21**	**100**

According to table 4.1, found that most respondents were 13 males, accounting for 61.90%, and 8 females, accounting for 38.10%. The age structure of the respondents was divided into four levels, 2 people were Under 30 years old accounting for 9.52%; There were 10 people aged 30-39, accounting for 47.62%; 6 people aged 40-49, accounting for 28.57%; 3 people aged 50-59, accounting for 14.29%. As for the working years of the respondents, 5 people worked for 5-9 years, accounting for 23.81%. From 10 to 14 years, 12 people, accounting for 57.14%;15 years and above 4 people, accounting for 19.05%. The number of Intermediate titles was 5 people, accounting for 23.81%; The number of Associate Professor title was 11 people, accounting for 52.38%; The number of Professor title was 5 people, accounting for23.81%. The main educational background is master's degree (15 people), accounting for 71.43%; 2 people with bachelor's degree accounting for 9.52%; The number of doctor’s degree was 4 people, accounting for 19.05%.

Part 2: The analysis results of interview data about the current situation problems of online teaching and learning in vocational education computer programming by Text Statistics.

Round 1 Result

Table4.2 Results for Round 1: Current situation problems

(n = 21)

Item	High	Medium	Low	Unspecified
Overall Level of Online Teaching and Leaning	13 (61.90)	3 (14.29)	5 (23.81)	0 (0.00)
Teachers' informatization teaching ability	13 (61.90)	2 (9.52)	6 (28.57)	0 (0.00)
Students' autonomous learning ability	8 (38.10)	3 (14.29)	7 (33.33)	3 (14.29)
Online teaching and learning interaction	7 (33.33)	5 (23.81)	6 (28.57)	3 (14.29)
Course Content	6 (28.57)	6 (28.57)	4 (19.05)	5 (23.81)
Teaching Resource	10 (47.62)	2 (9.52)	5 (23.81)	4 (19.05)
Teaching Design	8 (38.10)	4 (19.05)	4 (19.05)	5 (23.81)
Learning Engagement	8 (38.10)	4 (19.05)	5 (23.81)	4 (19.05)
School Policy Support	10 (47.62)	3 (14.29)	5 (23.81)	3 (14.29)
Online Teaching and Learning Platform	9 (42.86)	2 (9.52)	5 (23.81)	5 (23.81)

According to Table 4.2, reflect the 21 experts in the Open-Ended interviews answer to Q1: What do you think are the current situation problems of online teaching

and learning in vocational education computer programming? found that results from a survey of current situation problems in online teaching and learning. It covers several aspects, including the overall level of online teaching and learning, teachers' informatization teaching ability, students' autonomous learning ability, online teaching and learning interaction, course content, teaching resources, teaching design, learning engagement, school policy support, and online teaching and Learning platforms. Each aspect is evaluated in terms of high, medium, low, or unspecified levels, The overall level of online teaching and learning is rated high by 61.90% of respondents and low by 23.81%. Teachers' informatization teaching ability is considered high by 61.90% and low by 28.57%. Students' autonomous learning ability receives mixed ratings: 19.05% high, 23.81% medium, and 28.57% low. Online teaching and learning interaction are also varied: 19.05% high, 23.81% medium, 19.05% low. The evaluation of course content and teaching resources shows diversity: 14.29% high for content, 23.81% high for resources. Learning engagement rates as 14.29% high and 19.05% low. School policy support is seen as high by 23.81% and low by 19.05%. The use of teaching platforms is predominantly rated as average (42.86%). This table effectively summarizes the varied perceptions of the current state of online teaching and learning in vocational education.

Table4.3 Results for Round 1: Teachers' Informatization Teaching Ability

Strategy for Teachers' Informatization Teaching Ability	
1. Develop a five-year personal career development plan consistent with professional and school policies	2. Participate in competitions to enhance information technology teaching skills
3. Learn from experienced teachers' online teaching methods	4. Participate in online teaching achievement sharing sessions
5. Participate in short-term, online and off-campus trainings	6. Award certificates and prizes on Teachers' Day to teachers who are excellent in online teaching
7. Sharing online teaching experience among teachers	8. Encourage participation in information technology teaching reform research and provide financial support
9. Set up online teaching groups for regular discussions and seminars	10. Invite national famous teachers to share their IT teaching design and cases
11. Regular spot checks on teachers' teaching of informatization courses	12. Assign mentors to novice online teachers
13. Teachers listen to at least 10 lessons each semester	

According to Table 4.3, reflect the 21 experts in the Open-Ended interviews answer to Q2: What do you think is the strategy for teachers' information teaching ability in online teaching and learning in vocational education computer programming? A total of 13 strategies for teachers' informatization teaching ability were sorted and classified by text data statistics.

Table4.4 Results for Round 1: Students' Autonomous Learning Ability

Strategy for Students' Autonomous Learning Ability	
14. Engage with students to understand their thoughts and help them set career goals	15. Create clubs focusing on professional skills for voluntary social services
16. Offer courses to inspire self-assessment and positioning	17. Establish studios for research and skill competitions under teacher guidance
18. Encourage students to evaluate and develop interest in their majors	19. Incorporate tasks like micro-teaching videos for course grading
20. Assist in semester-wise study planning and time management	21. Conduct regular skill assessments for students
22. Schools should create a campus culture of active learning	23. Encourage students to obtain professional certifications and offer cash rewards
24. Monitor and analyze student learning behaviors	25. Monthly competitions with rewards for top performers
26. Offer courses to develop entrepreneurial skills and self-learning	27. Provide courses for self-confidence and motivation
28. Integrate career guidance into teaching	29. Organize events like mock interviews to boost learning motivation.

According to Table 4.4, reflect the 21 experts in the Open-Ended interviews answer to Q3: What do you think is the strategy for student's autonomous learning ability in online teaching and learning in vocational education computer programming? A total of 16 strategies for students' autonomous learning ability were sorted and classified by text data statistics.

Table4.5 Results for Round 1: Online Teaching and Learning Interaction

Strategy for Online Teaching and Learning Interaction	
30. Use tools like WeChat-Group for monitoring student learning	31. Focus on language use to strengthen teacher-student emotional connections
32. Initiate topics of interest in the online platform's discussion forums.	33. Implement a points system for interactive participation
34. Assign tasks like short answers or multiple-choice questions to evaluate self-learning	35. Incorporate pop-ups, polls, and Q&A features to enhance interaction
36. Students present their work and have it critiqued one by one	37. Set up a system with teaching assistants to boost interaction and assist in Q&A

According to table 4.5, reflect the 21 experts in the Open-Ended interviews answer to Q4: What do you think is the strategy for online teaching and learning interaction in online teaching and learning in vocational education computer programming? A total of 8 strategies for online teaching and learning interaction were sorted and classified by text data statistics.

Table4.6 Results for Round 1: Course Content

Strategy for Course Content	
38. Align course content with enterprise employment needs	39. More practical cases to be included in the course content
40. Develop course content that meets the characteristics of cultivating skilled personnel in vocational colleges	41. The course content should emphasize practicality and operability
42. Select and adapt content based on student needs to ease learning	43. Develop courses reflecting actual vocational tasks and processes
44. Industry experts participate in the whole process of course content development	45. Course content should be integrated with workplace culture
46. Modularization of course content, including knowledge module, skill module and ideology module	47. Integrate content with vocational skill certification knowledge points

According to table 4.6, reflect the 21 experts in the Open-Ended interviews answer to Q5: What do you think is the strategy for course content in online teaching and learning in vocational education computer programming? A total of 10 strategies for course content were sorted and classified by text data statistics.

Table4.7 Results for Round 1: Teaching Resource

Strategy for Teaching Resource	
48. Create a centralized database for resource sharing and reuse	49. Purchase or obtain resources from reputable organizations
50. Invest in creating engaging resources like videos, animations, and simulations	51. Establish an incentive mechanism for the development of teaching resources
52. Partner with enterprises for up-to-date practical training resources	53. Form a team dedicated to enhancing resource quality
54. Create micro-courses and small coursewares for mobile access	55. Utilize AI and AR/VR to diversify teaching resources
56. Provide financial support for teachers to update curricula with digital tools	57. Develop vocational education teaching resources

According to Table 4.7, reflect the 21 experts in the Open-Ended interviews answer to Q6: What do you think is the strategy for teaching resource in online teaching and learning in vocational education computer programming? A total of 10 strategies for teaching resource were sorted and classified by text data statistics.

Table4.8 Results for Round 1: Teaching Design

Strategy for Teaching Design	
58. Teachers to research students' learning environments before class	59. Adopt typical cases and project-based teaching design for the course
60. Opt for easy-to-use online teaching techniques	61. Rationalize the time schedule of each teaching session
62. Assign tasks and guide students to preview videos with questions	63. Increase the proportion of practical sessions
64. Reasonably design the amount of teaching content for online teaching	65. Design corresponding plans and flexibly adopt live broadcasting and video broadcasting
66. Focus on learning goals, break down knowledge points, and limit lessons to 15 minutes	67. Use interactive methods like games, quizzes, and voting judiciously
68. Define clear objectives and key points in teaching design	69. Regularly review and assess course lesson plans
70. Adjust teaching based on student feedback	71. Design learning tasks with varying difficulty levels

According to Table 4.8, reflect the 21 experts in the Open-Ended interviews answer to Q7: What do you think is the strategy for teaching design in online teaching and learning in vocational education computer programming? A total of 14 strategies for teaching design were sorted and classified by text data statistics.

Table4.9 Results for Round 1: Learning Engagement

Strategy for Learning Engagement	
72. Monitor online learning and alert non-participating students automatically	73. Developing personalized study plans
74. Implement a mechanism to flag low engagement and initiate intervention measures	75. Cultivate study habits and share learning methods
76. Employ specialized teaching assistants to continuously supervise and tutor students	77. Guiding students to establish learning partners and solve problems together
78. Praise and incentivize students who are highly engaged in their studies	79. Guiding students to reflect and digest knowledge in a timely manner
80. Provide rich and practical resources for learners	81. Enhance the fun and practicality of online courses

According to Table 4.9, reflect the 21 experts in the Open-Ended interviews answer to Q8: What do you think is the strategy for learning engagement in online teaching and learning in vocational education computer programming? A total of 10 strategies for learning engagement were sorted and classified by text data statistics.

Table4.10 Results for Round 1: School Policy Support

Strategy for School Policy Support	
82. Establishment of a training mechanism for teachers of different specialties	83. Schools can set up a teaching point system to favor teachers in their treatment and performance appraisal
84. Incorporate online teaching ability into the appraisal system of teachers' titles	85. Award points and rewards to teachers actively participating in online teaching training
86. Integrate online teaching into the school's overall development plans	87. Establish school, provincial, and national indicators for teaching informatization, linked to title promotions
88. Involvement in online teaching construction and individual excellent cases into the annual performance incentives	89. Actively introduce highly competent informatization talents
90. Enhance financial investment to build interactive teaching equipment and recording and broadcasting classrooms	91. Setting up a technology management department centered on the online teaching and learning platform
92. Build wired and wireless networks covering the whole school	93. Set up a teaching management department focusing on online teaching talent training.
94. Randomly check the online teaching of teachers in each semester	95. Organize an online teaching expert assessment team to regularly assess the quality of online teaching in all aspects

Table4.10 Results for Round 1: School Policy Support (Continue)

Strategy for School Policy Support	
96. Introducing school credit bank and credit recognition system to expand the recognition of online learning	97. Establish a comprehensive online teaching training system covering teaching, research, and competitions

According to Table 4.10, reflect the 21 experts in the Open-Ended interviews answer to Q9: What do you think is the strategy for school policy support in online teaching and learning in vocational education computer programming? A total of 16 strategies for school policy support were sorted and classified by text data statistics.

Table4.11 Results for Round 1: Online Teaching and Learning Platform

Strategy for Online Teaching and Learning Platform	
98. Online teaching and learning platform to enhance data security protection	99. Ensure system stability and reliability for many users
100. Support real-time interactions, discussions, tests, and mobile learning	101. Allow uploading various teaching resources and course creation
102. Enable seamless operation on different devices	103. Support flexible and skill-based assessments, like code reviews
104. Provide feedback collection, resource distribution, and course planning	105. Automatically design customized learning content
106. Focus on simple and efficient interface	107. Create profiles and suggestions using big data
108. Integrate vocational skill examination systems	109. Offer personalized job recommendations for students

According to Table 4.11, reflect the 21 experts in the Open-Ended interviews answer to Q10: What do you think is the strategy for online teaching and learning platform in online teaching and learning in vocational education computer programming? A total of 12 strategies for online teaching and learning platform were sorted and classified by text data statistics.

Part 3: The analysis results of the questionnaire data about the efficiency in online teaching and learning in vocational education computer programming strategy by Median, Mode and Inter-Quartile Range.

Round 2 Result

Table 4.12 Results for Round 2: Teachers' Informatization Teaching Ability

(n = 21)

Item	Teachers' Informatization Teaching Ability	Md	Mo	IQR	Consensus (%)
1	Develop a five-year personal career development plan consistent with professional and school policies	4.0	4.0	0.5	61.90
2	Participate in competitions to enhance information technology teaching skills	5.0	5.0	0.5	90.48
3	Learn from experienced teachers' online teaching methods	5.0	5.0	0.5	85.71
4	Participate in online teaching achievement sharing sessions	3.0	3.0	1.0	47.62
5	Participate in short-term, online and off-campus trainings	5.0	5.0	0.0	80.95
6	Award certificates and prizes on Teachers' Day to teachers who are excellent in online teaching	4.0	4.0	1.0	61.90
7	Sharing online teaching experience among teachers	4.0	5.0	0.5	80.95
8	Encourage participation in information technology teaching reform research and provide financial support	4.0	4.0	0.5	61.90

Table 4.12 Results for Round 2: Teachers' Informatization Teaching Ability (Continue)

(n = 21)

Item	Teachers' Informatization Teaching Ability	Md	Mo	IQR	Consensus (%)
9	Set up online teaching groups for regular discussions and seminars	4.0	5.0	0.5	80.95
10	Invite national famous teachers to share their IT teaching design and cases	3.0	4.0	1.0	47.62
11	Regular spot checks on teachers' teaching of informatization courses	4.0	4.0	0.5	80.95
12	Assign mentors to novice online teachers	3.0	3.0	0.5	42.86
13	Teachers listen to at least 10 lessons each semester	2.0	4.0	1.5	42.86

According to table 4.12, found that consensus among 75% or more of the 21 experts were obtained 6 of the 13 strategies for teachers' informatization teaching ability in Round 2. As follows: Item 2 “Participate in competitions to enhance information technology teaching skills” (Md =5.0,Mo =5.0,IQR =0.5), Item 3 “Learn from experienced teachers' online teaching methods” (Md =5.0,Mo =5.0,IQR =0.5), Item 5 “Participate in short-term, online and off-campus trainings” (Md =5.0,Mo =5.0,IQR =0.0). Item 7 “Sharing online teaching experience among teachers” ($Md = 4.0, Mo = 5.0, IQR = 0.5$). Item 9 “Set up online teaching groups for regular discussions and seminars” (Md =4.0,Mo =5.0,IQR =0.5). Item 11 “Regular spot checks on teachers' teaching of informatization courses” (Md =4.0,Mo =4.0,IQR =0.5).

