Strategies of Effective Online Teaching and Learning in Vocational Computer Programming Education

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Abstract
Background and Aim: This research analyzes the existing issues with online teaching and learning in vocational computer programming education, devises strategies for online teaching and learning, and then implements and adjusts these strategies to confirm their effectiveness. The expected strategies for effective online teaching and learning proposed in this study include nine aspects: The study focuses on the following nine aspects: 1) the informatization teaching ability of teachers; 2) the autonomous learning ability of students; 3) the interaction between online teaching and learning; 4) the course content; 5) the teaching resource; 6) the teaching design; 7) the learning engagement; 8) school policy support; and 9) the online teaching and learning platform.
Methodology: The sample consisted of 21 experts with qualified Delphi requirements from high vocational colleges in Guangxi, as well as 60 computer program students in their second year of study. Research instruments include an open-ended interview and Likert scale questionnaire, as well as data analysis using median, mode, interquartile range, percentage, and descriptive analysis.
Results: The research results found that online teaching and learning in vocational computer programming education in aspects were at a medium-high level; after implementing and readjusting the strategies, the effectiveness of online classes was comparable to that of traditional classes. The research results summarized 80 strategies and suggestions for online teaching and learning in vocational computer programming education and put forward a discussion of the future development trend.
Conclusion: The study's findings show that, with some strategic modifications, online instruction in vocational computer programming education achieved a medium-high effectiveness that was on par with traditional classroom settings. The study also offered eighty strategies and insights for the advancement of online education in this field in the future.
Keywords: Education Strategies; Online Teaching and Learning; Vocational Computer Programming Education

Introduction

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 a 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 strategies for Online teaching and learning to adapt to the changing educational environment.

Based on the above, this study focuses on online teaching and learning in vocational computer programming education in Guangxi and develops strategies to improve the effectiveness of online teaching and learning. To achieve the final research aim, the research focuses on "How to develop the strategies of effective online teaching and learning in vocational computer programming education?"

Objectives

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

2. To develop the strategies of effective online teaching and learning in vocational computer programming education.

3. To implement and readjust the strategies of effective online teaching and learning in vocational computer programming education.

Literature review

1. Online Education Definition.

Online education, also known as "online education," "e-learning," "web-based learning," or "web-based learning," originated from distance education and is known as the "fifth generation" version of distance education (Taylor, 2001). Modern Internet-based tools and a diverse array of Web resources, including Web-based applications (like audio and video streaming, learning management systems, 3D simulation and visualization, and multi-user games), along with new collaboration and communication technologies, provide support for online education. These technologies include Internet telephony, chat, screen sharing, and the use of shared graphics on whiteboards. Today's online learning is very different from the television broadcasting and videoconferencing that characterized early distance education.

Scholars from China have researched the concept and characteristics of online teaching. Online teaching uses the network as a medium to put both teachers and students in different times and spaces, and indirectly improve students' autonomous learning abilities through the auxiliary organization of teaching. Thus, a two-way feedback form of distance education activity develops between the two parties (Ding, 2000). This way of learning, based on modern Internet technology, is a new teaching model that focuses on individual learners to meet the needs of educational development (Yun, 2011). Online teaching is different from the traditional form of teaching, this type of non-face-to-face communication allows students to follow their plans and choose the knowledge and technology they want to learn. It can greatly improve the efficiency of learners (Xu, 2014).

2. Current situation and problems of online teaching and learning.

Currently, colleges and universities in China prioritize classroom teaching as the primary training method, neglect online teaching, and lack comprehensive organization and management, leading to a decline in the quality of online teaching (Weng, 2012). Some teachers are not familiar with the actual operation of online teaching, information technology literacy is low; online teaching courseware still uses the traditional teaching section, the teaching content is single, cannot meet the needs of modern students for high-quality knowledge (Lv and Lu, 2015). At the same time, in reality, there is 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 & Liu, 2016). While new media technology development can enhance online teaching to some degree, there is still a need to improve overall teaching resources, planning, and quality (Li, 2017).

3. Concept of online teaching and learning.

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.

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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 is 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 and Liu. (2018) proposed 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.

4. Context of vocational education.

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. To meet the needs of economic and social development, the state has issued several 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.

