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An Empirical Study on the Learning Outcomes of Vocational Students in A Smart Classroom

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Abstract
Background and Aim: Smart Classrooms, as a form of rich-media learning environments, were increasingly being implemented and utilized. This study aimed to investigate the impact of Smart Classrooms on learning outcomes by examining 133 first-year vocational students from a vocational college in Yunnan Province, China. The research focused on an applied writing course and compared Cognitive, Behavioral, and Affective learning outcomes between the SEEWO Smart Classroom and traditional classrooms.
Materials and Methods: In this study, 133 current vocational students participated. The participants were divided into two groups: a control group and a treatment group. The control group was taught in a traditional classroom while the treatment group was taught in a Seewo Smart Classroom. After a 10-week applied writing course, the course was evaluated using the course evaluation scale that had been used in the college for many years. This evaluation explored cognitive learning outcomes, behavioral learning outcomes, and affective learning outcomes in terms of final grades, classroom behavioral performance, and student course scoring.
Results: Students in Smart Classrooms showed significant improvement in final exam scores, enhancing Cognitive learning outcomes. Behavioral outcomes, including participation and attendance, also increased. Student feedback favored Smart Classrooms over traditional settings, with no significant impacts from gender, age, or admission methods observed.
Conclusion: Smart Classrooms notably enhanced Cognitive and Behavioral learning outcomes, indicating improved student performance and engagement. Positive student feedback underscores their potential to enhance educational experiences and outcomes compared to traditional classrooms.
Keywords: Cognitive Learning Outcomes; Behavioral Learning Outcomes; Affective Learning Outcomes; Smart Classroom; Seewo

Introduction

In recent years, the evolution of Smart Classrooms has garnered significant attention in educational research and practice worldwide. These technologically enhanced learning environments represent a pivotal shift towards learner-centered pedagogies, integrating advanced technologies such as Information and Communication Technology (ICT), Artificial Intelligence (AI), and Internet of Things (IoT). Originating from initiatives like IBM's "Smart Earth POV-education" and further catalyzed by global educational reforms, Smart Classrooms have emerged as transformative spaces designed to optimize learning experiences (Mobile Computing, 2023; Mohamed et al., 2022).

The adoption of Smart Classrooms reflects a broader trend toward educational informatization, with countries like China actively promoting smart education initiatives through comprehensive policies and infrastructural investments (Yan & Yang, 2021; He, 2023). These initiatives aim to create dynamic learning environments capable of enhancing engagement, collaboration, and personalized learning experiences for students (Ong & Ruthven, 2010; Shoikova et al., 2017). China, with its vast educational landscape, has seen substantial growth in Smart Classroom implementation across primary, secondary, and vocational education sectors.

The integration of Smart Classrooms into educational practices aims to address traditional classroom limitations by fostering interactive teaching methods and improving learning outcomes (Yang & Huang, 2015). Research on Smart Classrooms spans various dimensions including design, application, and assessment. Design innovations such as Technology Enabled Active Learning (TEAL) classrooms and

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pedagogical frameworks like the Pedagogy-Space-Technology (PST) model underscore efforts to optimize learning environments (Dourmashkin et al., 2020; Perkins, 2010).

Despite the advancements, challenges persist in the widespread adoption and effective utilization of Smart Classrooms, particularly in vocational colleges. These challenges include financial constraints, infrastructure inadequacies, and skepticism among educators regarding their pedagogical efficacy (Zhu et al., 2023; Huang et al., 2019).

Thus, this paper is to investigate the effects of smart classroom technology on vocational students' learning outcomes. Given the increasing use of digital tools and interactive learning environments in the classroom, it is crucial to comprehend how they specifically affect vocational training, which frequently blends theoretical knowledge with practical skills. By evaluating whether smart classrooms improve student engagement, retention of information, and skill development, the study hopes to provide empirical evidence that either validates or challenges the use of these technologies in vocational education. The article highlights the special requirements and advantages for experiential, skill-based learning in a technologically advanced setting by concentrating on vocational students, filling a research gap that is frequently focused on traditional academic settings.

Objectives

1. To explore the difference between a Smart classroom and a Traditional classroom on the Cognitive learning Outcomes of vocational students.
2. To explore the difference between a Smart classroom and a Traditional classroom on the Behavioral learning Outcomes of vocational students.
3. To explore the difference between a Smart classroom and a Traditional classroom on the Affective learning Outcomes of vocational students.

