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The 5E-based SPOC Instructional Approach on the ICVE Platform for Barista Training Courses

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Abstract

Background and Aim: In the digital era, traditional single-method teaching approaches are increasingly insufficient to meet the demands of modern education. Therefore, this study integrates the traditional 5E instructional model with modern educational technology—the ICVE platform's SPOC. It examines the impact of this approach on students' academic performance and their acceptance of ICVE SPOC technology. By leveraging the 5E-based ICVE SPOC Instructional Approach, the study aims to refine teaching strategies, enhance instructional effectiveness, and improve the quality of talent cultivation in barista training courses.

Materials and Methods: A quasi-experimental design was employed to evaluate students' performance, including barista knowledge, customer service provision, coffee station organization, coffee preparation and serving, and an overall barista knowledge and skills score, to assess the impact of the 5E-based ICVE SPOC for Barista Training Courses. Additionally, based on the Technology Acceptance Model (TAM), a random sample of 15 students from the experimental group was selected to respond to open-ended questions evaluating their acceptance of the 5E-based ICVE SPOC instructional approach.

Results: The implementation of the 5E-based ICVE SPOC instructional approach significantly improved students' performance. Additionally, respondents generally held a positive attitude toward the ICVE SPOC, particularly appreciating its rich learning resources, convenient classroom activities, and timely learning feedback. Based on the TAM, under the guidance of the 5E instructional model, the SPOC functionality of the ICVE platform enhanced learners' perceived usefulness (PU) and perceived ease of use (PEOU) by providing abundant course resources, convenient instructional activities, and timely learning feedback. Furthermore, the study also found that PU and PEOU significantly influenced participants' attitudes toward technology (ATT) and behavioral intention (BI).

Conclusion: This study confirms that the 5E-based ICVE SPOC instructional approach significantly enhances learning outcomes in barista training courses. The deep integration of the classic instructional model with modern intelligent teaching technologies will drive transformations in teaching methods, support vocational education classroom reform, and foster innovation in curriculum development.

Keywords: Vocational Education; ICVE; SPOC; 5E Model; Barista Training

Introduction

In recent years, vocational education has become an integral part of higher education. According to Greinert (2002), the European Centre for the Development of Vocational Training aims to equip people with the knowledge, know-how, skills, and competencies required in particular occupations or, more broadly, in the labor market. Barista training courses (BTC) are designed primarily to enhance students' occupational and technical knowledge and skills within the coffee industry. Although China is generally known as a tea-consuming country, both the production and consumption of coffee in China have seen double-digit growth in the last decade. Relevant data indicates that China's coffee market is experiencing an annual growth rate of 15%, significantly outpacing the global average growth rate of 2% (Wang, 2022). The rapid growth of the coffee market and the spread of coffee culture have significantly increased the demand for baristas.

Recognizing the growing importance of baristas in the workforce, the Ministry of Human Resources and Social Security revised *the Occupational Classification Code of the People's Republic of China (2022 edition)*, officially classifying baristas as service personnel within the accommodation and catering sector of the commercial and service industries (National Occupational Classification Revision Committee, 2022).

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Furthermore, to standardize professional skills and enhance expertise, the Ministry released the *National Occupational Skill Standards for Baristas (2022 edition) (Occupational code: 4-3-02-08)*. This initiative provides essential guidance and support for career development and skill enhancement, serving as a foundation for curriculum design and examinations in higher vocational education.

According to Jia and Zhang (2021), the development of information technology, along with the emergence of Massive Open Online Courses (MOOCs) and Small Private Online Courses (SPOCs), has led to the appearance of a diverse range of online courses that incorporate numerous new resources and innovative teaching methods. SPOCs are akin to MOOCs in that they constitute a modality of online education delivered through the Internet (Fox, 2013). The SPOC platform provides an extensive array of educational resources comparable to MOOCs while simultaneously offering streamlined administrative procedures and diminished operational costs (Guo, 2017; Zeng et al., 2021). According to Freitas and Paredes (2018), the SPOC platform consists of two components: online courses and offline teaching activities. As a result, the influencing factors of SPOC teaching encompass both online resources and offline instructional methods. Currently, specialized courses for students in higher vocational colleges in China are typically taught in a classroom setting at fixed times and locations. The SPOC platform combines online courses with offline teaching activities, requiring students to study SPOC resources while also needing guidance from teachers autonomously. Therefore, under such circumstances, researching how teachers can apply the SPOC platform in the classroom to enhance students' occupational and technical knowledge and skills is of great significance.

The ICVE (Intelligent Cloud of Vocational Education) platform, developed by the Higher Education Press, is a new interactive educational platform designed to provide intelligent, data-driven support and services for the teaching process through information technology (Zhao & Sun, 2020, February). The platform, accessible via its official website (https://www.icve.com.cn/), has garnered a user base of 4.44 million and is available on both web and mobile interfaces.

In the study of offline classroom teaching strategies, it was found that the 5E instructional model is an effective teaching approach. The 5E instructional model, which typically includes five phases: Engage, Explore, Explain, Elaborate, and Evaluate, has been proven to enhance student engagement and learning outcomes by providing structured and interactive learning experiences that facilitate deep understanding and application of concepts (Collins, 1998; Bybee et al., 2006). Previous studies have demonstrated that the 5E instructional model enhances cognitive learning outcomes (Pratiwi, 2016; Rodriguez et al., 2019; Utari et al., 2013). Additionally, this model has been found to improve students' problem-solving skills and inquiry abilities (Yeni et al., 2017; Zhang & Shi, 2024). Further research indicates that the 5E model positively affects students' learning outcomes and critical thinking skills (Novianti et al., 2014; Rahmawati et al., 2021). However, no research has yet explored the impact of combining the 5E instructional model with ICVE SPOC for BTC.