5. Delphi Method.

Originating from the RAND Corporation in 1950 (Okoli and Pawlowski, 2004), the Delphi method uses an interactive iterative process to seek expert consensus. (Vernon, 2009), 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, Hsu, & Fang, 2021).

Effective online teaching and learning emphasize the flexibility, accessibility, and personalized learning opportunities afforded by online platforms, while also noting the challenges such as the digital divide, engagement, and retention issues (Yanti et al., 2023). Web-based applications are shown to enhance interactive learning experiences but require robust infrastructure and technical support. Online teaching and learning practice covers multiple instructional strategies and platforms, emphasizing reactive and simultaneous modes. In China, vocational education was designed to produce highly qualified personnel to support the country's economic and social development. It mixes theoretical knowledge with practical skills, serving both student learning needs and societal demands across fields, and government regulations have aided its rise. The Delphi Method is frequently employed in these studies to reach a consensus among experts on best practices and future directions in vocational education, providing a structured approach to gathering and analyzing expert opinions (Kozax et al., 2023.)
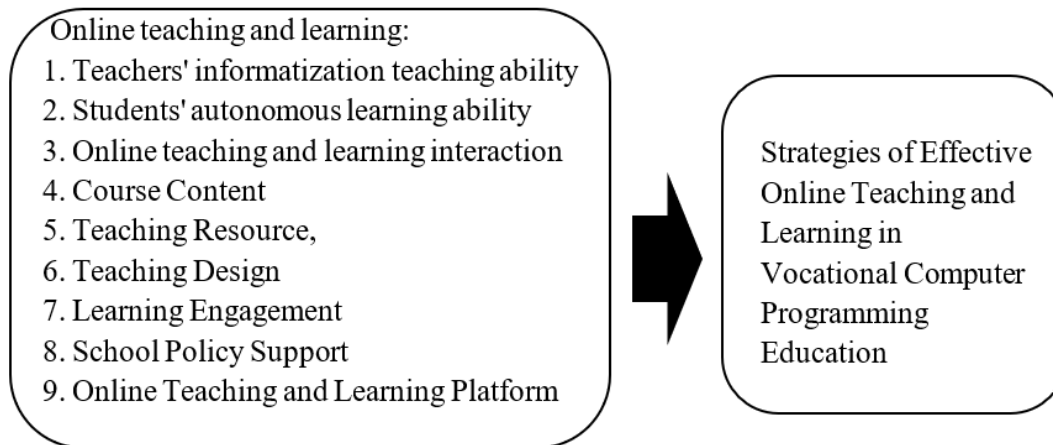
Conceptual Framework

Figure 1 Research Framework

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 computer programming education and to develop the strategies for effective online teaching and learning in vocational computer programming education. 2) Using the focus group discussion and class comparison to implement and readjust the strategies of effective online teaching and learning in vocational computer programming education.

Phase 1: Employ the Delphi Method to achieve Objective 1 and Objective 2.

Step 1: Reviewing and analysing documents, concepts, theories, and research related to the strategies of effective online teaching and learning in vocational computer programming education.

Step 2: Construct the Open-Ended Interview Form about the current situation of online teaching and learning in vocational computer programming education. Then sending the Open-Ended Interview Form to the thesis advisors to review and revise the contents according to the suggestions. Step 3: The Open-Ended Interview Form was distributed to 5 experts for try-out.

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

Step 5: The Open-Ended Interview Form was applied to the selected 21 experts.

Step 6: Based on the 21 experts' responses from the Open-Ended Interview Form, constructing the Likert Scale Questionnaire about the survey was conducted on the strategies of online teaching and learning in vocational computer programming education.

Step 7: The Index of Consensus. (IOC) of the questionnaire was examined by 5 experts. The Index of Consensus. (IOC) was 0.67 to 1.00.

Step 8: The Likert Scale Questionnaire was distributed to 21 experts.

Step 9: Revise the Likert Scale Questionnaire based on the experts' suggestions.

Step 10: Distribute the Likert Scale Questionnaire with median, mode, and inter-quartile range to the selected 21 experts, requesting experts' responses and opinions. Repeat steps 8-10 until the consensus reaches more than 75%.

Phase 2: Employ the focus group and class comparison to achieve objective 3.

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 the recording of the meeting content, including members' opinions, viewpoints, and suggestions.