Literature review

Constructivist learning theory

The concept of "Constructivism" traces its origins back to Jean Piaget's investigations in the 1930s, exploring how infants gradually shape their understanding of the world over time. Following Jean Piaget, his student Seymour Papert further developed constructionism and its principles of knowledge building(Semenov, 2017). Constructivist learning theory can be explained in terms of "the nature of learning" and "methods of learning".

Constructivist learning theory posits that knowledge is not solely imparted by teachers but is actively constructed by learners within a socio-cultural context(Doolittle & Hicks, 2003). This construction occurs through interactions with others, including teachers and learning partners, utilizing essential learning materials, and engaging in the process of meaning construction(Richardson, 2003). Situational, Collaboration, Conversational, and Meaning Construction were the four key elements of constructivism (Jonassen & Henning, 1999). The extent of knowledge acquisition hinges primarily on the learner's capability to construct the meaning of knowledge grounded in their individual experiences, rather than solely relying on their proficiency in memorizing and regurgitating the content imparted by the teacher. For students to become active constructors of meaning, they are required to use an exploratory and discovery approach to construct meaning in their knowledge(Richardson, 2003). Constructivist learning theory suggests that students should take the initiative to carry out dialogues and arguments with themselves, called self-negotiation; they should also initiate discussions with members within the learning group to explore their understanding of knowledge through cooperation and communication, a process called mutual negotiation(. Constructivism emphasizes that the acquisition of knowledge does not solely rely on teachers' instruction; rather, it necessitates students to actively explore and comprehend knowledge through self-construction (Jaleel & Verghis, 2015).

To be a facilitator of students' construction of meaning, teachers are required to stimulate students' interest in learning during the teaching process; to help students construct the meaning of what they are currently learning by creating situations that meet the requirements of the content and by suggesting clues to the connections between old and new knowledge(Prawat, 1992). To make the construction of meaning more meaningful, the teacher puts forward appropriate questions to arouse students' thinking and discussion, organizes collaborative learning (to carry out discussions and exchanges)(Njai, 2021); and also

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inspires and induces students to find out the law by themselves, and to correct and supplement the wrong or partial understanding by themselves(Richardson, 2003).

Regarding the smart classroom, Cebrián et al. (2020) argue that a smart classroom takes the form of a smart and efficient classroom based on constructivist learning theory and utilizes information technology such as big data, cloud computing, Internet of Things, and mobile Internet to realize the application of the whole process before, during, and after class. The smart classroom enables exploratory, collaborative, personalized, and reflective learning, fostering transferable knowledge and skills. Teachers customize the content, and students select, manage, reflect, and adjust, all for more effective learning. Theoretical guidance provided by constructivist learning theory for instructional design in smart classroom environments.

Bloom's Taxonomy Theory

Bloom's Taxonomy was a hierarchical framework that categorized educational objectives based on cognitive complexity (Bloom, 1984). It was proposed by educational psychologist Benjamin Bloom in 1956 and later revised by Mahmud et al. (2018). Bloom's Taxonomy serves not only as a measurement tool, but also as a common language for learning objectives, facilitating communication across populations, disciplines, and grade levels(Athanassiou et al., 2003). Bloom's Taxonomy has been widely used in education to develop learning objectives, design curricula, and assessments, and guide instructional strategies(Barari et al., 2022). The learning objectives are categorized into three levels, Cognitive, Affective, and Psychomotor, and each level is subdivided into different stages.

In the cognitive domain, the original taxonomy provided definitions for the six main categories of the cognitive domain. These are Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation. In 2001, a consortium of researchers, psychologists, and assessment experts introduced the revamped A Taxonomy of Teaching, Learning, and Assessment, a refinement of Bloom's Taxonomy. The new taxonomy employs verbs and gerunds to articulate the specific cognitive processes involved, encompassing remembering, understanding, applying, analyzing, evaluating, and creating (Athanassiou et al., 2003). These processes provide a more dynamic and granular framework for assessing learners' progress and guiding instructional design. Cognitive learning outcomes constitute a key measure for assessing the effectiveness of teaching and education (Michaelowa, 2001). Traditionally, it has been assessed through examinations or ongoing evaluations. Cognitive learning was a clear indicator of teaching outcomes (Michaelowa, 2001), typically measured through examinations. The literature, (Sevindik, 2010) used an experimental approach to conclude that smart classrooms significantly improve student achievement. (Menon et al, 2015) used a 50-question quiz to collect data and concluded that students who learn in smart classrooms have higher grades. (Celestin Ngendabanga et al., 2021) The study concluded that the use of smart classrooms can sufficiently improve learners' knowledge and comprehension. On the other hand, a meta-analytical study on the impact of academic achievement to determine the extent to which the smart classroom affects the cognitive learning outcomes. Shu and Gu (2023) investigated the impact of smart classrooms on the cognitive impact of English learning. The results showed that the smart classroom outperformed the traditional classroom in English speaking, vocabulary, grammar, reading comprehension, translation, and writing. However, Kuo et al. (2014) found very different results in their study of the impact of the smart classroom environment on students' vocabulary acquisition. Although students recognized the benefits of a smart classroom, the experimental group had lower test scores than the control group. It was also found that (Malik & Shanwal, 2017) there was no significant difference in the academic performance of the students when they were not given any guidance. (Nsabimana et al., 2024) Findings also suggest that while classroom technology can facilitate learning, this effect may only be realized after prolonged exposure.