Objectives

1) To determine the effectiveness of the 5E-based ICVE SPOC instructional approach in improving students' barista knowledge and skills in BTC.

2) To determine students' acceptance of using the 5E-based ICVE SPOC instructional approach in BTC based on the TAM.

Literature review

5E Instructional Model

The 5E instructional model is an effective inquiry-based learning framework grounded in constructivist theory and applicable across various educational settings. Developed by the Biological Sciences Curriculum Study (BSCS), the model consists of five phases—Engagement, Exploration, Explanation, Elaboration, and Evaluation—to foster deep understanding and self-directed learning (Bybee

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et al., 2006). Its flexibility in different educational contexts has been widely studied (Siwawetkul & Koraneekij, 2020; Rafon & Mistades, 2020; Lam et al., 2022; Jiang et al., 2023).

SPOC Teaching Model

Since 2020, research on the implementation and effectiveness of SPOCs in various educational contexts has increased significantly, especially in higher education. Several studies have explored the design, implementation, and impact of SPOC-based learning models, demonstrating their effectiveness in improving student engagement, learning outcomes, and satisfaction across different disciplines. Furthermore, the flexibility of the SPOC model enables its successful application across multiple fields, enhancing both theoretical understanding and practical skill development (Crosthwaite, 2020; Jiang & Liang, 2023; Ruiz-Palmero et al., 2020; Wen & Wu, 2022; Zeng et al., 2021; Zhang et al., 2020). However, limited research has focused on the integration of SPOCs with in-class teaching activities, particularly in combining SPOCs with the 5E instructional model.

The 5E-Based ICVE SPOC

The ICVE platform, developed by China Higher Education Press, is designed to facilitate hybrid learning and deliver SPOC-based instruction. The platform enables instructors to flexibly integrate various teaching materials, including courseware, digital textbooks, and question banks. For in-class activities, the ICVE platform provides robust tools for attendance tracking, questioning, group discussions, and brainstorming sessions. Numerous studies have provided strong evidence that a wealth of online course resources, convenient in-class activities, and immediate learning feedback can effectively enhance students' knowledge and skills (Jia & Zhang, 2021; Meikleham & Hugo, 2018; Malecka et al., 2020; Bing-You et al., 2018; Zhang, 2024).

The 5E-based ICVE SPOC Instructional Approach leverages the ICVE platform's SPOC technology to provide personalized and intelligent instructional support for vocational education. Following the 5E framework, it integrates the five key phases as previously outlined to enhance learning effectiveness.

Barista Knowledge and Skills

The rapid expansion of the coffee market, particularly with the rise of the third-wave coffee movement, has significantly increased the professionalization and diversification of the barista role. This evolution has led to heightened expectations for baristas, requiring them to develop comprehensive coffee knowledge, exceptional customer service skills, and advanced technical abilities (Lee & Ruck, 2022; Singh & Saluja, 2013). A competent barista must be proficient in recommending coffee beverages, selecting and grinding coffee beans, preparing and evaluating espresso drinks, and operating, maintaining, and cleaning espresso machines and grinders (Service Skills Australia [SSA], 2023). Furthermore, barista knowledge encompasses an in-depth understanding of coffee types, brewing techniques, and equipment handling, which are essential for crafting a high-quality coffee experience (Lee & Ruck, 2022).

The evaluation criteria consist of two equally weighted components: barista knowledge and barista skills. The latter includes customer service provision, coffee preparation and serving, and coffee station organization (Ministry of Human Resources and Social Security of the People's Republic of China [MOHRSS], 2022).

TAM

TAM, developed by Davis (1989), is a prominent framework used to predict users' acceptance of technology. TAM asserts that perceived usefulness (PU) and perceived ease of use (PEOU) significantly influence users' attitude (ATT) toward technology, which subsequently affects their behavioral intention (BI) to use the technology.

The constructs of PU, PEOU, ATT, and BI are central to TAM, providing a comprehensive framework for understanding technology adoption. Each construct is linked to two open-ended questions to explore users' experiences and perceptions.

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Conceptual Framework

The research examines the effectiveness of the 5E-based ICVE SPOC instructional approach over an 8-week treatment period, comparing five key variables: barista knowledge, customer service provision, coffee station organization, coffee preparation and serving, and barista knowledge and skills between the traditional and experimental groups through pre-test and post-test score analysis. Additionally, 15 randomly selected students from the experimental group will respond to open-ended questions to assess their acceptance of the 5E-based ICVE SPOC instructional approach. As illustrated in Figure 1, this framework provides a visual representation of the study's conceptual structure, outlining the key variables and methodological approach.

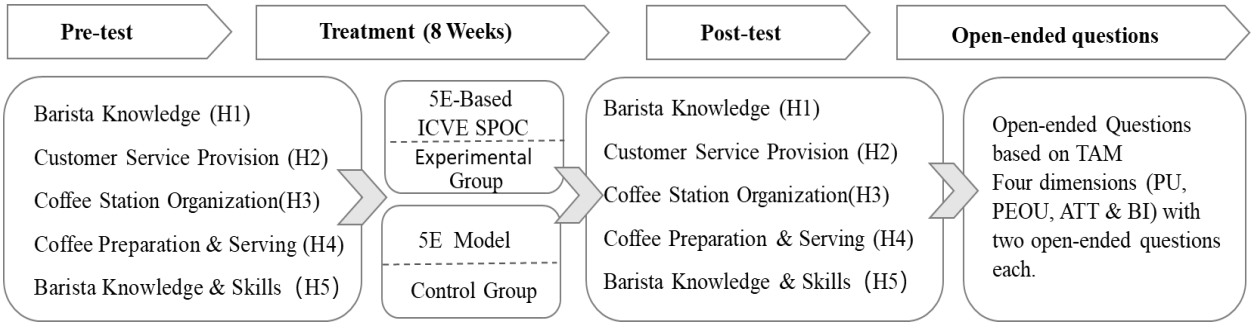

Figure 1 The Conceptual Framework of the Study

This study examines the effectiveness of the ICVE SPOC instructional approach based on the 5E instructional model in TBC within the catering management program, considering five key variables: barista knowledge, customer service provision, coffee station organization, coffee preparation and serving, and barista knowledge and skills. Based on the research objectives and prior studies, the following hypotheses are proposed:

Table 1 List of Hypotheses in the Study

Hypotheses	Statement	Literature Support
$H_0$1	There is no difference in barista knowledge between the control group and the experimental group in BTC.	(National Skill Standards Board, 2000; Prehanto et al., 2021; Lee & Ruck, 2022; MOHRSS, 2022)
H_a1	There is a difference in barista knowledge between the control group and the experimental group in BTC.	
$H_0$2	There is no difference in the customer service provision between the control group and the experimental group in BTC.	(Singh & Saluja, 2013; SSA, 2023; McMahon et al., 2009; MOHRSS, 2022)
H_a2	There is a difference in the customer service provision between the control group and the experimental group in BTC.	
$H_0$3	There is no difference in the coffee station organization between the control group and the experimental group in BTC.	(Manzo, 2014; SSA, 2023; MOHRSS, 2022)

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Hypotheses	Statement	Literature Support
H_a3	There is a difference in the coffee station organization between the control group and the experimental group in BTC.	
H_04	There is no difference in the coffee preparation and serving between the control group and the experimental group in BTC.	(Peterson et al, 2001; O*NET Online n.d.; SSA, 2023; MOHRSS,2022)
H_a4	There is a difference in the coffee preparation and serving between the control group and the experimental group in BTC.	
H_05	There is no difference in the barista knowledge and skills between the control group and the experimental group in BTC.	(SSA, 2000; Lee and Ruck, 2022; Parrish, 2020; MOHRSS, 2022)
H_a5	There is a difference in barista knowledge and skills between the control group and the experimental group in BTC.	

Methodology

This study adopted a mixed-methods research approach, integrating both quantitative and qualitative analyses. The participants were first-year students majoring in Smart Catering Management at Zhejiang Business and Technology Institute. The quantitative analysis employed a pre-test and post-test design in a quasi-experimental study, comparing independent samples from the control and experimental groups. Students' academic performance was used as an indicator of their learning achievement to assess the impact of the 5E-based ICVE SPOC instructional approach on performance in the BTC. Using a census sampling method, the two classes taught by the instructor were randomly divided into the experimental and control groups. Before the start of the course, a pre-test was conducted for both groups to assess barista knowledge, customer service provision, coffee station organization, coffee preparation, and serving, as well as an overall barista knowledge and skills score. Subsequently, both groups participated in an eight-week BTC course. The experimental group received instruction through the 5E-based ICVE SPOC platform, while the control group followed the traditional 5E instructional model. After eight weeks, a post-test was conducted for both groups to assess their barista knowledge, customer service provision, coffee station organization, coffee preparation, and serving, as well as their overall barista knowledge and skills score. For the qualitative analysis, open-ended questions were administered to students in the experimental group. A random sample of 15 students was selected to provide in-depth and comprehensive insights into learners' acceptance of the 5E-based ICVE SPOC instructional approach.

Instructional Design

The researcher first created a "Barista Training Course" SPOC on the ICVE platform. Then, the experimental group was added as a teaching class within the SPOC, where the 5E Instructional Model was applied throughout the course instruction. This study primarily utilizes three functions provided by the SPOC on the ICVE platform: accessing course resources, conducting teaching activities, and providing feedback on learning performance. The course resources include courseware and digital textbooks; class activities encompass check-ins, questions, brainstorming, and team competitions (group PK); and learning feedback involves quizzes, assignments, exams, and daily grades.

The barista training course is comprised of two components: Junior Barista Training and Intermediate Barista Training. This study employed a quasi-experimental design over 8 weeks, encompassing a total of 24 instructional hours dedicated to the "Junior Barista Training" curriculum. Each instructional hour lasts

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for 40 minutes. By the *National Occupational Skill Standards for Baristas* (MOHRSS, 2022), this research explicitly delineates the professional skill requirements for Junior Baristas and formulates the corresponding teaching content for Junior Barista Training.

Population and Sample

The study population consisted of 68 newly admitted students from the Smart Catering Management program who were enrolled in a coffee course at Zhejiang Business College in China. These learners are currently undergoing higher vocational education and have an interest in the barista profession but lack systematic barista training, making them highly relevant to the content of this study. The sample size used in this study is 68 participants, which aligns with the common practice in quasi-experimental studies on educational technology interventions. For the two classes taught by the researcher, the experimental and control groups were determined using random sampling. In this method, every member of the population has an equal and independent chance of being selected.

Table 2 Number of Population and Sample Size

Population	Sample	Experimental group	Control group	Total sample size
N=68	N=68	N=34	N=34	N=68

Research Instruments

1) Performance Tests

In this study, the experimental group and the control group underwent an 8-week Junior Barista Training based on the results of a pre-test. During these 8 weeks, the experimental group engaged in 5E instructional sessions using the SPOC on the ICVE platform, while the control group followed the traditional 5E instructional approach. After 8 weeks, both groups took a post-test to compare their scores in barista knowledge, customer service provision, coffee station organization, coffee preparation and serving, and barista knowledge and skills to determine if there were significant differences.