Step 3: Guide focus group experts to discuss the proposed strategies of effective online teaching and learning in vocational computer programming education. Ask for expert opinion on whether to " pass" " modify" " add" or " delete".

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

Step 5: Use a purpose sample and select 60 students from the second year of the computer program at Guangxi Vocational and Technical College.

Step 6: Randomly assign the selected 60 students to two classes, ensuring balance in terms of student abilities and backgrounds. Ensure that all variables other than teaching strategies (such as curriculum content, and class hours) are consistent.

Step 7: Implement traditional face-to-face Teaching Strategies and Online teaching and learning strategies, Record the course progress and participation in both classes.

Step 8: Compare the grades of both groups in tests, assignments, and projects. Evaluate student performance in programming skills and problem-solving abilities.

Step 9: Use descriptive statistical methods to analyse the learning effectiveness data of both groups. Assess which teaching strategy is more effective and its impact on different types of students.

Results

Part 1: Results of an interview about current situation problems and strategies of online teaching and learning in vocational computer programming education.

Table 1 Results for Current situation problems

Items	High	Medium	Low	Unspecified
Overall Level of Online Teaching and Learning	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%)

Table 1, reflects the 21 experts in the Open-Ended interview's answer to Q1: What do you think are the current situation problems of online teaching and learning in vocational computer programming education? 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, and 23.81% high for resources. Learning engagement rates as 14.29% high and 19.05% low. School policy support is seen as high at 23.81% and low at 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.

Part 2: Results of the questionnaire survey about the strategies of effective online teaching and learning in vocational computer programming education.

According to Figure 2 and Table 2, can classify and group the effective strategies of online teaching and learning into three layers that contain 9 aspects, 29 topics, and 80 strategies. It can be an implemented guideline for Guangxi vocational computer programming education to carry out online teaching and learning to improve quality and excellence.

Table 2 Strategies of effective online teaching and learning

Aspects	Topics	Strategies
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' information 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
		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 an 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

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Aspects	Topics	Strategies
	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 learning materials
		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 an 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
	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 courseware for mobile access
		45. Create a centralized database for resource sharing and reuse

Aspects	Topics	Strategies
Teaching Design	Teaching Preparation and Methodology	46. Partner with enterprises for up-to-date practical training resources
		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 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
		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 in 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
	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