Table 4.13 Results for Round 2: Students' Autonomous Learning Ability

(n = 21)

Item	Students' Autonomous Learning Ability	Md	Mo	IQR	Consensus (%)
1	Engage with students to understand their thoughts and help them set career goals	5.0	5.0	0.0	80.95
2	Create clubs focusing on professional skills for voluntary social services	3.0	4.0	1.0	42.86
3	Offer courses to inspire self-assessment and positioning	5.0	5.0	0.5	80.95
4	Establish studios for research and skill competitions under teacher guidance	5.0	5.0	0.0	85.71
5	Encourage students to evaluate and develop interest in their majors	4.0	4.0	1.0	71.43
6	Incorporate tasks like micro-teaching videos for course grading	4.0	5.0	0.5	76.19
7	Assist in semester-wise study planning and time management	3.0	4.0	1.0	52.38
8	Conduct regular skill assessments for students	4.0	5.0	0.5	80.95
9	Schools should create a campus culture of active learning	4.0	4.0	0.0	80.95
10	Encourage students to obtain professional certifications and offer cash rewards	5.0	5.0	0.5	95.24

Table 4.13 Results for Round 2: Students' Autonomous Learning Ability (Continue)

(n = 21)

Item	Students' Autonomous Learning Ability	Md	Mo	IQR	Consensus (%)
11	Monitor and analyze student learning behaviors	4.0	4.0	1.0	71.43
12	Monthly competitions with rewards for top performers	5.0	5.0	0.0	90.48
13	Offer courses to develop entrepreneurial skills and self-learning	3.0	4.0	1.0	38.10
14	Provide courses for self-confidence and motivation	3.0	4.0	0.5	42.86
15	Integrate career guidance into teaching	3.0	4.0	1.0	52.38
16	Organize events like mock interviews to boost learning motivation.	3.0	3.0	0.5	33.33

According to table 4.13, found that consensus among 75% or more of the 21 experts were obtained 8 of the 16 strategies for students' autonomous learning ability in Round 2. As follows: Item 1 “Engage with students to understand their thoughts and help them set career goals” (Md =5.0,Mo =5.0,IQR =0.0), Item 3 “Offer courses to inspire self-assessment and positioning” (Md = 5.0, Mo = 5.0, IQR = 0.5.0), Item 4 “Establish studios for research and skill competitions under teacher guidance” (Md =5.0,Mo =5.0,IQR =0.0), Item 6 “Incorporate tasks like micro-teaching videos for course grading”(Md =4.0,Mo =5.0,IQR =0.5), Item8 “Conduct regular skill assessments for students”(Md =4.0,Mo =5.0,IQR =0.5), Item 9 “Schools should create a campus culture of active learning”(Md =4.0,Mo =4.0,IQR =0.0), Item 10 “Encourage students to obtain professional certifications and offer cash rewards” (Md =5.0,Mo =5.0,IQR =0.5),

Item 12 “Monthly competitions with rewards for top performers” (Md =5.0,Mo =5.0,IQR =0.0).

Table 4.14 Results for Round 2: Online Teaching and Learning Interaction

(n = 21)

Item	Online Teaching and Learning Interaction	Md	Mo	IQR	Consensus (%)
1	Use tools like WeChat-Group for monitoring student learning	4.0	4.0	0.0	90.48
2	Focus on language use to strengthen teacher-student emotional connections	5.0	5.0	0.0	85.71
3	Initiate topics of interest in the online platform's discussion forums.	4.0	5.0	0.5	80.95
4	Implement a points system for interactive participation	3.0	4.0	0.5	52.38
5	Assign tasks like short answers or multiple-choice questions to evaluate self-learning	5.0	5.0	0.5	80.95
6	Incorporate pop-ups, polls, and Q&A features to enhance interaction	5.0	5.0	0.0	100.00
7	Students present their work and have it critiqued one by one	3.0	4.0	0.5	47.62
8	Set up a system with teaching assistants to boost interaction and assist in Q&A	4.0	4.0	0.5	57.14

According to table 4.14, found that consensus among 75% or more of the 21 experts were obtained 5 of the 8 strategies for online teaching and learning interaction

in Round 2. As follows: Item 1 “Use tools like WeChat-Group for monitoring student learning”(Md =4.0,Mo =4.0,IQR =0.0), Item 2 “Focus on language use to strengthen teacher-student emotional connections” (Md =5.0,Mo =5.0,IQR =0.0), Item 3 “Initiate topics of interest in the online platform's discussion forums” (Md =4.0,Mo =5.0,IQR =0.5), Item 5 “Assign tasks like short answers or multiple-choice questions to evaluate self-learning” (Md =5.0,Mo =5.0,IQR =0.5), Item 6 “Incorporate pop-ups, polls, and Q&A features to enhance interaction” (Md =5.0,Mo =5.0,IQR =0.0).

Table 4.15 Results for Round 2: Course Content

(n = 21)

Item	Course Content	Md	Mo	IQR	Consensus (%)
1	Align course content with enterprise employment needs	4.0	4.0	1.0	52.38
2	More practical cases to be included in the course content	4.0	5.0	0.5	80.95
3	Develop course content that meets the characteristics of cultivating skilled personnel in vocational colleges	4.0	4.0	0.0	90.48
4	The course content should emphasize practicality and operability	4.0	4.0	0.5	71.43
5	Select and adapt content based on student needs to ease learning	5.0	5.0	0.0	90.48
6	Develop courses reflecting actual vocational tasks and processes	3.0	4.0	0.5	47.62

Table 4.15 Results for Round 2: Course Content (Continue)

(n = 21)

Item	Course Content	Md	Mo	IQR	Consensus (%)
7	Industry experts participate in the whole process of course content development	4.0	5.0	1.0	66.67
8	Course content should be integrated with workplace culture	4.0	4.0	1.0	76.19
9	Modularization of course content, including knowledge module, skill module and ideology module	5.0	5.0	0.0	85.71
10	Integrate content with vocational skill certification knowledge points	5.0	5.0	0.5	95.24

According to table 4.15, found that consensus among 75% or more of the 21 experts were obtained 6 of the 10 strategies for course content in Round 2. As follows: Item 2 “More practical cases to be included in the course content” ($Md = 4.0$, $Mo = 5.0$, $IQR = 0.5$),Item 3 “Develop course content that meets the characteristics of cultivating skilled personnel in vocational colleges” (Md =4.0,Mo =4.0,IQR =0.0), Item 5 “Select and adapt content based on student needs to ease learning” (Md =5.0,Mo =5.0,IQR =0.0), Item 8 “Course content should be integrated with workplace culture”(Md =4.0,Mo =4.0,IQR =1.0). Item 9 “Modularization of course content, including knowledge module, skill module and ideology module” ($Md = 5.0$, $Mo = 5.0$, $IQR = 0.0$), Item 10 “Integrate content with vocational skill certification knowledge points” (Md =5.0,Mo =5.0,IQR =0.5).

Table 4.16 Results for Round 2: Teaching Resource

(n = 21)

Item	Teaching Resource	Md	Mo	IQR	Consensus (%)
1	Create a centralized database for resource sharing and reuse	5.0	5.0	0.0	85.71
2	Purchase or obtain resources from reputable organizations	3.0	4.0	1.0	42.86
3	Invest in creating engaging resources like videos, animations, and simulations	4.0	5.0	0.5	80.95
4	Establish an incentive mechanism for the development of teaching resources	5.0	5.0	0.5	95.24
5	Partner with enterprises for up-to-date practical training resources	4.0	4.0	1.0	66.67
6	Form a team dedicated to enhancing resource quality	5.0	5.0	0.0	90.48
7	Create micro-courses and small coursewares for mobile access	4.0	5.0	0.5	80.95
8	Utilize AI and AR/VR to diversify teaching resources	3.0	4.0	1.0	42.86
9	Provide financial support for teachers to update curricula with digital tools	4.0	4.0	0.0	80.95
10	Develop vocational education teaching resources	5.0	5.0	0.5	90.48

According to table 4.16, found that consensus among 75% or more of the 21 experts were obtained 7 of the 10 strategies for teaching resource in Round 2. As follows: Item 1 “Create a centralized database for resource sharing and reuse” (Md =5.0,Mo =5.0,IQR =0.0), Item 3 “Invest in creating engaging resources like videos, animations, and simulations”($Md = 4.0$, $Mo = 5.0$, $IQR = 0.5$), Item 4 “Establish an incentive mechanism for the development of teaching resources” (Md =5.0,Mo =5.0,IQR =0.5), Item 6 “Form a team dedicated to enhancing resource quality” ($Md = 5.0$, $Mo = 5.0$, $IQR = 0.0$), Item 7 “Create micro-courses and small coursewares for mobile access” (Md =4.0,Mo =5.0,IQR =0.5). , Item 9 “Provide financial support for teachers to update curricula with digital tools”(Md =4.0,Mo =4.0,IQR =0.0). Item 10 “Develop vocational education teaching resources” (Md =5.0,Mo =5.0,IQR =0.5).

Table 4.17 Results for Round 2: Teaching Design

(n = 21)

Item	Teaching Design	Md	Mo	IQR	Consensus (%)
1	Teachers to research students' learning environments before class	5.0	5.0	0.0	95.24
2	Adopt typical cases and project-based teaching design for the course	4.0	5.0	0.5	80.95
3	Opt for easy-to-use online teaching techniques	5.0	5.0	0.5	90.48
4	Rationalize the time schedule of each teaching session	4.0	4.0	0.0	80.95
5	Assign tasks and guide students to preview videos with questions	4.0	4.0	0.0	80.95
6	Increase the proportion of practical sessions	4.0	4.0	0.5	76.19

Table 4.17 Results for Round 2: Teaching Design (Continue)

(n = 21)

Item	Teaching Design	Md	Mo	IQR	Consensus (%)
7	Reasonably design the amount of teaching content for online teaching	3.0	4.0	1.0	47.62
8	Design corresponding plans and flexibly adopt live broadcasting and video broadcasting	3.0	4.0	1.0	33.33
9	Focus on learning goals, break down knowledge points, and limit lessons to 15 minutes	4.0	4.0	0.5	76.19
10	Use interactive methods like games, quizzes, and voting judiciously	4.0	4.0	0.0	85.71
11	Define clear objectives and key points in teaching design	3.0	4.0	1.0	42.86
12	Regularly review and assess course lesson plans	3.0	4.0	1.0	42.86
13	Adjust teaching based on student feedback	4.0	4.0	0.5	66.67
14	Design learning tasks with varying difficulty levels	4.0	5.0	0.5	80.95

According to table 4.17, found that consensus among 75% or more of the 21 experts were obtained 9 of the 14 strategies for teaching design in Round 2. As follows: Item 1 “Teachers to research students' learning environments before class” (Md =5.0,Mo =5.0,IQR =0.0), Item 2 “Adopt typical cases and project-based teaching design for the course” (Md =4.0,Mo =5.0,IQR =0.5), Item 3 “Opt for easy-to-use online teaching techniques” ($Md = 5.0, Mo = 5.0, IQR = 0.5$), Item 4 “Rationalize the time

schedule of each teaching session" (Md =4.0,Mo =4.0,IQR =0.0). Item 5 "Assign tasks and guide students to preview videos with questions" (Md =4.0,Mo =4.0,IQR =0.0). Item 6 "Increase the proportion of practical sessions" (Md =4.0,Mo =4.0,IQR =0.5). Item 9 "Focus on learning goals, break down knowledge points, and limit lessons to 15 minutes" (Md =4.0,Mo =4.0,IQR =0.5). Item 10 "Use interactive methods like games, quizzes, and voting judiciously" (Md =4.0,Mo =4.0,IQR =0.0). Item 14 "Design learning tasks with varying difficulty levels" (Md =4.0,Mo =5.0,IQR =0.5).

Table 4.18 Results for Round 2: Learning Engagement

(n = 21)

Item	Learning Engagement	Md	Mo	IQR	Consensus (%)
1	Monitor online learning and alert non-participating students automatically	3.0	3.0	0.0	9.52
2	Developing personalized study plans	3.0	4.0	1.0	33.33
3	Implement a mechanism to flag low engagement and initiate intervention measures	4.0	5.0	0.5	80.95
4	Cultivate study habits and share learning methods	5.0	5.0	0.0	95.24
5	Employ specialized teaching assistants to continuously supervise and tutor students	5.0	5.0	0.0	90.48
6	Guiding students to establish learning partners and solve problems together	4.0	4.0	0.5	66.67
7	Praise and incentivize students who are highly engaged in their studies	4.0	4.0	1.0	42.86

Table 4.18 Results for Round 2: Learning Engagement (Continue)

(n = 21)

Item	Learning Engagement	Md	Mo	IQR	Consensus (%)
8	Guiding students to reflect and digest knowledge in a timely manner	3.0	4.0	1.0	38.10
9	Provide rich and practical resources for learners	4.0	5.0	0.5	80.95
10	Enhance the fun and practicality of online courses	5.0	5.0	0.5	90.48

According to table 4.18, found that consensus among 75% or more of the 21 experts were obtained 5 of the 10 strategies for learning engagement in Round 2. As follows: The responses for Strongly Agree are as follows: Item 3 “Implement a mechanism to flag low engagement and initiate intervention measures” (Md =4.0,Mo =5.0,IQR =0.5), Item 4 “Cultivate study habits and share learning methods” ($Md = 5.0, Mo = 5.0, IQR = 0.0$), Item 5 “Employ specialized teaching assistants to continuously supervise and tutor students” ($Md = 5.0, Mo = 5.0, IQR = 0.0$). Item 9 “Provide rich and practical resources for learners” (Md =4.0,Mo =5.0,IQR =0.5), Item 10 “Enhance the fun and practicality of online courses” (Md =5.0,Mo =5.0,IQR =0.5).

Table 4.19 Results for Round 2: School Policy Support

(n = 21)

Item	School Policy Support	Md	Mo	IQR	Consensus (%)
1	Establishment of a training mechanism for teachers of different specialties	4.0	4.0	0.5	66.67
2	Schools can set up a teaching point system to favor teachers in their treatment and performance appraisal	4.0	5.0	0.5	80.95
3	Incorporate online teaching ability into the appraisal system of teachers' titles	5.0	5.0	0.0	95.24
4	Award points and rewards to teachers actively participating in online teaching training	3.0	4.0	1.0	42.86
5	Integrate online teaching into the school's overall development plans	5.0	5.0	0.0	90.48
6	Establish school, provincial, and national indicators for teaching informatization, linked to title promotions	4.0	4.0	0.5	57.14
7	Involvement in online teaching construction and individual excellent cases into the annual performance incentives	5.0	5.0	0.0	90.48
8	Actively introduce highly competent informatization talents	4.0	5.0	0.5	80.95

Table 4.19 Results for Round 2: School Policy Support (Continue)

(n = 21)

Item	School Policy Support	Md	Mo	IQR	Consensus (%)
9	Enhance financial investment to build interactive teaching equipment and recording and broadcasting classrooms	5.0	5.0	0.0	85.71
10	Setting up a technology management department centered on the online teaching and learning platform	4.0	4.0	0.5	66.67
11	Build wired and wireless networks covering the whole school	3.0	4.0	1.0	38.10
12	Set up a teaching management department focusing on online teaching talent training	4.0	5.0	0.5	80.95
13	Randomly check the online teaching of teachers in each semester	3.0	4.0	1.0	33.33
14	Organize an online teaching expert assessment team to regularly assess the quality of online teaching in all aspects.	4.0	4.0	1.0	38.10
15	Introducing school credit bank and credit recognition system to expand the recognition of online learning.	3.0	4.0	1.0	28.57
16	Establish a comprehensive online teaching training system covering teaching, research, and competitions	4.0	4.0	0.5	61.90

According to table 4.19, found that consensus among 75% or more of the 21 experts were obtained 7 of the 16 strategies for school policy support in Round 2. As follows: Item 2 “Schools can set up a teaching point system to favor teachers in their treatment and performance appraisal” ($Md = 4.0$, $Mo = 5.0$, $IQR = 0.5$), Item 3 “Incorporate online teaching ability into the appraisal system of teachers' titles” (Md =5.0,Mo =5.0,IQR =0.0), Item 5 “Integrate online teaching into the school's overall development plans” ($Md = 5.0, Mo = 5.0, IQR = 0.0$). Item 7 “Involvement in online teaching construction and individual excellent cases into the annual performance incentives” (Md =5.0,Mo =5.0,IQR =0.0), Item 8 “Actively introduce highly competent informatization talents” ($Md = 4.0, Mo = 5.0, IQR = 0.5$), Item 9 “Enhance financial investment to build interactive teaching equipment and recording and broadcasting classrooms” (Md =5.0,Mo =5.0,IQR =0.0). Item 12 “Set up a teaching management department focusing on online teaching talent training” (Md =4.0,Mo =5.0,IQR =0.5).