Bloom (1984) described the affective domain as encompassing "interest," "mindfulness," and "value" goals. Emotions influence all human actions. In the affective domain, students' learning process was divided into five levels: reception, reflection, formation of value systems, organization of value systems, and personalization of value systems (Syaiful et al., 2019). Essentially, the Affective learning outcomes measured the impact of learning on students' emotional and attitudinal responses, contributing to their overall learning outcomes and experiences. The Affective learning outcomes refer to the three manifestations of students responding as surrender, willingness, and satisfaction after the teaching and learning had stimulated the content. Learning attitudes and interest in learning serve as metrics for evaluating Affective learning outcomes (Schrader & Lawless, 2004). Dai (2023) conducted a study in which 765 student questionnaires concerning satisfaction and engagement in Smart Classroom were collected. Lu

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et al., (2023) utilized the experience sampling method to gauge the impact of seating arrangements and motivational factors on engagement and satisfaction within Smart Classroom environments. Lee et al. (2018) conducted interviews, surveys, and focus groups to examine student attitudes toward collaborative teaching and technology use in large-scale collaborative classrooms. In a quasi-experimental study, Sawers et al. (2016) used interviews to investigate how teachers' teaching philosophies and learning space types influenced their perceptions of student engagement.

According to Bloom, the Psychomotor domain involves rational abilities and skills, which include systematic approaches and procedures for addressing various materials and issues (Hoque, 2017). However, Bloom did not explicitly establish a ranking system for areas of expertise (Ennis, 1985). Krathwohl was presenting a hierarchical categorization of psychomotor domains(Ferris & Aziz, 2005). The psychomotor domain includes the use of physical movement, coordination, and motor skill areas(Hoque, 2016). Psychomotor domains have to do with actions, skills, and behaviors. The concept of behavioral objectives has been widely used in the objectives of subjects such as laboratory classes, physical education, and vocational training. Simpson et al., (2021) introduced a classification comprising seven instructional goals for behavioral domains: perceptual, stereotyped, guided response, mechanical, complicated external reaction, adaptive, and creative. (Saini & Goel, 2019One of the biggest challenges in the classroom is keeping students engaged by keeping them focused and receptive. (Umida et al., 2020) argue that traditional classrooms have fixed seating, rigid multimedia consoles, a lack of student display screens, and usually one-way obedient interactions. Student interaction behavior is inadequate. (Lim et al., 2022), on the other hand, argued that smart classrooms provide the use of collaborative tools and interactive spaces with the advantages of debating, sharing, and presenting. (Yu et al., 2022) studied that students were significantly more engaged in smart classrooms when the same teacher taught two classes.

Smart classrooms, as an important direction in the development of education, offer a wealth of opportunities for pedagogical innovation. However, rich technology does not directly equate to superior teaching and learning. Therefore, Bloom's Taxonomy Theory should be fully considered when using smart classrooms to achieve effective teaching.

Conceptual Framework

This study aims to compare the differences in learning outcomes in the cognitive, behavioral, and affective domains among vocational students after learning in smart classrooms and traditional classrooms. Guided by the Constructivist learning theory and Bloom's Taxonomy Theory, vocational school students were divided into two groups: an experimental group and a control group. The experimental group studied in a smart classroom environment for ten weeks, while the control group received traditional classroom instruction for the same period. After the learning period, the learning outcomes of both groups were assessed to analyze and compare the impacts of the two different teaching environments on students' learning outcomes.