The assessment criteria used to evaluate the five variables—occupational and technical knowledge, customer service provision, coffee station organization, coffee preparation and serving, and occupational and technical knowledge and skills—are based on the *National Occupational Skill Standards for Barista* (MOHRSS, 2022).

2) Open-ended Questions

In this study, open-ended questions were used to collect participants' intentions regarding the use of the 5E Instructional Model on the SPOC of the ICVE Platform in the barista course. The open-ended questions were adapted from the open-ended questions developed by Davis (1986), Davis (1989), Venkatesh and Davis (2000), Taylor and Todd (1995a, 1995b), and Venkatesh et al. (2003), and they underwent a rigorous development and validation process.

This section focuses on the acceptance of the use of the 5E Instructional Model on the SPOC of the ICVE Platform in the BTC. The questions included four variables: PU, PEOU, ATT, and BI. Each variable comprised two questions, resulting in a total of eight open-ended questions.

Validity of Research Instruments

This study includes both performance tests and open-ended question assessments. The scoring standards for the performance tests are based on the assessment methods, content, and weightings of the *Barista National Occupational Skill Standards* for Junior Barista certification (MOHRSS, 2022). The validity of the open-ended questions in this study was assessed using the Index of Objective Consistency (IOC).

1) Validity of the Performance Tests

Both the pre-test and post-test were conducted using the *Barista National Occupational Skill Standards* (MOHRSS, 2022). The national occupational skill standards are a set of normative guidelines established by relevant national authorities to measure the professional skill levels of workers. These

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standards detail the knowledge, skills, and work requirements that should be mastered in a specific profession or trade and serve as a crucial basis for vocational skill training and assessment.

The term "barista," as recognized by the Ministry of Labor and Social Security, refers to service personnel who are knowledgeable about coffee culture, preparation methods, and techniques. To further improve the national occupational standards system, the *National Occupational Skill Standards for Baristas* were developed and published by MOHRSS in June 2022. These standards provide a scientific and standardized basis for vocational education, training, and skill certification, ensuring that students acquire the necessary occupational and technical knowledge and skills in the coffee industry. Currently, first-tier cities such as Beijing, Shanghai, Guangzhou, Zhejiang, and Jiangsu have begun the certification process for the *Barista National Occupational Skill Standards*.

2) Validity of the Open-ended Questions

To validate the content of "The Acceptance of the 5E-based ICVE SPOC instructional approach in BTC," open-ended questions, the researcher employed the IOC (Index of Objective Consistency) validation method. The translated IOC form (consisting of 8 items) was submitted to a panel of three experts.

The expert panel members have extensive teaching experience and significant research achievements in the fields of education and culinary teaching. The researcher sought their opinions on whether the selected items were suitable for assessing students' acceptance of using the 5E-based ICVE SPOC instructional approach. Each expert rated the open-ended questions on a scale from 1 to -1, where 1 indicated strong agreement, 0 indicated neutrality, and -1 indicated strong disagreement.

The first expert, a university professor, rated all 8 items in the open-ended questions with a score of 1. The second expert, also a university professor, gave a score of 1 to all 8 items. The third expert, a Ph.D. holder, also rated all 8 items with a score of 1. All three experts gave the open-ended questions a full score of 1, indicating that the open-ended questions are valid and can be used in this study.

Data Collection Procedures

Before and following the course, students will participate in a barista knowledge and skills evaluation as mandated by the study protocol, allowing the researcher to collect performance data. Throughout the research process, as per the study design, the experimental group will utilize the 5E-based ICVE SPOC instructional approach to carry out teaching activities such as check-ins, inquiries, brainstorming sessions, group competitions, quizzes, assignments, exams, and regular assessments. Conversely, the control group will record attendance, other classroom activities, and assignment performance using the traditional 5E model. After an 8-week intervention period, 15 participants in the experimental group will complete open-ended questions assessing their acceptance of the 5E-based ICVE SPOC instructional approach through the WJX online survey platform; data from this survey will be compiled once all students have submitted their responses.

1) The Experimental Procedures

The course is 24 class hours long and lasts for 8 weeks. Learning tasks and requirements are determined before the student enters the study. At the end of their studies, students complete study assignments and assignments for each unit as required and, following the 8-week course, a preliminary barista knowledge and Skills Evaluation.

Grade data to be collected before and at the end of the course includes barista knowledge, customer service provision, coffee station organization, coffee preparation and serving, and barista knowledge and skills.

Barista Knowledge is assessed through a written test lasting 60 minutes. Students in the experimental and control groups are randomly assigned admission ticket numbers 2024001–2024068 based on a blind box drawing. Among them, students with ticket numbers 2024001–2024034 will take the test in Room 1, while students with ticket numbers 2024035–2024068 will be in Room 2. The test will be conducted simultaneously in both rooms under closed-book conditions, with each student taking the test individually. Candidates are only allowed to bring pens and other stationery into the test room. Each test room will have one invigilator and video recording for supervision.

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For the barista skills assessment, students will complete the Customer Service Provision and Drip Coffee Preparation and Serving assessments in Room 3. They will then complete the Customer Service Provision and Espresso-Based Coffee Preparation and Serving assessments in Room 4.

During both the pre-test and post-test, three professional coffee judges will evaluate students' performance based on the assessment scale. The judges will assign scores according to students' operational performance, and the final skill score will be the average of the judges' scores.

In the pre-test stage, due to students' lack of operational experience, tasks related to operating the Italian coffee machine were excluded for safety reasons. Additionally, before the Drip Coffee Preparation and Serving evaluation, students watched a five-minute instructional video as preparation.