| Aspects	Topics	Strategies
Online Teaching and Learning Platform	Set Multi-level Informatization Assessments	71. Establish a comprehensive online teaching training system covering teaching, research, and competitions
		72. Establish school, provincial, and national indicators for teaching informatization, linked to title promotions
	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 a simple and efficient interface
		78. Automatically design customized learning content
		79. Integrated Virtual Reality (VR) and Augmented Reality (AR) technologies for immersive learning experiences
	Data Utilization	80. Create profiles and suggestions using big data
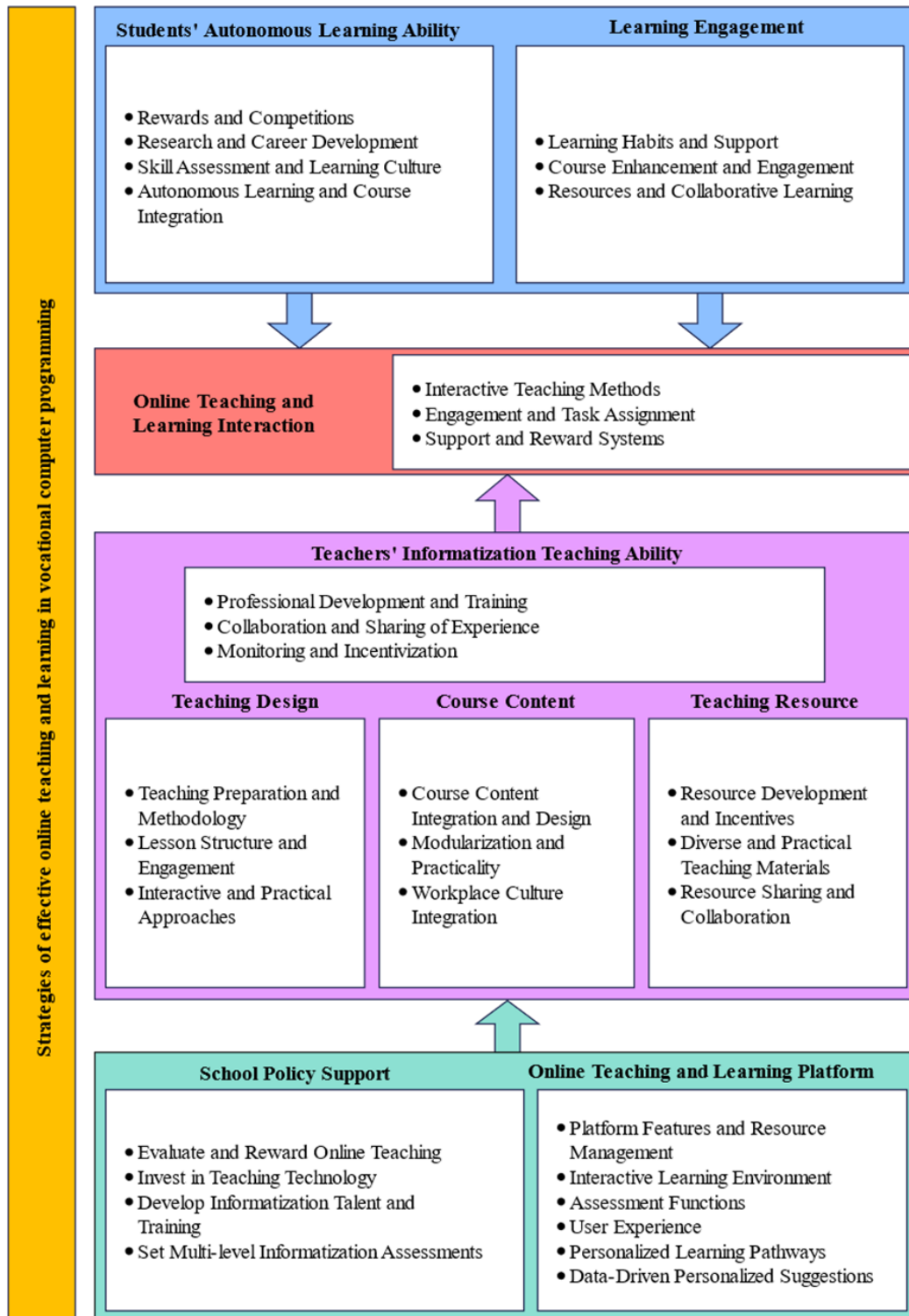
Figure 2 Strategies of effective online teaching and learning chart.

Part 3: The analysis results of the effectiveness of the traditional class and online class by Descriptive Analysis.

Table 3 Results of Descriptive Analysis for Learning Effectiveness

Items	Samples	Min	Max	Mean	S. D.	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

Table 3, 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 3 visualizes the comparison of the mean scores of the traditional class and the online class in the
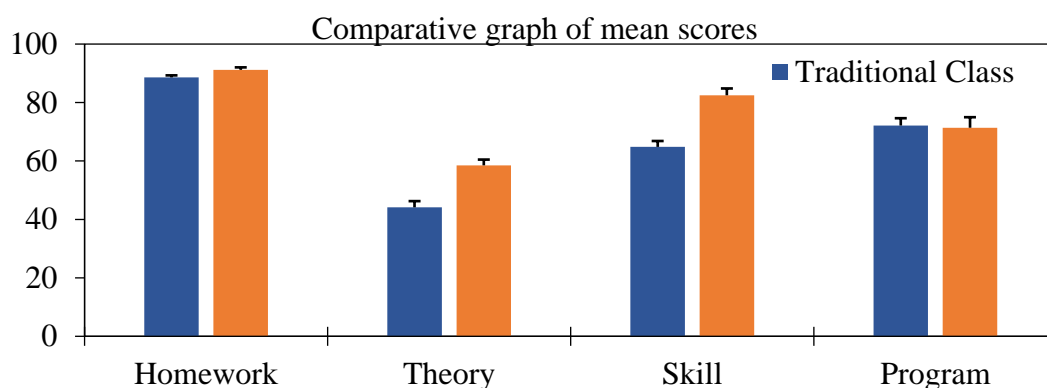
four parts of the homework, theory, skills, and program.

Discussion

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

The results of this study found that the 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 by 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 effective way to improve teachers' informatization ability. Schools can increase capital investment for hardware and software equipment and implement scientific and systematic training programs for teachers' professional development (Wang et al., 2022).