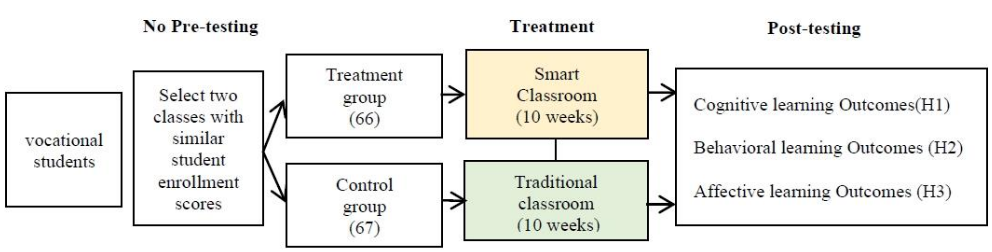

Figure 1 A Conceptual Framework for "Applied Writing" Courses in Smart Classroom

Hypotheses

H_a1: There is a significant difference in cognitive learning outcomes between the treatment group and the control group.

H_a2: There is a significant difference in behavioral learning outcomes between the treatment group and the control group.

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H_a3: There is a significant difference in affective learning outcomes between the treatment group and the control group.

Methodology

Research Design

A quasi-experimental research methodology was used in this thesis. The experimental cycle lasted ten weeks, during which a treatment group was set up in a Smart Classroom and a control group in a traditional classroom. This study aimed to investigate the effect of the Smart Classroom on the learning outcomes of the "Applied Writing" course for vocational students. First, a model for teaching "application writing" was designed using the smart classroom. The initial knowledge levels of the two groups of students were examined using the college's entrance scores to verify that their initial levels were generally comparable. Second, this study combined the smart classroom with the characteristics of vocational students to promote teaching and learning activities such as "project-based learning", "collaborative learning", and "self-directed learning" before, during, and after class. Students are assessed according to the Applied Writing course assessment criteria, a long-standing assessment tool used by the College. The treatment group utilized the Smart Classroom Learning Platform to submit feedback on tasks and receive appropriate scores, while the control group recorded scores using a traditional paper-based assessment booklet. At the end of the course, using a course evaluation form that has been used by the college for many years, students evaluated the course in different classroom settings. Figure 2 below illustrates the treatment.

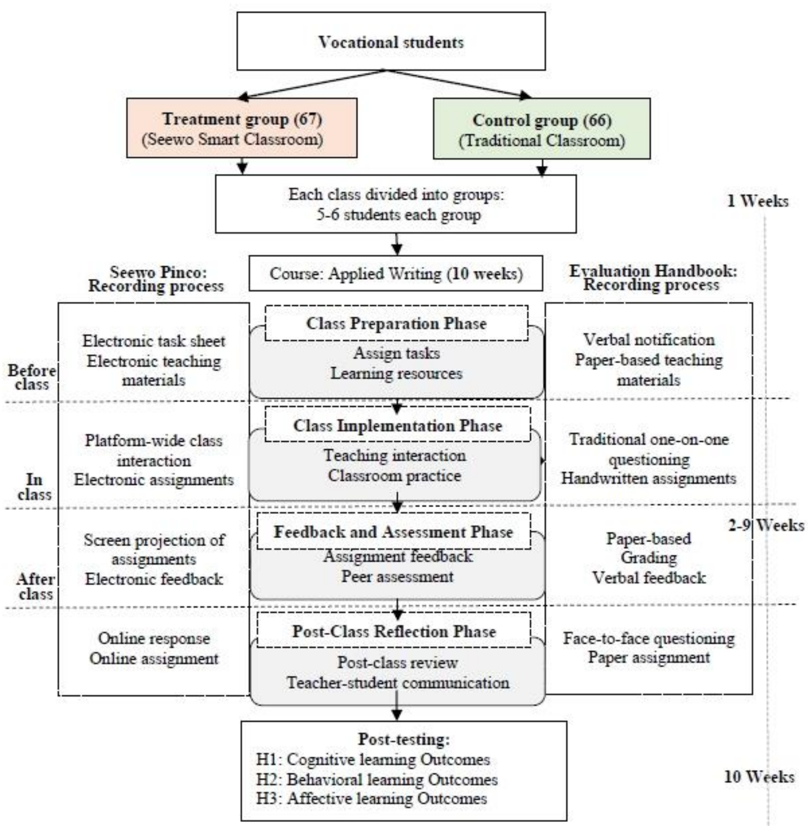

Figure 2 A research treatment of "Application writing" course teaching in the Smart Classroom