Table 4.20 Results for Round 2: Online Teaching and Learning Platform

(n = 21)

Item	Online Teaching and Learning Platform	Md	Mo	IQR	Consensus (%)
1	Online teaching and learning platform to enhance data security protection	3.0	4.0	1.0	33.33
2	Ensure system stability and reliability for many users	3.0	3.0	1.0	28.57
3	Support real-time interactions, discussions, tests, and mobile learning	5.0	5.0	0.0	85.71
4	Allow uploading various teaching resources and course creation	5.0	5.0	0.5	90.48
5	Enable seamless operation on different devices	3.0	5.0	1.0	42.86

Table 4.20 Results for Round 2: Online Teaching and Learning Platform (Continue)

(n = 21)

Item	Online Teaching and Learning Platform	Md	Mo	IQR	Consensus (%)
6	Support flexible and skill-based assessments, like code reviews	5.0	5.0	0.0	85.71
7	Provide feedback collection, resource distribution, and course planning	3.0	4.0	1.0	38.10
8	Automatically design customized learning content	4.0	4.0	0.0	80.95
9	Focus on simple and efficient interface	5.0	5.0	0.0	85.71
10	Create profiles and suggestions using big data	4.0	5.0	1.0	66.67
11	Integrate vocational skill examination systems	5.0	5.0	0.5	90.48
12	Offer personalized job recommendations for students	3.0	4.0	1.0	33.33

According to table 4.20, found that consensus among 75% or more of the 21 experts were obtained 6 of the 12 strategies for online teaching and learning platform in Round 2. As follows: Item 3 “Support real-time interactions, discussions, tests, and mobile learning” (Md =5.0,Mo =5.0,IQR =0.0), Item 4 “Allow uploading various teaching resources and course creation” (Md =5.0,Mo =5.0,IQR =0.5). Item 6 “Support flexible and skill-based assessments, like code reviews” (Md =5.0,Mo =5.0,IQR =0.0). Item 8 “Automatically design customized learning content” (Md =4.0,Mo =4.0,IQR =0.0), Item 9 “Focus on simple and efficient interface” (Md =5.0,Mo =5.0,IQR =0.0), Item 11 “Integrate vocational skill examination systems” (Md =5.0,Mo =5.0,IQR =0.5).

Round 3 Result

Table 4.21 Results for Round 3: Teachers' Informatization Teaching Ability

(n = 21)

Item	Teachers' Informatization Teaching Ability	Md	Mo	IQR	Consensus (%)
1	Participate in short-term, online and off-campus trainings	5.0	5.0	0.5	95.24
2	Learn from experienced teachers' online teaching methods	5.0	5.0	0.5	90.48
3	Participate in competitions to enhance information technology teaching skills	4.0	5.0	0.5	90.48
4	Sharing online teaching experience among teachers	5.0	5.0	0.0	85.71
5	Set up online teaching groups for regular discussions and seminars	4.0	5.0	0.5	80.95
6	Regular spot checks on teachers' teaching of informatization courses	4.0	4.0	0.0	80.95
7	Award certificates and prizes on Teachers' Day to teachers who are excellent in online teaching	4.0	4.0	0.5	76.19
8	Encourage participation in information technology teaching reform research and provide financial support	4.0	4.0	0.5	76.19

According to table 4.21, found that 21 experts were asked to internalize the opinions of other experts from Round 2 and consider further reaching a consensus of 75% or greater. Data from Round 2 showed only 6 of the 13 strategies for teachers'

informatization teaching ability. In Round 3, however, consensus was reached on 8 of the 13 strategies and was ranked in order of percentage.95.24% of experts agreed with Item 1 “Participate in short-term, online and off-campus trainings” (Md =5.0,Mo =5.0,IQR =0.5). 90.48% of experts believed Item 2,3. 85.71% of experts believed Item 4. 80.95%of experts believed Item 5,6. Also, 76.19% of experts believed Item 7,8.

Table 4.22 Results for Round 3: Students' Autonomous Learning Ability

(n = 21)

Item	Students' Autonomous Learning Ability	Md	Mo	IQR	Consensus (%)
1	Encourage students to obtain professional certifications and offer cash rewards	5.0	5.0	0.5	100.00
2	Monthly competitions with rewards for top performers	5.0	5.0	0.0	95.24
3	Establish studios for research and skill competitions under teacher guidance	5.0	5.0	0.5	85.71
4	Engage with students to understand their thoughts and help them set career goals	4.0	4.0	0.0	85.71
5	Offer courses to inspire self-assessment and positioning	4.0	4.0	0.5	85.71
6	Conduct regular skill assessments for students	5.0	5.0	0.5	80.95
7	Schools should create a campus culture of active learning	4.0	4.0	0.0	80.95

Table 4.22 Results for Round 3: Students' Autonomous Learning Ability (Continue)

(n = 21)

Item	Students' Autonomous Learning Ability	Md	Mo	IQR	Consensus (%)
8	Incorporate tasks like micro-teaching videos for course grading	4.0	4.0	0.5	76.19
9	Encourage students to evaluate and develop interest in their majors	4.0	4.0	0.5	76.19

According to table 4.22, found that 21 experts were asked to internalize the opinions of other experts from Round 2 and consider further reaching a consensus of 75% or greater. Data from Round 2 showed only 8 of the 16 strategies for students' autonomous learning ability. In Round 3, however, consensus was reached on 9 of the 16 strategies and was ranked in order of percentage. 100.00% of experts agreed with Item 1 “Encourage students to obtain professional certifications and offer cash rewards” (Md =5.0,Mo =5.0,IQR =0.5). 95.24% of experts believed Item 2. 85.71% of experts believed Item 3,4,5. 80.95%of experts believed Item 6,7. Also, 76.19% of experts believed Item 8,9.

Table 4.23 Results for Round 3: Online Teaching and Learning Interaction

(n = 21)

Item	Online Teaching and Learning Interaction	Md	Mo	IQR	Consensus (%)
1	Incorporate pop-ups, polls, and Q&A features to enhance interaction	5.0	5.0	0.0	100.00
2	Use tools like WeChat-Group for monitoring student learning	4.0	4.0	0.0	90.48
3	Focus on language use to strengthen teacher-student emotional connections	5.0	5.0	0.0	90.48
4	Initiate topics of interest in the online platform's discussion forums.	4.0	4.0	0.5	85.71
5	Assign tasks like short answers or multiple-choice questions to evaluate self-learning	5.0	5.0	0.5	80.95
6	Set up a system with teaching assistants to boost interaction and assist in Q&A	4.0	4.0	0.0	80.95
7	Implement a points system for interactive participation	4.0	4.0	0.5	76.19

According to table 4.23, found that 21 experts were asked to internalize the opinions of other experts from Round 2 and consider further reaching a consensus of 75% or greater. Data from Round 2 showed only 5 of the 8 strategies for online teaching and learning interaction. In Round 3, however, consensus was reached on 7 of the 8 strategies and was ranked in order of percentage. 100.00% of experts agreed with Item 1 “Incorporate pop-ups, polls, and Q&A features to enhance interaction” (Md =5.0,Mo =5.0,IQR =0.0). 90.48% of experts believed Item 2,3. 85.71% of experts

believed Item 4. 80.95%of experts believed Item 5,6. Also, 76.19% of experts believed Item 7.

Table 4.24 Results for Round 3: Course Content

(n = 21)

Item	Course Content	Md	Mo	IQR	Consensus (%)
1	Integrate content with vocational skill certification knowledge points	5.0	5.0	0.5	95.24
2	Develop course content that meets the characteristics of cultivating skilled personnel in vocational colleges	4.0	4.0	0.5	95.24
3	Select and adapt content based on student needs to ease learning	5.0	5.0	0.0	90.48
4	Modularization of course content, including knowledge module, skill module and ideology module	4.0	4.0	0.0	90.48
5	More practical cases to be included in the course content	4.0	5.0	0.5	80.95
6	Course content should be integrated with workplace culture	4.0	4.0	0.5	80.95
7	The course content should emphasize practicality and operability	4.0	4.0	0.5	76.19

According to table 4.24, found that 21 experts were asked to internalize the opinions of other experts from Round 2 and consider further reaching a consensus of 75% or greater. Data from Round 2 showed only 6 of the 10 strategies for course content. In Round 3, however, consensus was reached on 7 of the 10 strategies and was ranked in order of percentage. 95.24% of experts agreed with Item 1 “Integrate

content with vocational skill certification knowledge points" (Md =5.0,Mo =5.0,IQR =0.5) and Item 2 "Develop course content that meets the characteristics of cultivating skilled personnel in vocational colleges" (Md =4.0,Mo =4.0,IQR =0.5). 90.48% of experts believed Item 3,4. 80.95% of experts believed Item 5,6. Also, 76.19% of experts believed Item 7.

Table 4.25 Results for Round 3: Teaching Resource

(n = 21)

Item	Teaching Resource	Md	Mo	IQR	Consensus (%)
1	Establish an incentive mechanism for the development of teaching resources	5.0	5.0	0.5	100.00
2	Form a team dedicated to enhancing resource quality	5.0	5.0	0.0	95.24
3	Develop vocational education teaching resources	5.0	5.0	0.5	90.48
4	Create a centralized database for resource sharing and reuse	5.0	5.0	0.0	85.71
5	Invest in creating engaging resources like videos, animations, and simulations	4.0	5.0	0.5	85.71
6	Create micro-courses and small coursewares for mobile access	5.0	5.0	0.5	80.95
7	Provide financial support for teachers to update curricula with digital tools	4.0	4.0	0.5	80.95
8	Partner with enterprises for up-to-date practical training resources	4.0	4.0	0.5	76.19

According to table 4.25, found that 21 experts were asked to internalize the opinions of other experts from Round 2 and consider further reaching a consensus of 75% or greater. Data from Round 2 showed only 7 of the 10 strategies for teaching resource. In Round 3, however, consensus was reached on 8 of the 10 strategies and was ranked in order of percentage. 100.00% of experts agreed with Item 1 “Establish an incentive mechanism for the development of teaching resources” (Md =5.0,Mo =5.0,IQR =0.5). 95.24% of experts believed Item 2. 90.48% of experts believed Item 3. 85.71% of experts believed Item 4,5. 80.95% of experts believed Item 6,7. Also, 76.19% of experts believed Item 8.

Table 4.26 Results for Round 3: Teaching Design

(n = 21)

Item	Teaching Design	Md	Mo	IQR	Consensus (%)
1	Teachers to research students' learning environments before class	5.0	5.0	0.0	100.00
2	Opt for easy-to-use online teaching techniques	5.0	5.0	0.0	95.24
3	Define clear objectives and key points in teaching design	5.0	5.0	0.0	90.48
4	Adopt typical cases and project-based teaching design for the course	5.0	5.0	0.0	90.48
5	Rationalize the time schedule of each teaching session	4.0	4.0	0.0	85.71
6	Assign tasks and guide students to preview videos with questions	4.0	4.0	0.0	85.71
7	Design learning tasks with varying difficulty levels	4.0	5.0	0.5	80.95

Table 4.26 Results for Round 3: Teaching Design (Continue)

(n = 21)

Item	Teaching Design	Md	Mo	IQR	Consensus (%)
8	Increase the proportion of practical sessions	4.0	4.0	0.0	80.95
9	Focus on learning goals, break down knowledge points, and limit lessons to 15 minutes	4.0	4.0	0.5	76.19
10	Use interactive methods like games, quizzes, and voting judiciously	4.0	4.0	0.5	76.19

According to table 4.26, found that 21 experts were asked to internalize the opinions of other experts from Round 2 and consider further reaching a consensus of 75% or greater. Data from Round 2 showed only 9 of the 14 strategies for teaching design. In Round 3, however, consensus was reached on 10 of the 14 strategies and was ranked in order of percentage. 100.00% of experts agreed with Item 1 “Teachers to research students' learning environments before class” (Md =5.0,Mo =5.0,IQR =0.0). 95.24% of experts believed Item 2. 90.48% of experts believed Item 3,4. 85.71% of experts believed Item 5,6. 80.95% of experts believed Item 7,8. Also, 76.19% of experts believed Item 9,10.

Table 4.27 Results for Round 3: Learning Engagement

(n = 21)

Item	Learning Engagement	Md	Mo	IQR	Consensus (%)
1	Cultivate study habits and share learning methods	5.0	5.0	0.0	95.24
2	Employ specialized teaching assistants to continuously supervise and tutor students	5.0	5.0	0.0	90.48
3	Enhance the fun and practicality of online courses	5.0	5.0	0.0	90.48
4	Implement a mechanism to flag low engagement and initiate intervention measures	4.0	4.0	0.0	85.71
5	Provide rich and practical resources for learners	4.0	5.0	0.5	80.95
6	Guiding students to establish learning partners and solve problems together	4.0	4.0	0.0	80.95

According to table 4.27, found that 21 experts were asked to internalize the opinions of other experts from Round 2 and consider further reaching a consensus of 75% or greater. Data from Round 2 showed only 5 of the 10 strategies for teaching design. In Round 3, however, consensus was reached on 6 of the 10 strategies and was ranked in order of percentage. 95.24% of experts agreed with Item 1 “Cultivate study habits and share learning methods” (Md =5.0,Mo =5.0,IQR =0.0). 90.48% of experts believed Item 2,3. 85.71% of experts believed Item 4. 80.95% of experts believed Item 5,6.

Table 4.28 Results for Round 3: School Policy Support

(n = 21)

Item	School Policy Support	Md	Mo	IQR	Consensus (%)
1	Incorporate online teaching ability into the appraisal system of teachers' titles	5.0	5.0	0.0	95.24%
2	Integrate online teaching into the school's overall development plans	4.0	4.0	0.0	95.24%
3	Involvement in online teaching construction and individual excellent cases into the annual performance incentives	5.0	5.0	0.0	90.48%
4	Enhance financial investment to build interactive teaching equipment and recording and broadcasting classrooms	4.0	4.0	0.5	90.48%
5	Schools can set up a teaching point system to favor teachers in their treatment and performance appraisal	4.0	5.0	0.5	85.71%
6	Actively introduce highly competent informatization talents	4.0	5.0	0.5	85.71%
7	Set up a teaching management department focusing on online teaching talent training.	5.0	5.0	0.5	80.95%

Table 4.28 Results for Round 3: School Policy Support (Continue)

(n = 21)

Item	School Policy Support	Md	Mo	IQR	Consensus (%)
8	Establishment of a training mechanism for teachers of different specialties	4.0	4.0	0.0	80.95%
9	Establish a comprehensive online teaching training system covering teaching, research, and competitions	4.0	4.0	0.0	80.95%
10	Establish school, provincial, and national indicators for teaching informatization, linked to title promotions	4.0	4.0	0.5	76.19%

According to table 4.28, found that 21 experts were asked to internalize the opinions of other experts from Round 2 and consider further reaching a consensus of 75% or greater. Data from Round 2 showed only 7 of the 16 strategies for school policy support. In Round 3, however, consensus was reached on 10 of the 16 strategies and was ranked in order of percentage. 95.24% of experts agreed with Item 1 “Incorporate online teaching ability into the appraisal system of teachers' titles” (Md =5.0,Mo =5.0,IQR =0.0) and Item 2 “Integrate online teaching into the school's overall development plans” (Md =4.0,Mo =4.0,IQR =0.0), 90.48% of experts believed Item 3,4. 85.71% of experts believed Item 5,6. 80.95% of experts believed Item 7,8,9. Also, 76.19% of experts believed Item 10.

Table 4.29 Results for Round 3: Online Teaching and Learning Platform

(n = 21)

Item	Online Teaching and Learning Platform	Md	Mo	IQR	Consensus (%)
1	Allow uploading various teaching resources and course creation	4.0	4.0	0.0	95.24%
2	Integrate vocational skill examination systems	5.0	5.0	0.5	95.24%
3	Support real-time interactions, discussions, tests, and mobile learning	5.0	5.0	0.0	90.48%
4	Support flexible and skill-based assessments, like code reviews	4.0	4.0	0.0	90.48%
5	Focus on simple and efficient interface	5.0	5.0	0.5	85.71%
6	Automatically design customized learning content	4.0	4.0	0.0	85.71%
7	Create profiles and suggestions using big data	5.0	5.0	0.5	80.95%

According to table 4.29, found that 21 experts were asked to internalize the opinions of other experts from Round 2 and consider further reaching a consensus of 75% or greater. Data from Round 2 showed only 6 of the 12 strategies for online teaching and learning platform. In Round 3, however, consensus was reached on 7 of the 12 strategies and was ranked in order of percentage. 95.24% of experts agreed with Item 1 “Allow uploading various teaching resources and course creation” (Md =4.0,Mo =4.0,IQR =0.0) and Item 2 “Integrate vocational skill examination systems” (Md =5.0,Mo =5.0,IQR =0.5), 90.48% of experts believed Item 3,4. 85.71% of experts believed Item 5,6. 80.95% of experts believed Item 7.