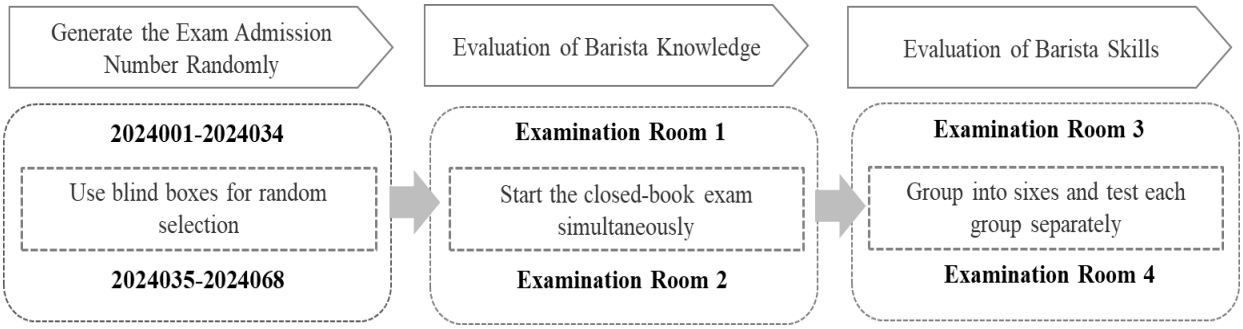

Figure 2 Data Collection for the Performance Test

Note: To ensure operational safety, and given that participants had no prior experience, a 5-minute demonstration video was arranged for candidates to watch during the pre-test in Examination Room 3 before evaluating "Drip Coffee preparation and serving." Additionally, in Examination Room 4, skills related to the use of coffee machines were excluded from the assessment scope, including omitting "equipment inspection" from the "coffee Station organization" module and excluding "Espresso-based preparation and service" from the "coffee preparation and service" module.

2) The Open-ended Questions Procedures

The exploratory study collected data using open-ended questions administered through the WJX online survey platform. According to Guest and Johnson (2006), reaching thematic saturation is a key consideration in qualitative research, and smaller sample sizes, often around 12 participants, are generally sufficient to achieve saturation, particularly in smaller, focused studies where no new themes emerge from additional data. Therefore, a sample size of 15 participants was selected via random sampling to encourage detailed and unrestricted responses. The researcher randomly invited students to participate in the study by sending them a link to the WJX online survey platform, ensuring confidentiality and providing contact information for inquiries.

The open-ended section comprised eight questions designed to collect rich qualitative data on participants' acceptance of the dimensions of PU, PEOU, ATT, and BI regarding the 5E-based ICVE SPOC instructional approach. Data collection took place after the post-test in the eighth week, with all participants required to complete the open-ended questions within one week using the WJX online survey platform. The experimental group was given ample time for completion. Qualitative data collection lasted one week, yielding comprehensive insights from 15 participants, which formed the basis for research analysis and facilitated a deep understanding of participants' use intentions in teaching activities based on the 5E-based ICVE SPOC instructional approach while maintaining strict anonymity and confidentiality throughout.

Data Analysis

The quantitative data will be analyzed using Jamovi 2.3.26 to compare the effectiveness of barista knowledge, customer service provision, coffee station organization, coffee preparation and serving, and barista knowledge and skills between the two student groups. The qualitative data will be analyzed using

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NVivo 14 software to examine students' acceptance, including perceived usefulness, perceived ease of use, attitude towards technology use, and behavioral intention to use these four elements during the 5E-based ICVE SPOC instructional approach.

Results

Demographic Information

The sample group for this study consisted of 68 newly enrolled students from the Smart Catering Management program at Zhejiang Business College in China. The control group consisted of 15 male students and 19 female students, totaling 34 participants, which accounted for approximately 50% of the total sample size. On the other hand, the experimental group comprised 13 male students and 21 female students, also totaling 34 participants and representing about 50% of the total sample size. Overall, the sample included 28 male students (41.18%) and 40 female students (58.82%). The majority of the sample students were aged between 19 and 20 years, accounting for 63 individuals (92.65%). Students older than 20 years comprised 4 individuals (5.88%), while those younger than 18 years accounted for 1 individual (1.47%). The majority of these students were from within Zhejiang Province, totaling 49 individuals (72.06% of the sample). Students from outside Zhejiang Province accounted for 19 individuals (27.94% of the sample).

Descriptive Statistics of Variables

There are five variables in the quantitative research, which are barista knowledge, customer service provision, coffee station organization, coffee preparation and serving, and barista knowledge and skills.

1) Barista Knowledge

Table 3 Means and Standard Deviations of Barista Knowledge Test Scores by Group

GROUPS	PRE-TEST		POST-TEST	
	MEAN	S.D.	MEAN	S.D.
CONTROL GROUP (N=34)	74.41	6.52	76.09	5.75
EXPERIMENTAL GROUP (N=34)	75.76	5.78	79.53	4.09

Note. The total score is 100.

As presented in Table 3, the control group (n = 34) exhibited a pre-test mean score of 74.71 (SD = 6.52), which increased to 76.09 (SD = 5.75) in the post-test. In the experimental group (n = 34), the mean score improved from 75.76 (SD = 5.78) in the pre-test to 79.53 (SD = 4.09) in the post-test.

2) Customer Service Provision

Table 4 Means and Standard Deviations of Customer Service Provision Test Scores by Group

GROUPS	PRE-TEST		POST-TEST	
	MEAN	S.D.	MEAN	S.D.
CONTROL GROUP (N=34)	23.38	2.93	24.26	1.80
EXPERIMENTAL GROUP (N=34)	24.35	2.44	25.62	1.54

Note. The total score is 30.

As shown in Table 4, the control group (n = 34) had a pre-test mean score of 23.38 (SD = 2.93) and a post-test mean of 24.26 (SD = 1.80). In the experimental group (n = 34), the pre-test and post-test mean scores were 24.35 (SD = 2.44) and 25.62 (SD = 1.54), respectively.