Part 2: The strategies of Effective Online Teaching and learning in Vocational Computer Programming Education

The researcher developed strategies to enhance the effectiveness of online teaching and learning in vocational computer programming education 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. Related to the research of Zhang et al (2022) pointed out that college teachers' recognition of online teaching can effectively improve teachers' willingness to carry out online teaching, and recognition of the value of online teaching. College teachers can 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 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. This approach aligns with the findings of Cho & Cho (2014), who highlight the significant role of teachers in facilitating effective online teaching by providing support and scaffolding to students, both during and after classes (Cho & Cho, 2014). By adopting a positive attitude, acquiring the necessary knowledge, and implementing innovative teaching strategies, teachers can contribute to the successful development of online teaching in higher vocational education.

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 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 effectively 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 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.

Part 3: Implement and readjustment the strategies of effective online teaching and learning in vocational computer programming education

After the focus group discussions, the group of experts comprehensively considered and adjusted the strategies for effective online teaching and learning in vocational computer programming education. After adjusting the strategies of effective online teaching and learning in vocational computer programming education the researcher implemented the 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 the online teaching strategies proposed in this study are effective. The related to research of Shi (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 personalities. Students are allowed to think in groups or independently according to their 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 to on the online teaching platform. For the questions assigned at the end of the course, students submit them to the online teaching platform, and teachers categorize and screen them for discussion in the next class. This series of teaching practices improves the effectiveness of online teaching. Therefore, in this study, the nine aspects of strategies to improve the effectiveness of online teaching and learning can promote the development of online teaching and learning in vocational computer program education in Guangxi.

Conclusion

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

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 abilities, students still need to improve in using online resources for self-guided learning. The current state of online teaching and learning in Guangxi higher vocational colleges demonstrates positive development, with strong institutional policies and a clear

intention to advance the mode of education. This aligned with the Chinese Ministry of Education's push for informatization reform. However, significant challenges remain, particularly in enhancing students' autonomous learning abilities, which are currently at the lowest level compared to other factors such as teachers' informatization teaching abilities, teaching resources, and school policy support. Despite the availability of online courses, course content quality and online interactivity require upgrading to ensure effectiveness. Schools must also bolster policy support and resources to optimize online teaching platforms and innovate teaching designs. Addressing these challenges requires comprehensive strategies and collaborative efforts to improve the overall quality and effectiveness of online teaching and learning (Ministry of Education, 2021). 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 effectiveness. 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 effectiveness of online teaching and learning.

Part 2: The strategies of Effective Online Teaching and learning in Vocational Computer Programming Education

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 80 strategies to enhance the effectiveness of online teaching and learning in vocational computer programming education 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.

Part 3: Implement and readjustment the strategies of effective online teaching and learning in vocational computer programming education

After the focus group discussions, the group of experts comprehensively considered and adjusted the strategies for effective online teaching and learning in vocational computer programming education. Regarding the strategies for efficient online teaching in vocational computer programming, researchers evaluated these strategies in an online class before comparing their results to a traditional class of 60 second-year students. The online class demonstrated significantly higher mean scores in the "homework" and "skill" categories, with more concentrated results as shown by a smaller standard deviation. 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 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 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.

Recommendation

Based on the above conclusions, combined with the analysis of the strategies of effective online teaching and learning in vocational computer programming education, to better promote the development of online teaching and learning in vocational education in Guangxi. 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 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. Build a curriculum system that integrates production and education in a joint effort. By "introducing enterprises into the school," actively developing school-enterprise cooperation courses, inviting industrial enterprises to deeply participate in course construction, incorporating enterprise experts into the classroom, implementing curriculum reforms, designing the curriculum system, and optimizing the course structure 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, employment, and entrepreneurial abilities according to the characteristics of the specialty, effectively 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. In response to the need for training innovative and complex talents, industry enterprises support the development of online high-quality courses. They align the course standards with job skill standards, industry certificate standards, and competition ability standards. They build an online high-quality course system with a modularized knowledge and ability ladder. This system emphasizes vocational quality, restructures course objectives to match job levels, encourages participation in skill competitions, adheres to quality requirements, and promotes the redesign of teaching materials. On the other hand, they adopt 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.) to support students' continuous and in-depth personalized learning.

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