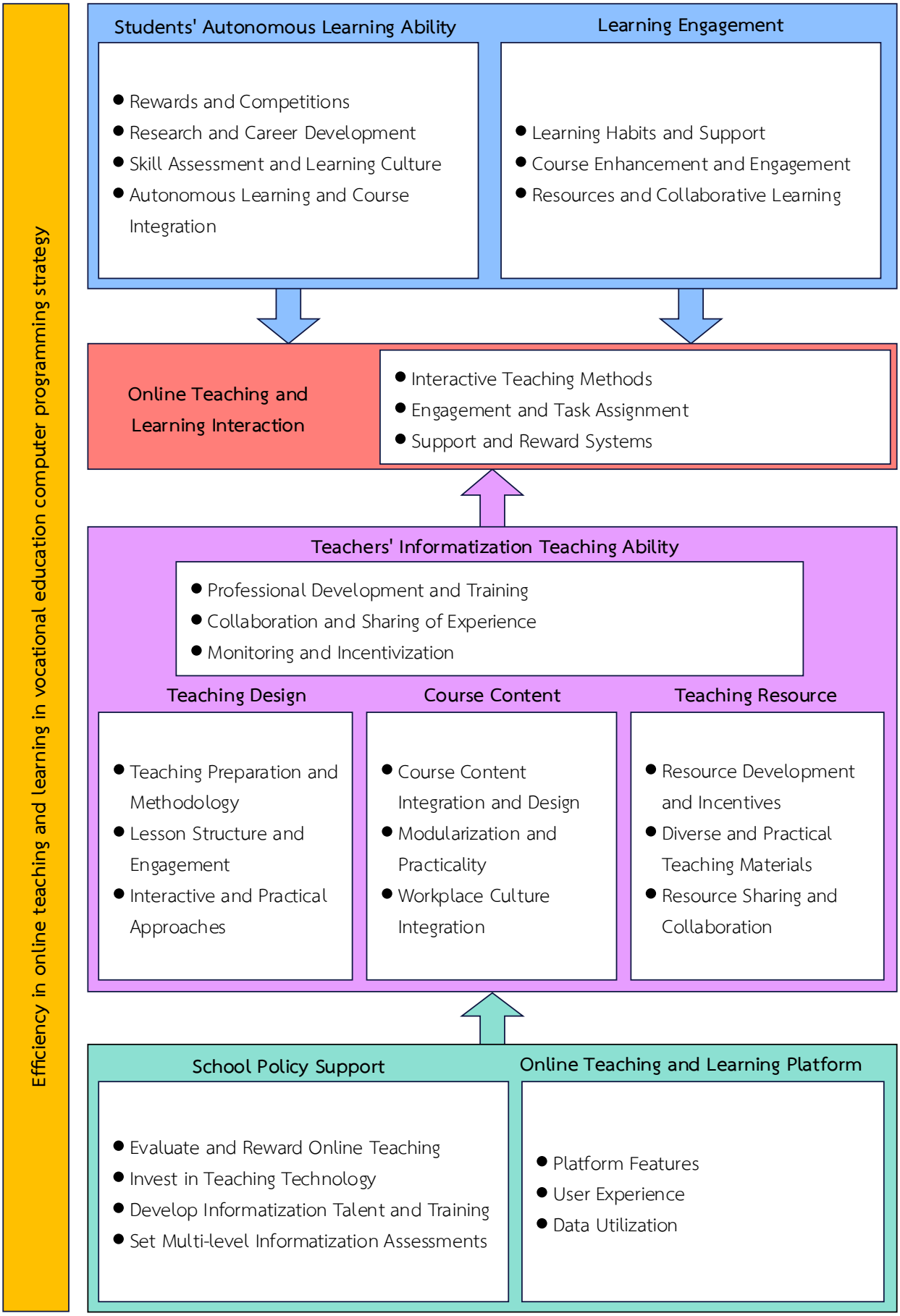

Figure 4.1 Efficiency in online teaching and learning in vocational education computer programming strategy (Version 1)

In Figure 4.1, After conducting 3 rounds of 21 experts' questionnaires using Delphi method, researchers propose efficiency in online teaching and learning in vocational education computer programming strategy (Version 1), covering 9 different aspects. The enhancement strategies for each aspect were classified and summarized in short sentences called "topics". The topics are followed at the next level by strategies for enhancement. The researcher has suggested 8 strategies for enhancing teachers' informatization teaching ability, 9 for strengthening students' autonomous learning ability, 7 for promoting online teaching and learning interaction, 7 to enhance course content, 8 to enrich teaching resources, 10 to optimize teaching design, 6 for increasing students' learning engagement, 10 for bolstering school policy support, 7 strategies to improve online teaching and learning platform, A total of 72 strategies. The details are as follows:

Teachers' informatization teaching ability includes three topics: Professional Development and Training, Collaboration and Sharing of Experience, Monitoring and Incentivization. Professional Development includes two strategies: participate in short-term, online and off-campus trainings, learn from experienced teachers' online teaching methods. Collaboration and Sharing of Experience includes three strategies: sharing online teaching experience among teachers, set up online teaching groups for regular discussions and seminars, participate in competitions to enhance information technology teaching skills. Monitoring and Incentivization includes three strategies: regular spot checks on teachers' teaching of informatization courses, award certificates and prizes on Teachers' Day to teachers who are excellent in online teaching, encourage participation in information technology teaching reform research and provide financial support.

Students' autonomous learning ability includes four topics: Rewards and Competitions, Research and Career Development, Skill Assessment and Learning Culture, Autonomous Learning and Course Integration. Rewards and competitions includes two strategies: encourage students to obtain professional certifications and offer cash rewards, monthly competitions with rewards for top performers. Research and Career Development includes three strategies: establish studios for research and skill competitions under teacher guidance, engage with students to understand their

thoughts and help them set career goals, offer courses to inspire self-assessment and positioning. Skill Assessment and Learning Culture includes two strategies: conduct regular skill assessments for students, schools should create a campus culture of active learning. Autonomous Learning and Course Integration includes two strategies: incorporate tasks like micro-teaching videos for course grading, encourage students to evaluate and develop interest in their majors.

Teaching and learning interaction includes three topics: Interactive Teaching Methods, Engagement and Task Assignment, Support and Reward Systems. Interactive Teaching Methods includes three strategies: incorporate pop-ups, polls, and Q&A features to enhance interaction, use tools like WeChat-Group for monitoring student learning, focus on language use to strengthen teacher-student emotional connections. Engagement and Task Assignment includes two strategies: initiate topics of interest in the online platform's discussion forums, assign tasks like short answers or multiple-choice questions to evaluate self-learning. Support and Reward Systems includes two strategies: set up a system with teaching assistants to boost interaction and assist in Q&A, implement a points system for interactive participation.

Course content includes three topics: Course Content Integration and Design, Modularization and Practicality, Workplace Culture Integration. Course Content Integration and Design includes three strategies: integrate content with vocational skill certification knowledge points, develop course content that meets the characteristics of cultivating skilled personnel in vocational colleges, select and adapt content based on student needs to ease learning. Modularization and Practicality includes three strategies: modularization of course content, including knowledge module, skill module and ideology module, more practical cases to be included in the course content, the course content should emphasize practicality and operability. Workplace Culture Integration includes one strategy: course content should be integrated with workplace culture.

Teaching resources includes three topics: Resource Development and Incentives, Diverse and Practical Teaching Materials, Resource Sharing and Collaboration. Resource Development and Incentives includes three strategies: establish an incentive mechanism for the development of teaching resources, form a

team dedicated to enhancing resource quality, provide financial support for teachers to update curricula with digital tools. Diverse and Practical Teaching Materials includes three strategies: develop vocational education teaching resources, invest in creating engaging resources like videos, animations, and simulations, create micro-courses and small coursewares for mobile access. Resource Sharing and Collaboration includes two strategies: create a centralized database for resource sharing and reuse, partner with enterprises for up-to-date practical training resources.

Teaching design includes three topics: Teaching Preparation and Methodology, Lesson Structure and Engagement, Interactive and Practical Approaches. Teaching Preparation and Methodology includes five strategies: teachers to research students' learning environments before class, opt for easy-to-use online teaching techniques, define clear objectives and key points in teaching design, adopt typical cases and project-based teaching design for the course, design learning tasks with varying difficulty levels. Lesson Structure and Engagement includes three strategies: rationalize the time schedule of each teaching session, assign tasks and guide students to preview videos with questions, focus on learning goals, break down knowledge points, and limit lessons to 15 minutes. Interactive and Practical Approaches includes two strategies: increase the proportion of practical sessions, use interactive methods like games, quizzes, and voting judiciously.

Students' learning engagement includes three topics: Learning Habits and Support, Course Enhancement and Engagement, Resources and Collaborative Learning. Learning Habits and Support includes two strategies: cultivate study habits and share learning methods, employ specialized teaching assistants to continuously supervise and tutor students. Course Enhancement and Engagement includes two strategies: enhance the fun and practicality of online courses, implement a mechanism to flag low engagement and initiate intervention measures. Resources and Collaborative Learning includes two strategies: provide rich and practical resources for learners, guiding students to establish learning partners and solve problems together.

School policy support includes four topics: Evaluate and Reward Online Teaching, Invest in Teaching Technology, Develop Informatization Talent and Training, Set Multi-level Informatization Assessments. Evaluate and Reward Online Teaching

includes four strategies: incorporate online teaching ability into the appraisal system of teachers' titles, integrate online teaching into the school's overall development plans, involvement in online teaching construction and individual excellent cases into the annual performance incentives, schools can set up a teaching point system to favor teachers in their treatment and performance appraisal. Invest in Teaching Technology includes one strategy: enhance financial investment to build interactive teaching equipment and recording and broadcasting classrooms. Develop Informatization Talent and Training includes four strategies: actively introduce highly competent informatization talents, set up a teaching management department focusing on online teaching talent training, establishment of a training mechanism for teachers of different specialties, establish a comprehensive online teaching training system covering teaching, research, and competitions. Set Multi-level Informatization Assessments includes one strategy: establish school, provincial, and national indicators for teaching informatization, linked to title promotions.

Online teaching and learning platform includes three topics: Platform Features, User Experience, Data Utilization. Platform Features includes four strategies: allow uploading various teaching resources and course creation, integrate vocational skill examination systems, support real-time interactions, discussions, tests, and mobile learning, support flexible and skill-based assessments, like code reviews. User Experience includes two strategies: focus on simple and efficient interface, automatically design customized learning content. Data Utilization includes one strategy: create profiles and suggestions using big data.

Part 4: The analysis results of the Focus Group discussion about the efficiency in online teaching and learning in vocational education computer programming strategy by Qualitative Analysis

Table 4.30 Result for discussion: Teachers' Informatization Teaching Ability

(n = 9)

Item	Teachers' Informatization Teaching Ability	Result
1	Participate in short-term, online and off-campus trainings	Pass
2	Learn from experienced teachers' online teaching methods	Pass
3	Participate in competitions to enhance information technology teaching skills	Pass
4	Sharing online teaching experience among teachers	Pass
5	Set up online teaching groups for regular discussions and seminars	Pass
6	Regular spot checks on teachers' teaching of informatization courses	Modify
	Regular organize peer review of teachers' informatization teaching	
7	Award certificates and prizes on Teachers' Day to teachers who are excellent in online teaching	Pass
8	Encourage participation in information technology teaching reform research and provide financial support	Pass

According to Table 4.30, found that 9 experts were asked to evaluate the feasibility of the 8 strategies for teachers' informatization teaching ability, 7 of the 8 strategies were consensually passed, and Item 6 "Regular spot checks on teachers' teaching of informatization courses" was modified to "Regular organize peer review of teachers' informatization teaching".

Table 4.31 Result for discussion: Students' Autonomous Learning Ability

(n = 9)

Item	Students' Autonomous Learning Ability	Result
1	Encourage students to obtain professional certifications and offer cash rewards	Pass
2	Monthly competitions with rewards for top performers	Pass
3	Establish studios for research and skill competitions under teacher guidance	Pass
4	Engage with students to understand their thoughts and help them set career goals	Pass
5	Offer courses to inspire self-assessment and positioning	Pass
6	Conduct regular skill assessments for students	Pass
7	Schools should create a campus culture of active learning	Pass
8	Incorporate tasks like micro-teaching videos for course grading	Pass
9	Encourage students to evaluate and develop interest in their majors	Pass
10	Encourage students to participate in social practice and internship	Add

According to Table 4.31, found that 9 experts were asked to evaluate the feasibility of the 9 strategies for students' autonomous learning ability, all of the 9 strategies were consensually passed, and added Item 10 “Encourage students to participate in social practice and internship”.

Table 4.32 Result for discussion: Online Teaching and Learning Interaction

(n = 9)

Item	Online Teaching and Learning Interaction	Result
1	Incorporate pop-ups, polls, and Q&A features to enhance interaction	Pass
2	Use tools like WeChat-Group for monitoring student learning	Pass
3	Focus on language use to strengthen teacher-student emotional connections	Pass
4	Initiate topics of interest in the online platform's discussion forums.	Pass
5	Assign tasks like short answers or multiple-choice questions to evaluate self-learning	Pass
6	Set up a system with teaching assistants to boost interaction and assist in Q&A	Pass
7	Implement a points system for interactive participation	Pass
8	Encourage students to create and share their own learning materials	Add
9	Provide instant feedback mechanism to understand students' progress	Add
10	Regular online group discussions on specific topics or case studies	Add

According to Table 4.32, found that 9 experts were asked to evaluate the feasibility of the 7 strategies for online teaching and learning interaction, all of the 7 strategies were consensually passed, and added 3 strategies as follow: Item 8 “Encourage students to create and share their own learning materials”, Item 9 “Provide instant feedback mechanism to understand students' progress”, Item 10 “Regular online group discussions on specific topics or case studies”.

Table 4.33 Result for discussion: Course Content

(n = 9)

Item	Course Content	Result
1	Integrate content with vocational skill certification knowledge points	Pass
2	Develop course content that meets the characteristics of cultivating skilled personnel in vocational colleges	Modify
	Collaborate with industry experts to Develop course content that meets the characteristics of cultivating skilled personnel in vocational colleges	
3	Select and adapt content based on student needs to ease learning	Pass
4	Modularization of course content, including knowledge module, skill module and ideology module	Pass
5	More practical cases to be included in the course content	Pass
6	Course content should be integrated with workplace culture	Pass
7	The course content should emphasize practicality and operability	Pass

According to Table 4.33, found that 9 experts were asked to evaluate the feasibility of the 7 strategies for course content, 6 of the 7 strategies were consensually passed, and Item 2 “Develop course content that meets the characteristics of cultivating skilled personnel in vocational colleges” was modified to “Collaborate with industry experts to Develop course content that meets the characteristics of cultivating skilled personnel in vocational colleges”.

Table 4.34 Result for discussion: Teaching Resource

(n = 9)

Item	Teaching Resource	Result
1	Establish an incentive mechanism for the development of teaching resources	Pass
2	Form a team dedicated to enhancing resource quality	Pass
3	Develop vocational education teaching resources	Pass
4	Create a centralized database for resource sharing and reuse	Pass
5	Invest in creating engaging resources like videos, animations, and simulations	Pass
6	Create micro-courses and small coursewares for mobile access	Pass
7	Provide financial support for teachers to update curricula with digital tools	Pass
8	Partner with enterprises for up-to-date practical training resources	Pass
9	Regular evaluation and updating of teaching and learning resources	Add

According to Table 4.34, found that 9 experts were asked to evaluate the feasibility of the 8 strategies for teaching resource, all of the 8 strategies were consensually passed, and added Item 9 “Regular evaluation and updating of teaching and learning resources”.

Table 4.35 Result for discussion: Teaching Design

(n = 9)

Item	Teaching Design	Result
1	Teachers to research students' learning environments before class	Pass
2	Opt for easy-to-use online teaching techniques	Pass
3	Define clear objectives and key points in teaching design	Pass
4	Adopt typical cases and project-based teaching design for the course	Pass
5	Rationalize the time schedule of each teaching session	Pass
6	Assign tasks and guide students to preview videos with questions	Pass
7	Design learning tasks with varying difficulty levels	Pass
8	Increase the proportion of practical sessions	Pass
9	Focus on learning goals, break down knowledge points, and limit lessons to 15 minutes	Pass
10	Use interactive methods like games, quizzes, and voting judiciously	Pass

According to Table 4.35, found that 9 experts were asked to evaluate the feasibility of the 10 strategies for teaching design, all of the 10 strategies were consensually passed.