3) Coffee Station Organization

Table 5 Means and Standard Deviations of Coffee Station Organization Test Scores by Group

GROUPS	PRE-TEST		POST-TEST	
	MEAN	S.D.	MEAN	S.D.
CONTROL GROUP (N=34)	5.88	1.27	6.18	0.97

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GROUPS	PRE-TEST		POST-TEST	
	MEAN	S.D.	MEAN	S.D.
EXPERIMENTAL GROUP (N=34)	6.03	1.14	7.03	1.06

Note. The total score is 10.

As shown in Table 5, in the control group (n = 34), the pre-test yielded a mean score of 5.88 (SD = 1.27), while the post-test mean was 6.18 (SD = 0.97). In the experimental group (n = 34), the pre-test and post-test mean scores were 6.03 (SD = 1.14) and 7.03 (SD = 1.06), respectively.

4) Coffee Preparation and Serving

Table 6 Means and Standard Deviations of Coffee Preparation and Serving Test Scores by Group

GROUPS	PRE-TEST		POST-TEST	
	MEAN	S.D.	MEAN	S.D.
CONTROL GROUP (N=34)	39.56	4.79	39.74	4.92
EXPERIMENTAL GROUP (N=34)	41.18	4.35	43.85	2.68

Note. The total score is 60.

As shown in Table 6, in the control group (n = 34), the pre-test yielded a mean score of 39.56 (SD = 4.79), while the post-test mean was 39.74 (SD = 4.92). In the experimental group (n = 34), the pre-test and post-test mean scores were 41.18 (SD = 4.35) and 43.85 (SD = 2.68), respectively.

5) Barista Knowledge and Skills

Table 7 Means and Standard Deviations of Coffee Preparation and Serving Test Scores by Group

GROUPS	PRE-TEST		POST-TEST	
	MEAN	S.D.	MEAN	S.D.
CONTROL GROUP (N=34)	71.62	3.71	73.85	3.58
EXPERIMENTAL GROUP (N=34)	72.94	3.26	78.01	2.39

Note. The total score is 100.

As shown in Table 7, in the control group (n = 34), the pre-test yielded a mean score of 71.62 (SD = 3.71), while the post-test mean was 73.85 (SD = 3.58). In the experimental group (n = 34), the pre-test and post-test mean scores were 72.94 (SD = 3.26) and 78.01 (SD = 2.39), respectively.

Hypotheses Testing

By analyzing the pre-test and post-test average scores, the study assessed the impact of integrating the ICVE platform SPOC into the 5E model framework on students' learning outcomes. The null hypothesis and the research hypothesis were as follows.

Hypothesis 1

$H_0$1: There is no difference in barista knowledge between the control group and the experimental group in BTC.

H_a1: There is a difference in barista knowledge between the control group and the experimental group in BTC.

Table 8 Summary of Mean Scores for Students' Barista Knowledge Improvement

Groups	Mean	SD	N
Control	1.68	0.77	34
Experimental	3.77	1.69	34

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Table 9 T-Tests on Students' Barista Knowledge Score Gains: Control vs. Experimental Group

Groups	Mean Difference	Sig.
Control and Experimental	-2.09	0.006

The independent samples t-test was conducted to compare the improvement in students' barista knowledge scores between the control group and the experimental group. The t-test was significant, t (68) = -2.844, p = 0.006 < 0.05, and the null hypothesis was rejected. The result indicated a significant difference in the improvement of students' barista knowledge scores between the control group and the experimental group.

Hypothesis 2

$H_0$2: There is no difference in the customer service provision between the control group and the experimental group in BTC.

H_a2: There is a difference in the customer service provision between the control group and the experimental group in BTC.

Table 10 Summary of Mean Scores for Students' Customer Service Provision Improvement

Groups	Mean	SD	N
Control	0.88	1.13	34
Experimental	1.72	0.9	34

Table 11 T-Test: Customer Service Provision Score Gains (Control vs. Experimental)

Groups	Mean Difference	Sig.
Control and Experimental	-0.39	0.001

The independent samples t-test was calculated to compare the students' customer service provision scores improvement between the control group and the experimental group. The t-test was significant, *t* (68) = -3.335, *p = 0.001<0.05*. Thus, the null hypothesis was rejected. The result indicated that students' customer service provision scores between the control group and experimental group were different.

Hypothesis 3

$H_0$3: There is no difference in the coffee station organization between the control group and the experimental group in BTC.

H_a3: There is a difference in the coffee station organization between the control group and the experimental group in BTC.

Table 12 Summary of Mean Scores for Students' Coffee Station Organization Improvement

Groups	Mean	SD	N
Control	0.38	0.3	34
Experimental	1	0.08	34

Table 13 T-Test: Coffee Station Organization Score Gains (Control vs. Experimental)

Groups	Mean Difference	Sig.
Control and Experimental	-0.62	0.001

The independent samples t-test was calculated to compare the students' coffee station organization scores improvement between the control group and the experimental group. The t-test was significant, *t*

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(68) = -3.467, $p = 0.001<0.05$. Thus, the null hypothesis was rejected. The result indicated that students' coffee station organization scores between the control group and experimental group were different.

Hypothesis 4

$H_0$4: There is no difference in the coffee preparation and serving between the control group and the experimental group in BTC.

H_a4: There is a difference in the coffee preparation and serving between the control group and the experimental group in BTC.