Table 4.36 Result for discussion: Learning Engagement

(n = 9)

Item	Learning Engagement	Result
1	Cultivate study habits and share learning methods	Pass
2	Employ specialized teaching assistants to continuously supervise and tutor students	Pass
3	Enhance the fun and practicality of online courses	Pass
4	Implement a mechanism to flag low engagement and initiate intervention measures	Pass
5	Provide rich and practical resources for learners	Pass
6	Guiding students to establish learning partners and solve problems together	Pass
7	Increase opportunities for student involvement in course design	Add

According to Table 4.36, found that 9 experts were asked to evaluate the feasibility of the 6 strategies for learning engagement. all of the 6 strategies were consensually passed, and added Item 7 “Increase opportunities for student involvement in course design”.

Table 4.37 Result for discussion: School Policy Support

(n = 9)

Item	School Policy Support	Result
1	Incorporate online teaching ability into the appraisal system of teachers' titles	Pass
2	Integrate online teaching into the school's overall development plans	Pass
3	Involvement in online teaching construction and individual excellent cases into the annual performance incentives	Pass
4	Enhance financial investment to build interactive teaching equipment and recording and broadcasting classrooms	Pass
5	Schools can set up a teaching point system to favor teachers in their treatment and performance appraisal	Pass
6	Actively introduce highly competent informatization talents	Pass
7	Set up a teaching management department focusing on online teaching talent training.	Pass
8	Establishment of a training mechanism for teachers of different specialties	Pass
9	Establish a comprehensive online teaching training system covering teaching, research, and competitions	Pass
10	Establish school, provincial, and national indicators for teaching informatization, linked to title promotions	Pass
11	Building an industry-education integration community and introducing industry technologies and resources	Add

According to Table 4.37, found that 9 experts were asked to evaluate the feasibility of the 10 strategies for school policy support. all of the 10 strategies were

consensually passed, and added Item 11 “Building an industry-education integration community and introducing industry technologies and resources”.

Table 4.38 Result for discussion: Online Teaching and Learning Platform

(n = 9)

Item	Online Teaching and Learning Platform	Result
1	Allow uploading various teaching resources and course creation	Pass
2	Integrate vocational skill examination systems	Pass
3	Support real-time interactions, discussions, tests, and mobile learning	Pass
4	Support flexible and skill-based assessments, like code reviews	Pass
5	Focus on simple and efficient interface	Pass
6	Automatically design customized learning content	Pass
7	Create profiles and suggestions using big data	Pass
8	Integrated Virtual Reality (VR) and Augmented Reality (AR) technologies for immersive learning experiences	Add

According to Table 4.38, found that 9 experts were asked to evaluate the feasibility of the 10 strategies for online teaching and learning platform. all of the 7 strategies were consensually passed, and added Item 8 “Integrated Virtual Reality (VR) and Augmented Reality (AR) technologies for immersive learning experiences”.

Figure 4.2 Efficiency in online teaching and learning in vocational education computer programming strategy (Version 2)

In Figure 4.2, After evaluating the efficiency in online teaching and learning in vocational education computer programming strategy (version 1) through a Focus Group of 9 experts, the researcher classified and grouped the strategy (version 2) contained 9 aspects: 1) The enhancement of teachers' informatization teaching ability can be strategized in terms of professional development and training, collaboration and sharing of experience, monitoring and incentivization. 2) Strategies to enhance students' autonomous learning ability include rewards and competitions, research and career development, skill assessment and learning culture, autonomous learning and course integration. 3) Enhancing online teaching and learning interaction can be implemented by developing implementation strategies from interactive teaching methods, engagement and task assignment, support and reward systems. 4) Optimizing course content include course content integration and design, modularization and practicality, and workplace culture integration. 5) Strategies for improving teaching resources can range from resource development and incentives, diverse and practical teaching materials, and resource sharing and collaboration. 6) Strategies for enhancing teaching design include teaching preparation and methodology, lesson structure and engagement, interactive and practical approaches. 7) Increasing students' learning engagement can be approached from learning habits and support, course enhancement and engagement, resources and collaborative learning. 8) Strengthening school policy support enhancement strategies can be formulated in terms of evaluate and reward online teaching, invest in teaching technology, develop informatization talent and training, set multi-level informatization assessments. 9) Upgrading an online teaching platform can be implemented in terms of platform features, user experience, and data utilization.

Table4.39 Efficiency in online teaching and learning in vocational education computer programming strategy

Aspect	Topic	Strategy
Teachers' informatization teaching ability	Professional Development and Training	1. Participate in short-term, online and off-campus trainings
		2. Learn from experienced teachers' online teaching methods
	Collaboration and Sharing of Experience	3. Sharing online teaching experience among teachers
		4. Set up online teaching groups for regular discussions and seminars
		5. Participate in competitions to enhance information technology teaching skills
	Monitoring and Incentivization	6. Regular organize peer review of teachers' informatization teaching
		7. Award certificates and prizes on Teachers' Day to teachers who are excellent in online teaching
		8. Encourage participation in information technology teaching reform research and provide financial support
Students' autonomous learning ability	Rewards and Competitions	9. Encourage students to obtain professional certifications and offer cash rewards
		10. Monthly competitions with rewards for top performers
	Research and Career Development	11. Establish studios for research and skill competitions under teacher guidance
		12. Engage with students to understand their thoughts and help them set career goals

Table4.39 Efficiency in online teaching and learning in vocational education computer programming strategy (Continue)

Aspect	Topic	Strategy
Students' autonomous learning ability	Research and Career Development	13. Offer courses to inspire self-assessment and positioning
		14. Encourage students to participate in social practice and internship
	Skill Assessment and Learning Culture	15. Conduct regular skill assessments for students
		16. Schools should create a campus culture of active learning
	Autonomous Learning and Course Integration	17. Incorporate tasks like micro-teaching videos for course grading
		18. Encourage students to evaluate and develop interest in their majors
Online teaching and learning interaction	Interactive Teaching Methods	19. Incorporate pop-ups, polls, and Q&A features to enhance interaction
		20. Use tools like WeChat-Group for monitoring student learning
		21. Focus on language use to strengthen teacher-student emotional connections
	Engagement and Task Assignment	22. Initiate topics of interest in the online platform's discussion forums.
		23. Assign tasks like short answers or multiple-choice questions to evaluate self-learning
		24. Encourage students to create and share their own learning materials

Table4.39 Efficiency in online teaching and learning in vocational education computer programming strategy (Continue)

Aspect	Topic	Strategy
Online teaching and learning interaction	Engagement and Task Assignment	25. Regular online group discussions on specific topics or case studies
	Support and Reward Systems	26. Set up a system with teaching assistants to boost interaction and assist in Q&A
		27. Implement a points system for interactive participation
		28. Provide instant feedback mechanism to understand students' progress
Course Content	Course Content Integration and Design	29. Integrate content with vocational skill certification knowledge points
		30. Collaborate with industry experts to Develop course content that meets the characteristics of cultivating skilled personnel in vocational colleges
		31. Select and adapt content based on student needs to ease learning
	Modularization and Practicality	32. Modularization of course content, including knowledge module, skill module and ideology module
		33. More practical cases to be included in the course content
		34. The course content should emphasize practicality and operability

Table4.39 Efficiency in online teaching and learning in vocational education computer programming strategy (Continue)

Aspect	Topic	Strategy
Course Content	Workplace Culture Integration	35. Course content should be integrated with workplace culture
Teaching Resource	Resource Development and Incentives	36. Establish an incentive mechanism for the development of teaching resources
		37. Form a team dedicated to enhancing resource quality
		38. Provide financial support for teachers to update curricula with digital tools
		39. Establish an incentive mechanism for the development of teaching resources
	Diverse and Practical Teaching Materials	40. Form a team dedicated to enhancing resource quality
		41. Provide financial support for teachers to update curricula with digital tools
		42. Develop vocational education teaching resources
	Resource Sharing and Collaboration	43. Invest in creating engaging resources like videos, animations, and simulations
		44. Create micro-courses and small coursewares for mobile access
Teaching Design	Teaching Preparation and Methodology	45. Create a centralized database for resource sharing and reuse
		46. Partner with enterprises for up-to-date practical training resources

Table4.39 Efficiency in online teaching and learning in vocational education computer programming strategy (Continue)

Aspect	Topic	Strategy
Teaching Design	Teaching Preparation and Methodology	47. Define clear objectives and key points in teaching design
		48. Adopt typical cases and project-based teaching design for the course
		49. Design learning tasks with varying difficulty levels
	Lesson Structure and Engagement	50. Rationalize the time schedule of each teaching session
		51. Assign tasks and guide students to preview videos with questions
		52. Focus on learning goals, break down knowledge points, and limit lessons to 15 minutes
	Interactive and Practical Approaches	53. Increase the proportion of practical sessions
		54. Use interactive methods like games, quizzes, and voting judiciously
Learning Engagement	Learning Habits and Support	55. Cultivate study habits and share learning methods
		56. Employ specialized teaching assistants to continuously supervise and tutor students
	Course Enhancement and Engagement	57. Enhance the fun and practicality of online courses
		58. Implement a mechanism to flag low engagement and initiate intervention measures

Table4.39 Efficiency in online teaching and learning in vocational education computer programming strategy (Continue)

Aspect	Topic	Strategy
Learning Engagement	Course Enhancement and Engagement	59. Increase opportunities for student involvement in course design
	Resources and Collaborative Learning	60. Provide rich and practical resources for learners
		61. Guiding students to establish learning partners and solve problems together
School Policy Support	Evaluate and Reward Online Teaching	62. Incorporate online teaching ability into the appraisal system of teachers' titles
		63. Integrate online teaching into the school's overall development plans
		64. Involvement in online teaching construction and individual excellent cases into the annual performance incentives
		65. Schools can set up a teaching point system to favor teachers in their treatment and performance appraisal
	Invest in Teaching Technology	66. Enhance financial investment to build interactive teaching equipment and recording and broadcasting classrooms
		67. Building an industry-education integration community and introducing industry technologies and resources

Table4.39 Efficiency in online teaching and learning in vocational education computer programming strategy (Continue)

Aspect	Topic	Strategy
School Policy Support	Develop Informatization Talent and Training	68. Actively introduce highly competent informatization talents
		69. Set up a teaching management department focusing on online teaching talent training.
		70. Establishment of a training mechanism for teachers of different specialties
		71. Establish a comprehensive online teaching training system covering teaching, research, and competitions
	Set Multi-level Informatization Assessments	72. Establish school, provincial, and national indicators for teaching informatization, linked to title promotions
Online Teaching and Learning Platform	Platform Features	73. Allow uploading various teaching resources and course creation
		74. Integrate vocational skill examination systems
		75. Support real-time interactions, discussions, tests, and mobile learning
		76. Support flexible and skill-based assessments, like code reviews
	User Experience	77. Focus on simple and efficient interface
		78. Automatically design customized learning content

Table4.39 Efficiency in online teaching and learning in vocational education computer programming strategy (Continue)

Aspect	Topic	Strategy
Online Teaching and Learning Platform	User Experience	79. Integrated Virtual Reality (VR) and Augmented Reality (AR) technologies for immersive learning experiences
	Data Utilization	80. Create profiles and suggestions using big data

According to Table 4.39, found that contained 9 aspects, 29 topics, and 80 strategies in online teaching and learning in vocational education computer programming: 8 strategies for enhancing teachers' informatization teaching ability, 10 for strengthening students' autonomous learning ability, 10 for promoting online teaching and learning interaction, 7 to enhance course content, 9 to enrich teaching resources, 10 to optimize teaching design, 7 for increasing students' learning engagement, 11 for bolstering school policy support, 8 strategies to improve online teaching and learning platform. It can be an implement guideline for Guangxi vocational education computer programming to carry out online teaching and learning to improve quality and excellence.

Part 5: The analysis results of the efficiency in the traditional class and online class by Descriptive Analysis.

Table 4.40 Results of Descriptive Analysis for Learning efficiency

(n = 60)

Item	Samples	Min	Max	Mean	Std. Deviation	Median	IQR
T_Homework	30	80.00	96.00	88.60	4.695	88.00	7.25
O_Homework	30	82.00	97.00	91.17	3.797	92.00	7.00
T_Theory	30	22.00	66.00	44.13	10.833	43.00	15.50
O_Theory	30	27.00	78.00	58.50	11.635	59.00	16.50
T_Skill	30	42.50	92.50	64.82	12.837	66.00	13.00
O_Skill	30	57.50	97.50	82.47	11.012	86.25	15.63
T_Program	30	34.00	98.00	72.13	19.725	84.00	37.50
O_Program	30	38.00	92.00	71.37	13.667	74.50	20.75

According to Table 4.40, found that in the “Homework” and “Skill” parts, the online class (O) had significantly higher mean scores and smaller standard deviations than the traditional class (T), indicating more concentrated achievement. In the “Theory” part, the online class had a significantly higher mean and median score than the traditional class, even though the standard deviations of the two classes were similar. In the “Program” part, the mean scores of the two classes were similar, but the standard deviation of the traditional class was larger, indicating a more dispersed distribution of performance. That is, online teaching is better than traditional teaching in most assessment dimensions, especially in the learning of theoretical knowledge and basic skills. However, in the “Program” part, which requires more hands-on practice, traditional teaching has a certain advantage over online teaching.

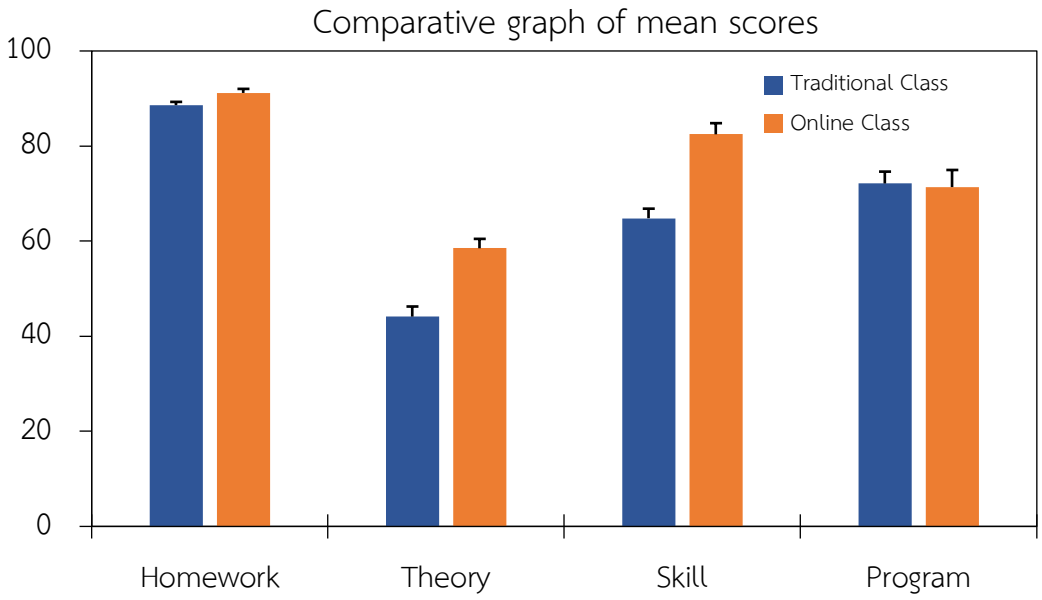

Figure 4.3 Comparative graph of mean scores of the two classes

In Figure 4.3, visualizes the comparison of the mean scores of the traditional class and the online class in the four parts of the homework, theory, skill, and program. In implementing this experiment, the researcher carefully planned and carried out the steps in an orderly manner. First, 60 second-year students were selected and they were equally divided into two classes through random assignment. Then, traditional and online teaching programs were developed for each of the two classes. The traditional class was taught in a face-to-face mode through classroom lectures, question-and-answer interactions and group discussions, while the online class utilized an online platform to teach through video lessons, real-time live lectures, online Q&A and forum discussions.

In order to ensure the quality of teaching and the fairness of assessment, the researcher chose the same syllabus, teaching materials and assessment criteria for both classes. The same test questions were carefully designed for the four aspects of assessment: homework, theory, skills and program, to ensure the same difficulty and coverage of the questions. During the assessment, the same assessment time slots were arranged for both classes and the same assessment environment was ensured to exclude the influence of external factors on the assessment results.