Table 14 Summary of Mean Scores for Students' Coffee Preparation & Serving Improvement

Groups	Mean	SD	N
Control	1.62	0.44	34
Experimental	4.11	2.24	34

Table 15 T-Test: Coffee Preparation & Serving Score Gains (Control vs. Experimental)

Groups	Mean Difference	Sig.
Control and Experimental	-2.49	0.003

An independent samples t-test was conducted to compare the improvement in students' coffee preparation and serving scores between the control group and the experimental group. The analysis revealed a significant difference, t (68) = -3.055, p = 0.003 < 0.05, leading to the rejection of the null hypothesis. These results indicate that the improvement in students' coffee preparation and serving scores differed significantly between the two groups.

Hypothesis 5

$H_0$5: There is no difference in the barista knowledge and skills between the control group and the experimental group in BTC.

H_a5: There is a difference in barista knowledge and skills between the control group and the experimental group in BTC.

Table 16 Summary of Mean Scores for Students' Barista Knowledge & Skills Improvement

Groups	Mean	SD	N
Control	2.23	0.13	34
Experimental	5.07	0.87	34

Table 17 T-Test: Barista Knowledge & Skills Score Gains (Control vs. Experimental)

Groups	Mean Difference	Sig.
Control and Experimental	-2.84	0.000

An independent samples t-test was performed to examine the difference in the improvement of students' barista knowledge and skills scores between the control group and the experimental group. The results showed a significant difference, t (68) = -5.637, p < 0.001, leading to the rejection of the null hypothesis. This finding indicates that the improvement in students' barista knowledge and skills scores varied significantly between the two groups.

Qualitative Data Analysis

Data collection was conducted during the final week of the experiment. Participants completed the open-ended questions within one week via the WJX online survey platform. The qualitative data were analyzed using thematic analysis with the aid of NVivo 14 software.

1) PU

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Facilitating Barista Knowledge Acquisition: Most participants indicated that offering SPOC courses on the ICVE platform enhanced their learning experience through its extensive online resources. Additionally, it enabled them to acquire knowledge about coffee preparation processes. The platform's visualized tracking and feedback on learning progress not only provided a sense of accomplishment upon task completion but also served as a motivator for sustained engagement in learning.

Enhancing Barista Skill Development: Participants identified several key factors contributing to skill improvement. They noted that watching videos of the coffee-making process significantly enhanced their practical coffee-making skills. Additionally, discussions in the interactive sections were perceived as valuable for fostering barista skills through peer exchange and collaborative problem-solving. Furthermore, the structured presentation of coffee-related knowledge within the courses was recognized as beneficial for deepening learners' understanding of coffee characteristics, thereby supporting the refinement of their coffee-making abilities.

2) PEOU

Perceived Convenient Features: Participants primarily emphasized three aspects: online course resources, in-class activities, and learning feedback. In the BTC class, students generally perceived the ICVE SPOC platform as offering a variety of convenient features that streamline the learning process and enhance efficiency. One participant specifically highlighted the Check-in and Group PK functions, stating: "The Check-in function allows us to conveniently complete the process on our phones, eliminating the need for manual roll calls on paper. The Group PK function facilitates quick group formation for competitions, providing a clear display of member information and scores at a glance."

Perceived Inconvenient Features: Four students reported no difficulties. Among those who encountered challenges, platform lag was the most frequently identified issue.

3) ATT

Favorite Features: In terms of online course resources, participants generally indicated that the platform provides comprehensive course content that meets their learning needs, aligning with PU. For in-class activities, the Check-in function was particularly favored for its convenience, reflecting PEOU, as well as its association with regular grading, which also relates to PU. Regarding learning feedback, participants appreciated the Interactive Q&A function, as they believed it enhances learning efficiency and fosters greater classroom engagement.

Least Favorite Feature: Some users reported no significant dissatisfaction, suggesting an overall positive user experience. However, others identified issues such as a complicated navigation interface, interaction delays, and resource library lag, all of which negatively impacted learning efficiency and the teaching experience. Some students expressed a dislike for the exam feature, attributing their dissatisfaction to both design flaws and a general aversion to exams. Additionally, participants noted that uploading assignments via mobile devices was cumbersome due to difficulties in locating files, thereby reducing submission convenience. Furthermore, participants preferred course materials in PDF format over PPT, as the latter's page-turning operations were perceived as less intuitive.

4) BI

Behavioral Intention for Continued Use: The decision to continue using the platform was influenced by both PEOU and PU. In terms of PEOU, participants emphasized that the platform's smoothness and stability played a crucial role. One participant noted, 'The most important factor is whether it is convenient and efficient to use,' highlighting the impact of ease of use on continued engagement. On the other hand, PU was primarily associated with the richness of resources and interactive features available on the platform. As another participant stated, "If the platform does not offer any courses provided by the school, I would seldom use it," suggesting that the platform's perceived usefulness directly affects users' intention to continue utilizing it.

Behavioral Intention to Recommend Use: For the second question, the vast majority of participants indicated that they would recommend ICVE SPOC. Most respondents believed that ICVE SPOC offered a convenient learning experience by enabling centralized management of multiple courses and reducing the

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need to navigate multiple applications. Only one participant stated otherwise; however, this participant still provided positive feedback, commenting, “I think the ICVE is pretty good.”

Discussion

Research Question 1: What is the effectiveness of the 5E-based ICVE SPOC instructional approach in enhancing students' barista knowledge and skills?

This study aims to evaluate the extent to which technology can enhance the performance of vocational college students majoring in catering management in areas such as barista knowledge, customer service provision, coffee station organization, coffee preparation and serving, and barista knowledge and skills. The findings confirm that the 5E-based ICVE SPOC instructional approach significantly improves students' performance for BTC.

Research Question 2: Based on TAM, how do learners perceive and accept the use of the 5E-based ICVE SPOC instructional approach in BTC?

To further understand learners' acceptance of the 5E-Based ICVE SPOC instructional approach in BTC, this study conducted an in-depth qualitative analysis of learners' PU, PEOU, ATT, and BI based on TAM. The open-ended question results indicate that respondents generally held a positive attitude toward the SPOC function of the ICVE platform.

1) PU

Participants provided positive evaluations of the SPOC function on the ICVE platform and its contribution to learning both coffee theory and practical skills. In addition to the rich and systematic learning resources that facilitated their studies, the platform’s learning progress feedback and interactive features were perceived as beneficial to their overall learning experience. The findings support the claims of Fathema et al. (2015) and Rehman & Shaikh (2020) that users are more likely to adopt systems they perceive as beneficial. Additionally, the results align with Liu & Wan (2021) and Jia (2022), who emphasized that ICVE creates a powerful learning environment for vocational training.

2) PEOU

Participants generally perceived that ICVE SPOC offers a variety of convenient features, significantly simplifying the learning process and enhancing learning efficiency. Regarding PEOU, participants mainly focused on three aspects: online course resources, classroom activities, and learning feedback. This aligns with findings by Yuan (2020), Wang (2022), and Yintong et al. (2023), who highlighted the role of digital tools within ICVE in fostering interactive and participatory learning environments. In terms of challenges, participants emphasized that platform lag was the primary issue. As Ma and Li (2021) recommended, future enhancements of ICVE should focus on improving user accessibility and expanding interactive features to better meet diverse learning needs.

3) ATT

As Davis (1989) stated, PU and PEOU significantly influence users' ATT. Regarding online course resources, participants generally agreed that the platform provides comprehensive course content, meeting their learning needs, which aligns with PU. In terms of classroom activities, the Check-in function was particularly favored for its convenience, reflecting PEOU, and its association with regular grading also aligns with PU. Similarly, factors affecting learning outcomes and efficiency contributed to either positive or negative attitudes toward the platform.

4) BI

The decision to continue using the platform was also influenced by PU and PEOU. Regarding PU, participants highlighted the richness of resources and the availability of interactive features on the platform. From a PEOU perspective, participants emphasized that the smoothness and stability of the platform played a critical role in their behavioral intention.

Overall, the SPOC function on the ICVE platform enhances learners' PU and PEOU by providing abundant course resources, convenient teaching activities, and timely learning feedback. Consequently, PU

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and PEOU foster positive ATT and BI. However, some learners encountered inconveniences or negative experiences, as challenges to PEOU and ATT often stemmed from technical and usage issues.

Conclusion

This study conducted a comprehensive investigation into the application of the 5E-based ICVE SPOC instructional approach in BTC teaching. The primary objective was to examine the extent to which this approach enhances the performance of hospitality management students in higher vocational education across five key areas: barista knowledge, customer service provision, coffee station organization, coffee preparation, and serving, and barista knowledge and skills. Additionally, the study evaluated students' acceptance of the 5E-based ICVE SPOC instructional approach.

By employing performance tests and open-ended questionnaires, this study provided comprehensive and valuable insights into the application of the 5E-based ICVE SPOC instructional approach in BTC teaching. Its uniqueness lies in the pioneering integration of the classic 5E teaching model with the ICVE platform and SPOC in BTC education. This study represents the first attempt to examine the impact of this approach on student performance and acceptance in the Smart Catering Management program, specifically in five key areas: barista knowledge, customer service provision, coffee station organization, coffee preparation and serving, and barista knowledge and skills.

The findings of the study revealed several key insights. The use of the ICVE SPOC platform had a positive impact on the learning outcomes of certain students in coffee-related skills. The platform's technology significantly enhanced students' barista knowledge, customer service provision, coffee station organization, coffee preparation and serving, and barista knowledge and skills. In the quasi-experimental design of this study, students in the experimental group demonstrated significantly better performance in barista knowledge, customer service provision, coffee station organization, coffee preparation and serving, and barista knowledge and skills compared to the control group. These results indicate that integrating ICVE SPOC into BTC teaching is highly effective in improving students' barista professional competencies. From the perspective of technology acceptance, the integration of ICVE SPOC has proven to be a powerful tool. Open-ended questions within the ICVE platform-based SPOC teaching activities received positive feedback. Respondents generally held a favorable attitude toward the SPOC functionality of the ICVE platform, with most acknowledging that ICVE SPOC provides abundant learning resources and flexible learning methods. These features effectively support both theoretical and practical learning in barista training courses while meeting the needs of personalized learning.

In conclusion, the findings of this study demonstrate that integrating ICVE SPOC into the 5E instructional model for BTC teaching can serve as an effective method for vocational education. Its rich online course resources, convenient classroom activity design, and timely feedback mechanisms significantly enhance students' theoretical and practical learning outcomes, improving barista knowledge, customer service provision, coffee station organization, coffee preparation and serving, and barista knowledge and skills.

Recommendation

For the ICVE platform, future improvements should focus on enhancing user accessibility and expanding interactive features to better accommodate diverse learning needs. For course instructors utilizing the SPOC functions of the ICVE platform, it is essential to continuously optimize online teaching resources to enhance learning effectiveness. Instructors should also stay updated on platform developments and analytics, promptly respond to students' inquiries about the platform, and adjust teaching strategies to meet personalized learning needs. For researchers, future studies will build upon the ICVE platform and the SPOC model, further expanding the scope and context of learning by applying them to different cultural and educational settings to validate the universality of educational technology. Researchers will also focus on the deep integration of traditional teaching models with modern intelligent instructional technologies, optimizing course design and learning pathways to promote the practical application of digital technology

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in vocational skills training. Additionally, future research will emphasize assessing the long-term impact on students' professional development. Through the joint efforts of the platform, course instructors, and researchers, this initiative will contribute significantly to economic development and the cultivation of high-quality talent.

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