Chapter 5
Conclusion Discussion and Recommendations

The objectives of this research included: 1) To study the current situation problems of online teaching and learning in vocational education computer programming. 2) To develop the efficiency in online teaching and learning in vocational education computer programming strategy. 3) To implement and readjustment the efficiency in online teaching and learning in vocational education computer programming strategy. Specific enhancement strategies include the following 9 aspects: 1) Teachers' Informatization Teaching Ability, 2) Students' Autonomous Learning Ability, 3) Online Teaching and Learning Interaction, 4) Course Content, 5) Teaching Resource, 6) Teaching Design, 7) Learning Engagement, 8) School Policy Support, 9) Online Teaching and Learning Platform. The sample of the study was 21 experts with qualified Delphi requirements and 9 experts with qualified Focus Group method from high vocational colleges in Guangxi, as well as 60 computer program students in the second year of study. The research instruments were Open-Ended Interview Form, Likert Scale Questionnaire, Focus Group Form, and Learning Efficiency Evaluation Form, and the statistics were analyzed by Median, Mode, Inter-Quartile Range, Percentage, and Frequency, Qualitative Analysis and Descriptive Analysis.

The details are as follows.

Conclusion

The research of the efficiency in online teaching and learning in vocational education computer programming strategy. The researcher summarizes the conclusion into three parts, details as follows:

Part 1: The current situation problems of online teaching and learning in vocational education computer programming

Part 2: The efficiency in online teaching and learning in vocational education computer programming strategy

Part 3: Implement and readjustment the efficiency in online teaching and learning in vocational education computer programming strategy

Part 1: The current situation problems of online teaching and learning in vocational education computer programming

Through a sample survey of several higher vocational colleges in Guangxi on the situation of computer programs to carry out online teaching and learning, it can be seen that on the whole, online teaching and learning in vocational education in Guangxi is at a medium-high level, and the vast majority of colleges have already offered online teaching and learning courses, and even all the majors in some colleges have offered online courses. Only a small number of colleges are in the beginning stage, but the colleges have formulated policies to develop online teaching and learning, and have a strong intention to develop online teaching and learning, which coincides with the policy requirement of actively promoting the reform of informatization teaching in higher vocational education put forward by the Chinese Ministry of Education. For the 9 aspects of this study, most of the experts are considered to be at a medium-high level, as shown by the ranking from high to low: the highest level is the teacher's informatization teaching ability, followed by teaching resources, school policy support, online teaching and learning platform, teaching design, learning engagement, online teaching and learning interaction, course content, and the lowest level is the students' autonomous learning ability. Therefore, it is concluded that the current situation problems are summarized as follows: the current situation of online teaching and learning in Guangxi higher vocational colleges shows positive development, but at the same time, it also faces some problems and challenges. Among them, the most obvious problem is the lack of students' autonomous learning ability. This indicates that although teachers have strong informatization teaching ability, students still need to improve in using online resources for self-guided learning. In addition, although most colleges have already offered online courses, the quality of course content and online interaction may still need to be improved to ensure teaching and learning efficiency. What's more, schools need to continue to strengthen the policy support and resources to support the online

teaching and learning platform optimization and innovation in teaching and learning design. These challenges need to be addressed through comprehensive strategies and multiple collaborations to enhance the overall quality and efficiency in online teaching and learning.

Part 2: The efficiency in online teaching and learning in vocational education computer programming strategy

After 3 rounds of Delphi method survey and comprehensive analysis, the key strategies with more than 75% consensus among experts were retained. The researcher developed 72 strategies to enhance the efficiency in online teaching and learning in vocational education computer programming from 9 aspects: Teachers' informatization teaching ability, students' autonomous learning ability, online teaching and learning interaction, course content, teaching resource, teaching design, learning engagement, school policy support, online teaching and learning platform.

The 8 strategies for enhancing the efficiency in teachers' informational teaching ability include: Participate in short-term, online and off-campus trainings. Learn from experienced teachers' online teaching methods. Sharing online teaching experience among teachers. Set up online teaching groups for regular discussions and seminars. Participate in competitions to enhance information technology teaching skills. Regular spot checks on teachers' teaching of informatization courses. Award certificates and prizes on Teachers' Day to teachers who are excellent in online teaching. Encourage participation in information technology teaching reform research and provide financial support.

The 9 strategies for enhancing the efficiency in students' autonomous learning ability include: Encourage students to obtain professional certifications and offer cash rewards. Monthly competitions with rewards for top performers. Establish studios for research and skill competitions under teacher guidance. Engage with students to understand their thoughts and help them set career goals. Offer courses to inspire self-assessment and positioning. Conduct regular skill assessments for students. Schools should create a campus culture of active learning. Incorporate tasks like micro-teaching videos for course grading. Encourage students to evaluate and develop interest in their majors.

The 7 strategies for enhancing the efficiency in online teaching and learning interaction include: Incorporate pop-ups, polls, and Q&A features to enhance interaction. Use tools like WeChat-Group for monitoring student learning. Focus on language use to strengthen teacher-student emotional connections. Initiate topics of interest in the online platform's discussion forums. Assign tasks like short answers or multiple-choice questions to evaluate self-learning. Set up a system with teaching assistants to boost interaction and assist in Q&A. Implement a points system for interactive participation.

The 7 strategies for enhancing the efficiency in course content include: Integrate content with vocational skill certification knowledge points. Develop course content that meets the characteristics of cultivating skilled personnel in vocational colleges. Select and adapt content based on student needs to ease learning. Modularization of course content, including knowledge module, skill module and ideology module. More practical cases to be included in the course content. The course content should emphasize practicality and operability. Course content should be integrated with workplace culture.

The 8 strategies for enhancing the efficiency in teaching resource include: Establish an incentive mechanism for the development of teaching resources. Form a team dedicated to enhancing resource quality. Provide financial support for teachers to update curricula with digital tools. Develop vocational education teaching resources. Invest in creating engaging resources like videos, animations, and simulations. Create micro-courses and small coursewares for mobile access. Create a centralized database for resource sharing and reuse. Partner with enterprises for up-to-date practical training resources.

The 10 strategies for enhancing the efficiency in teaching design include: Teachers to research students' learning environments before class. Opt for easy-to-use online teaching techniques. Define clear objectives and key points in teaching design. Adopt typical cases and project-based teaching design for the course. Design learning tasks with varying difficulty levels. Rationalize the time schedule of each teaching session. Assign tasks and guide students to preview videos with questions. Focus on learning goals, break down knowledge points, and limit lessons to 15 minutes. Increase

the proportion of practical sessions. Use interactive methods like games, quizzes, and voting judiciously.

The 6 strategies for enhancing the efficiency in learning engagement include: Cultivate study habits and share learning methods. Employ specialized teaching assistants to continuously supervise and tutor students. Enhance the fun and practicality of online courses. Implement a mechanism to flag low engagement and initiate intervention measures. Provide rich and practical resources for learners. Guiding students to establish learning partners and solve problems together.

The 10 strategies for enhancing the efficiency in school policy support include: Incorporate online teaching ability into the appraisal system of teachers' titles. Integrate online teaching into the school's overall development plans. Involvement in online teaching construction and individual excellent cases into the annual performance incentives. Schools can set up a teaching point system to favor teachers in their treatment and performance appraisal. Enhance financial investment to build interactive teaching equipment and recording and broadcasting classrooms. Actively introduce highly competent informatization talents. Set up a teaching management department focusing on online teaching talent training. Establishment of a training mechanism for teachers of different specialties. Establish a comprehensive online teaching training system covering teaching, research, and competitions. Establish school, provincial, and national indicators for teaching informatization, linked to title promotions.

The 7 strategies for enhancing the efficiency in online teaching and learning platform include: Allow uploading various teaching resources and course creation. Integrate vocational skill examination systems. Support real-time interactions, discussions, tests, and mobile learning. Support flexible and skill-based assessments, like code reviews. Focus on simple and efficient interface. Automatically design customized learning content. Create profiles and suggestions using big data.

Part 3: Implement and readjustment the efficiency in online teaching and learning in vocational education computer programming strategy

After the focus group discussions, the group of experts comprehensively considered and adjusted the 72 strategies to enhance the efficiency in online teaching

and learning in vocational education computer programming. It consensually passed 70 of the 72 strategies, 2 of which were modified and 8 strategies were added, as follows:

In the strategies for enhancing teachers' informatization teaching ability, experts suggested that “Regular spot checks on teachers' teaching of informatization courses” be modified to “Regular organize peer review of teachers' informatization teaching”. In the strategies for enhancing course content, experts suggested that “Develop course content that meets the characteristics of cultivating skilled personnel in vocational colleges” be modified to “Collaborate with industry experts to Develop course content that meets the characteristics of cultivating skilled personnel in vocational colleges”. In the strategies for improving teaching design consistency, the expert group passed by consensus with no suggestions.

In the strategies for improving students' autonomous learning ability, experts suggested adding a strategy: “Encourage students to participate in social practice and internship”. In the strategies for enhancing online teaching and learning interaction, three strategies were added. As follows: “Encourage students to create and share their own learning materials”, “Provide instant feedback mechanism to understand students' progress”. “Regular online group discussions on specific topics or case studies”. In teaching resources enhancement strategies, experts suggested adding a strategy: “Regular evaluation and updating of teaching and learning resources”. In the strategies for improving learning engagement, experts suggested adding a strategy: “Increase opportunities for student involvement in course design”. In the strategies for improving school policy support, experts suggested adding a strategy: “Building an industry-education integration community and introducing industry technologies and resources”. In the strategies for enhancing online teaching and learning platform, experts suggested adding a strategy: “Integrated Virtual Reality (VR) and Augmented Reality (AR) technologies for immersive learning experiences”.

After adjusting the efficiency in online teaching and learning in vocational education computer programming strategy, the researcher implemented these strategies, and created a comparison group in which 60 second-year computer program students were equally divided between the traditional and online class, and the

developed strategies were implemented in the online class to evaluate the efficiency in the strategies. From the results of the descriptive analysis, the mean scores of the online class were significantly higher than those of the traditional class in the " homework" and " skill" parts, and the standard deviation was significantly smaller than that of the traditional class which indicated that the results of the online class were more concentrated. In the “theory” part, the mean and median scores of the online class were significantly higher than the traditional class, although the standard deviations of the two class were similar. In the “program” part, the mean scores of the two classes were similar, but the standard deviation of the traditional class was larger, indicating a more dispersed distribution of scores. In other words, online teaching was better than traditional teaching on most of the evaluation dimensions, especially in the learning of theory and basic skills. However, in the part of the program that requires more hands-on practice, traditional teaching has some advantages over online teaching.

Discussion

Base on the research the efficiency in online teaching and learning in vocational education computer programming strategy. some questions proposed for discussion are as follows:

Part 1: The current situation problems of online teaching and learning in vocational education computer programming

Part 2: The efficiency in online teaching and learning in vocational education computer programming strategy

Part 3: Implement and readjustment the efficiency in online teaching and learning in vocational education computer programming strategy

Part 1: The current situation problems of online teaching and learning in vocational education computer programming

From the results of this study, found that the current status of online teaching and learning in Guangxi vocational colleges is overall at a high level. For the 9 aspects of this study, most of the experts are considered to be at a medium-high level, as

shown by the ranking from high to low: the highest level is the teacher's informatization teaching ability, followed by teaching resources, school policy support, online teaching and learning platform, teaching design, learning engagement, online teaching and learning interaction, course content, and the lowest level is the students' autonomous learning ability. Related research of Jin (2021) believed that the overall level of teachers' informatization teaching ability in higher vocational colleges is high. However, the development of teaching design and teaching resources is not balanced, the school should increase the capital investment, focus on the updating and construction of hardware and software equipment, and build a smart teaching environment to provide a foundation and guarantee for improving teachers' informatization teaching ability. According to the law of teachers' professional development and teachers' personal needs, formulating a scientific and systematic training program and carrying out hierarchical and categorical training is an efficient way to improve teachers' informatization ability. Ma et al. (2023) pointed out that the level of learning engagement in online teaching is low, the form of learning is dominated by listening to lectures, and the external interfering factors increase. Online course instructional design is also an important factor affecting students' learning engagement. Communication between teachers and students and among peers is low. Teachers neglect to guide, instruct and promote students' independent learning ability, and most students have difficulty in efficiently planning, regulating and adhering to the online learning process. Compared with the traditional classroom, online teaching needs more support from a good online resource space and a teaching interactive platform, and strategies such as teaching design for different disciplines, enriching teaching resources, changing evaluation methods, and emphasizing the cultivation of students' learning ability, learning thinking and learning habits are proposed. Therefore, in this study, the nine aspects of teacher's informatization teaching ability, students' autonomous learning ability, online teaching and learning interaction, course content, teaching resources, teaching design, learning engagement, school policy support, online teaching and learning platform, Developing the efficiency in online teaching and learning in vocational education computer programming strategy is the breakthrough point.

Part 2: The efficiency in online teaching and learning in vocational education computer programming strategy

The researcher developed 72 strategies to enhance the efficiency in online teaching and learning in vocational education computer programming from 9 aspects: Teachers' informatization teaching ability, students' autonomous learning ability, online teaching and learning interaction, course content, teaching resource, teaching design, learning engagement, school policy support, online teaching and learning platform. The related to the research of Zhang (2022) pointed out that college teachers' recognition of online teaching can efficiently improve teachers' willingness to carry out online teaching, and recognition of the value of online teaching. College teachers are able to consciously apply new online technologies to teaching, as well as use online technologies reasonably and legally for teaching. Proficient online teaching design and implementation ability is an important guarantee for successful online teaching. Yang (2022) suggests that in order to develop online teaching in higher vocational colleges, firstly, teachers should correct their attitude towards online teaching, they should also take the initiative to learn the theoretical and practical knowledge of information technology, actively build learning contexts, and boldly practice the blended teaching mode of online and offline teaching. The education authorities should also formulate relevant regulations to quantify the proportion of teachers teaching online. Enhance their online teaching application innovation ability by participating in online teaching competitions. Invite experts to give lectures on online teaching topics, and send out or online learning exchanges. Incorporate the online teaching ability of teachers in higher vocational colleges and universities into the assessment standards. Schools should improve online teaching software and hardware conditions. To have sufficient teaching resources as a guarantee, schools must establish a perfect online teaching resource system. The formation of a reasonably structured online teaching team, through the technical exchanges and collision of ideas among team members, can efficiently realize the common construction and sharing of educational resources. It is especially important to establish a perfect online teaching platform, which can not only provide teachers with standardized templates for building classes, but also build channels for teachers to

communicate and share resources online. Students can make use of fragmented learning time for learning. At the same time, teachers can also use the online platform for online lesson preparation and examination. Higher vocational colleges and universities should formulate relevant assessment and reward methods according to their own reality, and it is best to incorporate teachers' online teaching ability into the assessment system of teachers' performance appraisal, annual appraisal, and appraisal of title promotion. Online teaching into the school development strategy, through the sound relevant system specification, the establishment of rewards and punishments incentive mechanism, to create a campus cultural atmosphere to actively meet the online teaching reform. Li (2022) pointed out that guiding students, helping students, serving students, understanding and paying attention to what students think and need in a timely manner, improving the relevance and realism of teaching, and prompting students to change their active learning. Based on students' interests, strengthen the "interest-oriented" learning mode, in order to better achieve the educational goals. Strengthen the construction and application of network resources. Relying on the online teaching platform, combined with the teaching content, recording relevant microclasses, enriching teaching resources, providing protection for students' online independent learning, discussion and interaction, and truly giving full play to the advantageous role of information technology in online teaching activities. On the other hand, it actively introduces high-quality curriculum resources from famous schools to provide more choices for students' independent learning, stimulate students' interest in independent learning, and meet students' diversified learning needs. At the same time, students are mobilized to build online learning resources, and are guided to post assignments, discuss and collaborate in online learning communities. In addition, as far as the school level is concerned, it is necessary to make full use of new technologies such as big data and artificial intelligence to establish an intelligent management service platform to provide technical guarantee for improving students' independent learning ability, so that students can feel more fun and have a stronger sense of acquisition in learning, which will contribute to the enhancement of independent learning ability. Therefore, in this study, the nine aspects of strategies to improve the efficiency in online teaching and learning can promote the development

of online teaching and learning in vocational education computer programming in Guangxi.

Part 3: Implement and readjustment the efficiency in online teaching and learning in vocational education computer programming strategy

After the focus group discussions, the group of experts comprehensively considered and adjusted the 72 strategies to enhancing the efficiency in online teaching and learning in vocational education computer programming. After adjusting the efficiency in online teaching and learning in vocational education computer programming strategy, the researcher implemented these strategies, From the results, it is found that online teaching is better than traditional teaching in most of the evaluation dimensions, especially in the learning of theory and basic skills. However, in the part that requires more hands-on practice, traditional teaching is more advantageous than online teaching. It also shows that these online teaching strategies proposed in this study is efficient. The related to the research of Shi et al. (2023) pointed out that the teaching content should be reconstructed to include corresponding practical applications, especially focusing on adding application cases closely related to the frontiers of specialties and disciplines. Design problem task points to guide students to think in groups or independently, with constant interaction between teachers and students to mobilize the flexibility of students' thinking. Focus on cultivating students' independent learning ability, introducing characters and events involved in the course content, and cultivating students' creative personality. Students are allowed to think in groups or independently according to their own preferences. For the questions raised in the course, students will answer them on the online teaching platform, the teacher will choose representative answers to interact with students, and the rest of the answers will be replied on the online teaching platform. For the questions assigned at the end of the course, students submit them in the online teaching platform, and teachers categorize and screen them for discussion in the next class. This series of teaching practices improves the efficiency in online teaching. Su (2019) makes an innovative design for the curriculum of higher vocational colleges and universities. First of all, combined with the students' vocational skills competition and the needs of industry and enterprises, the content of the practical

part of the course is abstracted, giving students more practical operation in practice and space to realize the characteristics of the students as the main body; again, on this basis, with information technology, such as microclasses, video animation, cell phone APPs, virtual technology, simulation software, etc., so as to make the learning process of the students more graphic, vivid and concrete, and to improve the students' learning At the same time, it cultivates students' ability to think about problems, solve problems independently, and realize innovation and entrepreneurship, so as to better realize employment and entrepreneurship. In the implementation of online teaching, teachers master the professional theoretical knowledge of e-commerce courses on the basis of information technology means to formulate a good project, do a good job of course design, in the process of information technology teaching practice, according to the problems encountered by the students, and constantly adjust the teaching key points, so as to continuously optimize the teaching design. At the same time, the teacher also plays a supervisory role in the whole process, for the implementation of student group teaching appeared in the study of the situation of not serious supervision and prevention, in the pre-course, the class, the whole process of post-course supervision, to prevent the occurrence of plagiarism of the results of others. The online teaching effect has been improved. Therefore, in this study, the nine aspects of strategies to improve the efficiency in online teaching and learning can promote the development of online teaching and learning in vocational education computer program in Guangxi.

Recommendations

Based on the above conclusions, combined with the analysis of the efficiency in online teaching and learning in vocational education computer programming strategy, in order to better promote the development of online teaching and learning in vocational education in Guangxi. The researcher believes that the development of online teaching and learning should be supported in the following aspects.

1. Utilizing new technology to integrate the teaching mode of professional courses. Combining the VR/AR course with the virtual simulation training center allows students to complete practical operations through interaction in the virtual

environment, which improves students' interest in independent learning and promotes the absorption and transformation of professional knowledge. The teaching mode of the course is transformed from the traditional teacher-oriented and student-supported lecture mode to a new mode in which students' independent learning is the main focus and teachers are supplementary. Teachers' main task is no longer to explain the traditional knowledge points, but to optimize the teaching design, enrich the classroom content and improve students' participation.

2. Promote the integration of industry and education, and jointly build an industrial college. Jointly build the curriculum system of integration of production and education. Through "introducing enterprises into the school", actively developing school-enterprise cooperation courses, inviting industrial enterprises to deeply participate in the construction of courses, implementing enterprise experts into the classroom, and carrying out curriculum reforms, designing the curriculum system and optimizing the structure of the courses by taking the needs of the industries and enterprises served by the Modern Industrial College as a starting point. Promote the docking of curriculum content with enterprise standards, focus on improving students' practical and employment and entrepreneurial abilities according to the characteristics of the specialty, efficiently improve students' knowledge of the industry and their ability to solve complex problems, and form application-oriented course clusters or course modules highlighting the cultivation of practical abilities.

3. Supporting the construction of online high-quality courses, starting from the demand for training innovative and complex talents, the course standard is docked to the job skill standard, industry certificate standard and competition ability standard, and the online high-quality course system with modularized knowledge and ability ladder is built with industry enterprises, highlighting the vocational quality, reconstructing the course objectives based on the level of the job, the ability to compete in skill competitions, and the quality requirements, promoting the reconstruction of the teaching content. On the other hand, a variety of content bearing forms (such as live broadcasting, broadcasting, dialogue, practical exercises, screen recording, etc.) and diversified resource presentation forms (text, image, video,

animation, virtual simulation, etc.) are adopted to support students' continuous and in-depth personalized learning.

Future Researches

1. Future research will combine the integration of online and offline teaching in higher education to design teaching strategies, utilize the advantages of online teaching and traditional teaching, form the integration of diverse teaching methods, and further improve the quality of teaching in higher vocational courses.

2. Future research using learning analytics and big data technologies to better understand students' learning needs and habits. Developing relevant intelligent algorithms, online teaching platforms can automatically adjust course content according to students' learning progress and interests. Online learning strategies that support personalized customization can improve student engagement and learning outcomes.

3. Future research increases interaction in online teaching and learning by integrating VR and AR technologies into online teaching and learning to facilitate collaboration between students and between students and instructors. This could include the development of virtual labs, online project teamwork, or real-time tutoring and feedback mechanisms to increase student engagement and motivation to learn.

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No	**Efficiency in online teaching and learning in vocational education computer programming strategy**	5	4	3	2	1
63	Increase the proportion of practical sessions					
64	Reasonably design the amount of teaching content for online teaching					
65	Design corresponding plans and flexibly adopt live broadcasting and video broadcasting					
66	Focus on learning goals, break down knowledge points, and limit lessons to 15 minutes					
67	Use interactive methods like games, quizzes, and voting judiciously					
68	Define clear objectives and key points in teaching design					
69	Regularly review and assess course lesson plans					
70	Adjust teaching based on student feedback					
71	Design learning tasks with varying difficulty levels					
7. Learning Engagement						
72	Monitor online learning and alert non-participating students automatically					
73	Developing personalized study plans					
74	Implement a mechanism to flag low engagement and initiate intervention measures					
75	Cultivate study habits and share learning methods					
76	Employ specialized teaching assistants to continuously supervise and tutor students					
77	Guiding students to establish learning partners and solve problems together					
78	Praise and incentivize students who are highly engaged in their studies					

No	**Efficiency in online teaching and learning in vocational education computer programming strategy**	5	4	3	2	1
79	Guiding students to reflect and digest knowledge in a timely manner					
80	Provide rich and practical resources for learners					
81	Enhance the fun and practicality of online courses					
	8. School Policy Support					
82	Establishment of a training mechanism for teachers of different specialties					
83	Schools can set up a teaching point system to favor teachers in their treatment and performance appraisal					
84	Incorporate online teaching ability into the appraisal system of teachers' titles					
85	Award points and rewards to teachers actively participating in online teaching training					
86	Integrate online teaching into the school's overall development plans					
87	Establish school, provincial, and national indicators for teaching informatization, linked to title promotions					
88	Involvement in online teaching construction and individual excellent cases into the annual performance incentives					
89	Actively introduce highly competent informatization talents					
90	Enhance financial investment to build interactive teaching equipment and recording and broadcasting classrooms					
91	Setting up a technology management department centered on the online teaching and learning platform					
92	Build wired and wireless networks covering the whole school					
93	Set up a teaching management department focusing on online teaching talent training.					

No	**Efficiency in online teaching and learning in vocational education computer programming strategy**	5	4	3	2	1
94	Randomly check the online teaching of teachers in each semester.					
95	Organize an online teaching expert assessment team to regularly assess the quality of online teaching in all aspects.					
96	Introducing school credit bank and credit recognition system to expand the recognition of online learning					
97	Establish a comprehensive online teaching training system covering teaching, research, and competitions					
9. Online Teaching and Learning Platform						
98	Online teaching and learning platform to enhance data security protection					
99	Ensure system stability and reliability for many users					
100	Support real-time interactions, discussions, tests, and mobile learning					
101	Allow uploading various teaching resources and course creation					
102	Enable seamless operation on different devices					
103	Support flexible and skill-based assessments, like code reviews					
104	Provide feedback collection, resource distribution, and course planning					
105	Automatically design customized learning content					
106	Focus on simple and efficient interface					
107	Create profiles and suggestions using big data					
108	Integrate vocational skill examination systems					
109	Offer personalized job recommendations for students					

Modified Likert Scale Questionnaire （Round 3）

Efficiency in online teaching and learning in vocational education computer programming strategy

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Explanation:

This questionnaire is based on the information provided by the Likert Scale Questionnaire (Round 2). It also includes the Median (Md), Mode (Mo) and Inter-Quartile Range (IQR) of each strategy counted in the previous round of questionnaires for the expert to refer to the degree of consistency of that strategy, and you will again be able to choose a scale of 1-5, meaning “Strongly Disagree”, “Disagree”, “Neutral”, “Agree” or “Strongly Agree”.

Regarding the issue of efficiency in online teaching and learning in vocational education computer programming strategy, please tick √ the corresponding option column.

Thankyou

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No	Efficiency in online teaching and learning in vocational education computer programming strategy	Md	Mo	IQR	5	4	3	2	1
1. Teachers' Informatization Teaching Ability									
1	Develop a five-year personal career development plan consistent with professional and school policies	4.0	4.0	0.5					
2	Participate in competitions to enhance information technology teaching skills	5.0	5.0	0.5					
3	Learn from experienced teachers' online teaching methods	5.0	5.0	0.5					
4	Participate in online teaching achievement sharing sessions	3.0	3.0	1.0					
5	Participate in short-term, online and off-campus trainings	5.0	5.0	0.0					
6	Award certificates and prizes on Teachers' Day to teachers who are excellent in online teaching	4.0	4.0	1.0					
7	Sharing online teaching experience among teachers	4.0	5.0	0.5					
8	Encourage participation in information technology teaching reform research and provide financial support	4.0	4.0	0.5					
9	Set up online teaching groups for regular discussions and seminars	4.0	5.0	0.5					
10	Invite national famous teachers to share their IT teaching design and cases	3.0	4.0	1.0					
11	Regular spot checks on teachers' teaching of informatization courses	4.0	4.0	0.5					
12	Assign mentors to novice online teachers	3.0	3.0	0.5					

No	Efficiency in online teaching and learning in vocational education computer programming strategy	Md	Mo	IQR	5	4	3	2	1
13	Teachers listen to at least 10 lessons each semester	2.0	4.0	1.5					
2. Student's Autonomous Learning Ability									
14	Engage with students to understand their thoughts and help them set career goals	5.0	5.0	0.0					
15	Create clubs focusing on professional skills for voluntary social services	3.0	4.0	1.0					
16	Offer courses to inspire self-assessment and positioning	5.0	5.0	0.5					
17	Establish studios for research and skill competitions under teacher guidance	5.0	5.0	0.0					
18	Encourage students to evaluate and develop interest in their majors	4.0	4.0	1.0					
19	Incorporate tasks like micro-teaching videos for course grading	4.0	5.0	0.0					
20	Assist in semester-wise study planning and time management	3.0	4.0	1.0					
21	Conduct regular skill assessments for students	4.0	5.0	0.5					
22	Schools should create a campus culture of active learning	4.0	4.0	0.0					
23	Encourage students to obtain professional certifications and offer cash rewards	5.0	5.0	0.5					
24	Monitor and analyze student learning behaviors	4.0	4.0	1.0					
25	Monthly competitions with rewards for top performers	5.0	5.0	0.0					

No	Efficiency in online teaching and learning in vocational education computer programming strategy	Md	Mo	IQR	5	4	3	2	1
26	Offer courses to develop entrepreneurial skills and self-learning	3.0	4.0	1.0					
27	Provide courses for self-confidence and motivation	3.0	4.0	0.5					
28	Integrate career guidance into teaching	3.0	4.0	1.0					
29	Organize events like mock interviews to boost learning motivation	3.0	3.0	0.5					
3. Online Teaching and Learning Interaction									
30	Use tools like WeChat-Group for monitoring student learning	4.0	4.0	0.0					
31	Focus on language use to strengthen teacher-student emotional connections	5.0	5.0	0.0					
32	Initiate topics of interest in the online platform's discussion forums.	5.0	4.0	0.5					
33	Implement a points system for interactive participation	3.0	4.0	0.5					
34	Assign tasks like short answers or multiple-choice questions to evaluate self-learning	5.0	5.0	0.5					
35	Incorporate pop-ups, polls, and Q&A features to enhance interaction	5.0	5.0	0.0					
36	Students present their work and have it critiqued one by one	3.0	4.0	0.5					
37	Set up a system with teaching assistants to boost interaction and assist in Q&A	4.0	4.0	0.5					
4. Course Content									
38	Align course content with enterprise employment needs	4.0	4.0	1.0					

No	Efficiency in online teaching and learning in vocational education computer programming strategy	Md	Mo	IQR	5	4	3	2	1
39	More practical cases to be included in the course content	4.0	5.0	0.5					
40	Develop course content that meets the characteristics of cultivating skilled personnel in vocational colleges	4.0	4.0	0.0					
41	The course content should emphasize practicality and operability	4.0	4.0	0.5					
42	Select and adapt content based on student needs to ease learning	5.0	5.0	0.0					
43	Develop courses reflecting actual vocational tasks and processes	3.0	4.0	0.5					
44	Industry experts participate in the whole process of course content development	4.0	5.0	1.0					
45	Course content should be integrated with workplace culture	4.0	4.0	1.0					
46	Modularization of course content, including knowledge module, skill module and ideology module	5.0	5.0	0.0					
47	Integrate content with vocational skill certification knowledge points	5.0	5.0	0.5					
5. Teaching Resource									
48	Create a centralized database for resource sharing and reuse	5.0	5.0	0.0					
49	Purchase or obtain resources from reputable organizations	3.0	4.0	1.0					
50	Invest in creating engaging resources like videos, animations, and simulations	4.0	5.0	0.5					

No	Efficiency in online teaching and learning in vocational education computer programming strategy	Md	Mo	IQR	5	4	3	2	1
51	Establish an incentive mechanism for the development of teaching resources	5.0	5.0	0.5					
52	Partner with enterprises for up-to-date practical training resources	4.0	4.0	1.0					
53	Form a team dedicated to enhancing resource quality	5.0	5.0	0.0					
54	Create micro-courses and small coursewares for mobile access	4.0	5.0	0.5					
55	Utilize AI and AR/VR to diversify teaching resources	3.0	4.0	1.0					
56	Provide financial support for teachers to update curricula with digital tools	4.0	4.0	0.0					
57	Develop vocational education teaching resources	5.0	5.0	0.5					
6. Teaching Design									
58	Teachers to research students' learning environments before class	5.0	5.0	0.0					
59	Adopt typical cases and project-based teaching design for the course	4.0	5.0	0.5					
60	Opt for easy-to-use online teaching techniques	5.0	5.0	0.5					
61	Rationalize the time schedule of each teaching session	4.0	4.0	0.0					
62	Assign tasks and guide students to preview videos with questions	4.0	4.0	0.0					
63	Increase the proportion of practical sessions	4.0	4.0	0.5					

No	Efficiency in online teaching and learning in vocational education computer programming strategy	Md	Mo	IQR	5	4	3	2	1
64	Reasonably design the amount of teaching content for online teaching	3.0	4.0	1.0					
65	Design corresponding plans and flexibly adopt live broadcasting and video broadcasting	3.0	4.0	1.0					
66	Focus on learning goals, break down knowledge points, and limit lessons to 15 minutes	4.0	4.0	0.5					
67	Use interactive methods like games, quizzes, and voting judiciously	4.0	4.0	0.0					
68	Define clear objectives and key points in teaching design	3.0	4.0	1.0					
69	Regularly review and assess course lesson plans	3.0	4.0	1.0					
70	Adjust teaching based on student feedback	4.0	4.0	0.5					
71	Design learning tasks with varying difficulty levels	4.0	5.0	0.5					
7. Learning Engagement									
72	Monitor online learning and alert non-participating students automatically	3.0	3.0	0.0					
73	Developing personalized study plans	3.0	4.0	1.0					
74	Implement a mechanism to flag low engagement and initiate intervention measures	4.0	5.0	0.5					
75	Cultivate study habits and share learning methods	5.0	5.0	0.0					

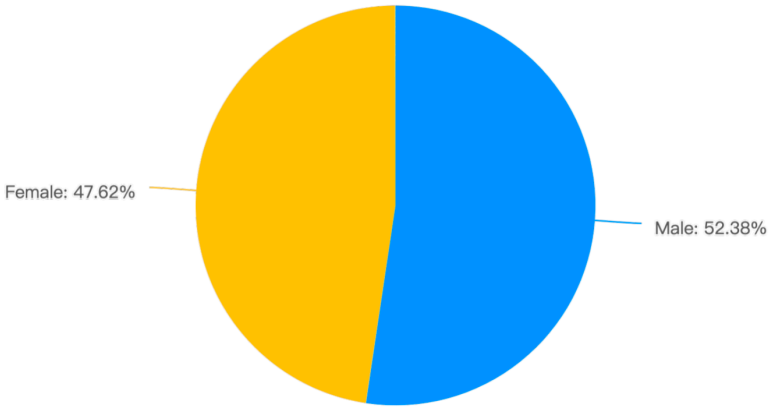
No	Efficiency in online teaching and learning in vocational education computer programming strategy	Md	Mo	IQR	5	4	3	2	1
76	Employ specialized teaching assistants to continuously supervise and tutor students	5.0	5.0	0.0					
77	Guiding students to establish learning partners and solve problems together	4.0	4.0	0.5					
78	Praise and incentivize students who are highly engaged in their studies	4.0	4.0	1.0					
79	Guiding students to reflect and digest knowledge in a timely manner	3.0	4.0	1.0					
80	Provide rich and practical resources for learners	4.0	5.0	0.5					
81	Enhance the fun and practicality of online courses	5.0	5.0	0.5					
8. School Policy Support									
82	Establishment of a training mechanism for teachers of different specialties	4.0	4.0	0.5					
83	Schools can set up a teaching point system to favor teachers in their treatment and performance appraisal	4.0	5.0	0.5					
84	Incorporate online teaching ability into the appraisal system of teachers' titles	5.0	5.0	0.0					
85	Award points and rewards to teachers actively participating in online teaching training	3.0	4.0	1.0					
86	Integrate online teaching into the school's overall development plans	5.0	5.0	0.0					
87	Establish school, provincial, and national indicators for teaching informatization, linked to title promotions	4.0	4.0	0.5					

No	Efficiency in online teaching and learning in vocational education computer programming strategy	Md	Mo	IQR	5	4	3	2	1
88	Involvement in online teaching construction and individual excellent cases into the annual performance incentives	5.0	5.0	0.0					
89	Actively introduce highly competent informatization talents	4.0	5.0	0.5					
90	Enhance financial investment to build interactive teaching equipment and recording and broadcasting classrooms	5.0	5.0	0.0					
91	Setting up a technology management department centered on the online teaching and learning platform	4.0	4.0	0.5					
92	Build wired and wireless networks covering the whole school	3.0	4.0	1.0					
93	Set up a teaching management department focusing on online teaching talent training.	4.0	5.0	0.5					
94	Randomly check the online teaching of teachers in each semester.	3.0	4.0	1.0					
95	Organize an online teaching expert assessment team to regularly assess the quality of online teaching in all aspects.	4.0	4.0	1.0					
96	Introducing school credit bank and credit recognition system to expand the recognition of online learning	3.0	4.0	1.0					
97	Establish a comprehensive online teaching training system covering teaching, research, and competitions	4.0	4.0	0.5					

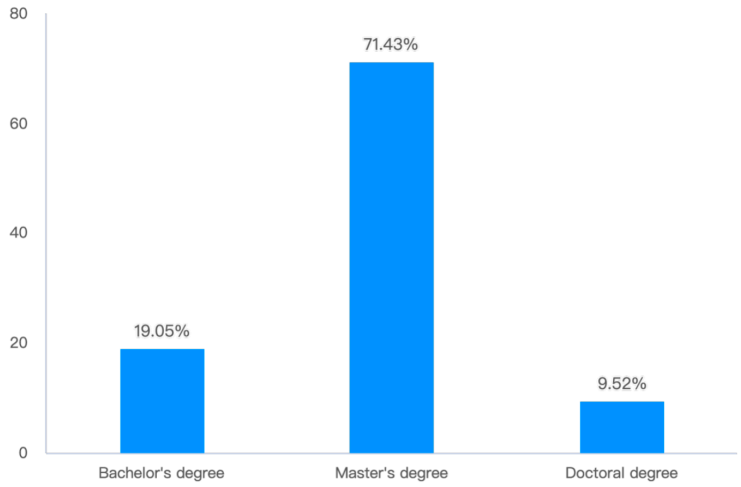
No	Efficiency in online teaching and learning in vocational education computer programming strategy	Md	Mo	IQR	5	4	3	2	1
9. Online Teaching and Learning Platform									
98	Online teaching and learning platform to enhance data security protection	3.0	4.0	1.0					
99	Ensure system stability and reliability for many users	3.0	3.0	1.0					
100	Support real-time interactions, discussions, tests, and mobile learning.	5.0	5.0	0.0					
101	Allow uploading various teaching resources and course creation	5.0	5.0	0.5					
102	Enable seamless operation on different devices	3.0	5.0	1.0					
103	Support flexible and skill-based assessments, like code reviews	5.0	5.0	0.0					
104	Provide feedback collection, resource distribution, and course planning	3.0	4.0	1.0					
105	Automatically design customized learning content	4.0	4.0	0.0					
106	Focus on simple and efficient interface	5.0	5.0	0.0					
107	Create profiles and suggestions using big data	4.0	5.0	1.0					
108	Integrate vocational skill examination systems	5.0	5.0	0.5					
109	Offer personalized job recommendations for students	3.0	4.0	1.0					

位置分布

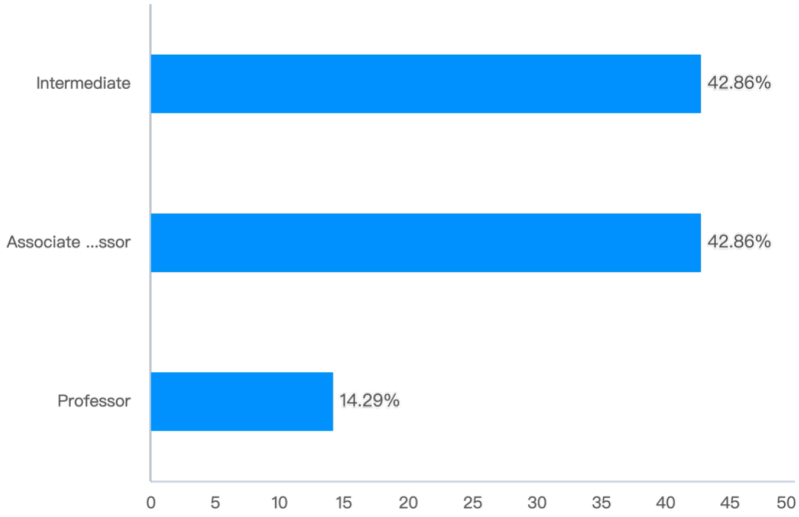
Your gender:



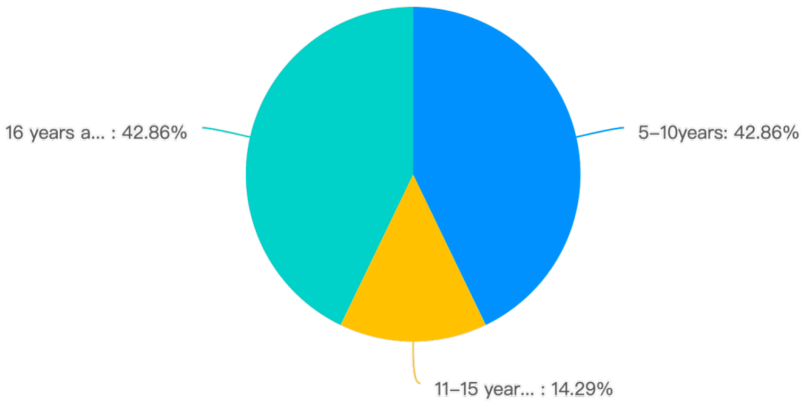
Your cultural level:



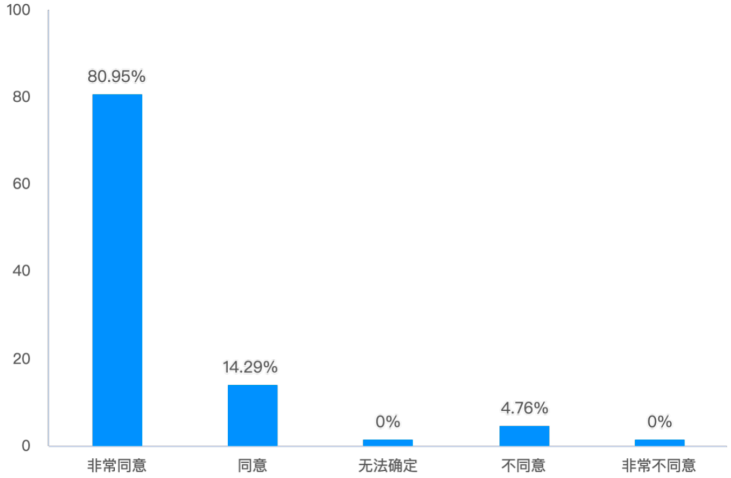
What is your professional title:



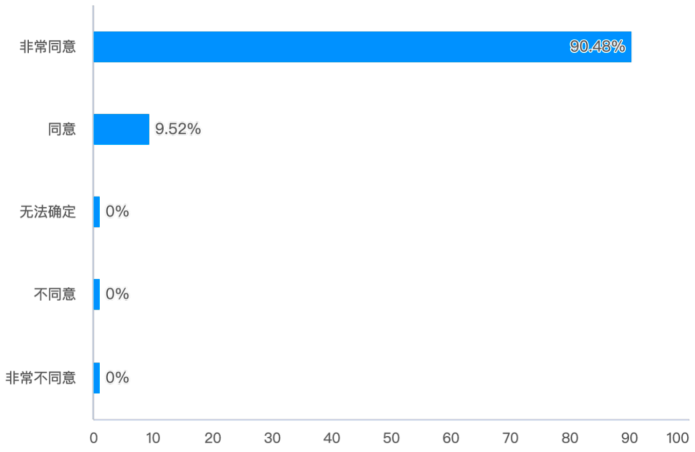
Your years of experience in university management:



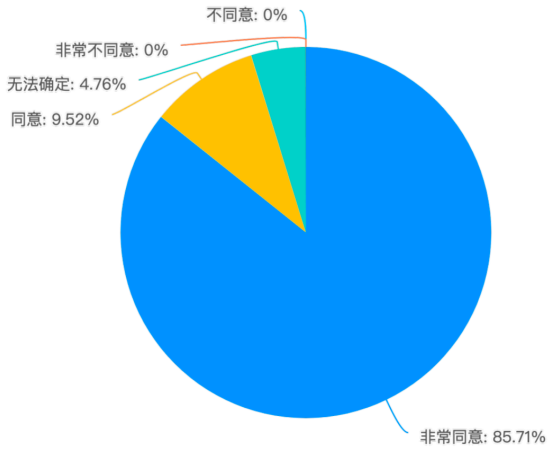
你认为可以定期为教师举办信息技术应用培训班，以提高他们的信息化教学能力。



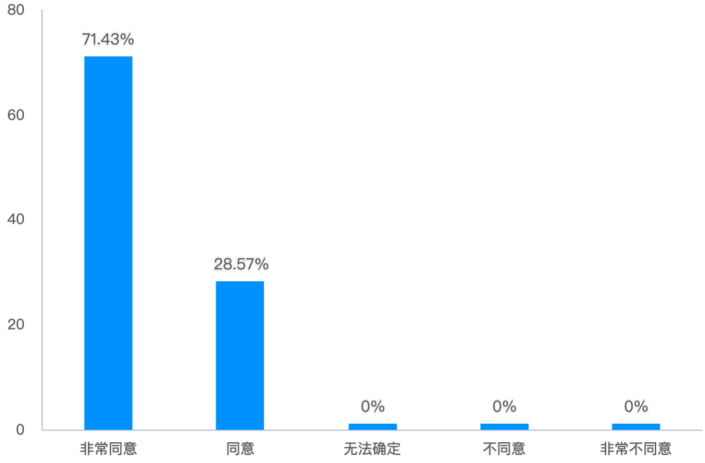
你认为应该组织教师团队来开发在线教学资源库，从而通过分工来提高效率。



您认为可以建立教师在线教学绩效评价体系，纳入教学质量评价体系。



您认为可以通过实施教师角色分层管理，有针对性地提升教师信息化教学能力。



Lists of experts in Focus Group

No	Experts	Experience (Years)	Professional Title	Work Unit
1	Experts 1	10	Professor	Guangxi Vocational and Technical College
2	Experts 2	10	Professor	Nanning College for Vocational Technology
3	Experts 3	13	Professor	Liuzhou Vocational and Technical College
4	Experts 4	12	Professor	Guangxi International Business Vocational and Technical College
5	Experts 5	15	Professor	Guangxi International Business Vocational and Technical College
6	Experts 6	10	Professor	Liuzhou City Vocational College
7	Experts 7	13	Professor	Guangxi Vocational and Technical College
8	Experts 8	10	Professor	Guangxi Vocational and Technical College
9	Experts 9	13	Professor	Guangxi Vocational and Technical College

Focus Group Form

Efficiency in online teaching and learning in vocational education computer programming strategy

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Explanation:

The purpose of this form is to focus on the efficiency in online teaching and learning in vocational education computer programming strategy through the Focus Group method. 9 experts who meet the qualification requirements have been carefully selected to ensure the professionalism and depth of the discussion. Together, the experts will delve into each specific strategy proposed for online teaching and learning. The team of experts will review each proposed strategy individually, and based on the discussion, a final conclusion will be made for each strategy: “Pass”, “Modify”, “Add”, “Delete”.

Regarding the efficiency in online teaching and learning in vocational education computer programming strategy, please tick √ the corresponding option column.

Thankyou

Mr. Zhou Jie

A doctoral student in Digital Technology Management for Education

Bansomdejchaopraya Rajabhat University

Items	Efficiency in online teaching and learning in vocational education computer programming strategy	Result			
		Pass	Modify	Add	Delete
1. Teachers' Informatization Teaching Ability					
1	Participate in short-term, online and off-campus trainings				
2	Learn from experienced teachers’ online teaching methods				
3	Participate in competitions to enhance information technology teaching skills				
4	Sharing online teaching experience among teachers				
5	Set up online teaching groups for regular discussions and seminars				
6	Regular spot checks on teachers' teaching of informatization courses				
7	Award certificates and prizes on Teachers' Day to teachers who are excellent in online teaching				
8	Encourage participation in information technology teaching reform research and provide financial support				
Suggestion:					
2. Students' Autonomous Learning Ability					
9	Encourage students to obtain professional certifications and offer cash rewards				
10	Monthly competitions with rewards for top performers				

Items	Efficiency in online teaching and learning in vocational education computer programming strategy	Result			
		Pass	Modify	Add	Delete
11	Establish studios for research and skill competitions under teacher guidance				
12	Engage with students to understand their thoughts and help them set career goals				
13	Offer courses to inspire self-assessment and positioning				
14	Conduct regular skill assessments for students				
15	Schools should create a campus culture of active learning				
16	Incorporate tasks like micro-teaching videos for course grading				
17	Encourage students to evaluate and develop interest in their majors				
Suggestion:					
3. Online Teaching and Learning Interaction					
18	Incorporate pop-ups, polls, and Q&A features to enhance interaction				
19	Use tools like WeChat-Group for monitoring student learning				
20	Focus on language use to strengthen teacher-student emotional connections				
21	Initiate topics of interest in the online platform's discussion forums.				
22	Assign tasks like short answers or multiple-choice questions to evaluate self-learning				