Students were naturally assigned to classes based on the results of the college entrance examination and the gender ratio. At the course's outset, the instructor initiated an "ice-breaker activity" by forming student groups of 5-6 individuals, allowing them the freedom to self-select their groups. Subsequently,

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adjustments were made to accommodate the significant variance in the initial knowledge levels of group members, with the consent of all participants. Following the group formation, a 10-week period ensued, during which each group appointed a leader, and each class designated a subject representative. At the onset of each session, the treatment group accessed the lesson's learning task sheet through the Smart Classroom interactive platform, while the control group received a paper-based task sheet. After the teacher presented the case, groups engaged in classroom exercises and subsequently reported their findings. During the final mutual assessment session, student assignments in the Smart Classroom were electronically displayed on a projection screen and graded, whereas those in the traditional classroom were assessed on paper. The instructor provided electronic materials to facilitate student reflection, and students revised their work before submitting it for evaluation. The teacher recorded the learning performance of the treatment group using the learning platform and that of the control group in paper-based assessment booklets.

Population and Sample

In the second semester of the 2023-2024 academic year, this study was conducted at a vocational college in Yunnan, focusing on in-school vocational students aged 19 to 20. These students, characterized by their high information technology skills and autonomy, are considered "digital natives," exhibiting active thinking and unique personalities. However, the transition to vocational college introduced challenges such as reduced parental supervision and the absence of academic pressure, which could lead to declines in academic diligence and classroom engagement (Ye et al., 2022).

The target population for this study consisted of first-year students from the Hotel Management and Digital Operations programs at a vocational college in Yunnan in 2023. This group comprised 133 students aged between 18 and 20. Preliminary analyses revealed minimal differences in entry scores and knowledge levels between the two classes, with no prior experience in Smart Classroom learning. To ensure the rigor of the experimental design, purposive sampling was used to recruit one class as the treatment group and another as the control group. The treatment group included 67 students who received instruction in a Smart Classroom environment, with their performance recorded using the Seewo Pinco platform. The control group, consisting of 66 students, was taught in a traditional classroom setting, with their performance documented through paper-based assessments. Both groups were taught by the same instructor, using identical study materials, resources, activities, and tasks, ensuring that the primary variable was the classroom environment.

Purposive sampling, also referred to as judgmental sampling or selective sampling, has been a non-probability sampling technique frequently employed in research(Campbell et al., 2020). Unlike random sampling methods, which rely on chance to select participants, purposive sampling involved researchers intentionally selecting participants based on specific criteria or characteristics pertinent to the research question or objectives(Rai & Thapa, 2015). This study utilized a purposive sampling method to select two classes from those taught by the lead teachers. The specific criteria for choosing the two classes included the students' entrance test scores, gender ratio, type of enrollment, urban or rural origin, etc. These two classes were largely similar, except for a slight difference in class scheduling.

Research Instruments

The measurement tools used in this study mainly include the Evaluation Criteria for Required Public Courses Programs from a vocational college in Yunnan. The evaluation scales assess the Cognitive learning outcomes, Behavioral learning outcomes, and Affective learning outcomes of students through process and summative assessments.

The program requires teachers to evaluate student learning outcomes based on process results. It proposes examining process evaluation dimensions across four components: "Student Attendance," "Classroom Discipline," "Teaching Interaction," and "Classroom assignments." Summative evaluation results were derived from the "College Standardized Final Exams." This evaluation program entails portfolio assessment, encompassing various learning outcomes throughout the study. It encourages educators to emphasize the learning process and foster the multifaceted development of learners, thereby enhancing their reflective and independent learning abilities. This approach aligned with the vocational colleges' goal of nurturing skilled professionals.

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Student final grades were determined based on data from each classroom activity and final examination results, which were collected in the file bag and adjusted according to a specific ratio. The program utilized a point-based system in project-based learning. Students earned points for completing each part of the task, scoring 100 points for the comprehensive evaluation. This total score comprised 40% of the process evaluation and 60% of the summative assessment. The process evaluation contained four sections, each assigned a different percentage of points, which were aggregated and then multiplied by 40% to determine the process evaluation score. Similarly, the paper score from the College Standardized Final Exam was multiplied by 60% to determine the summative evaluation score. After class, using the Course Evaluation Form, students were invited to rate the course, resulting in affective learning outcomes. Figure 3 illustrates the calculation method.

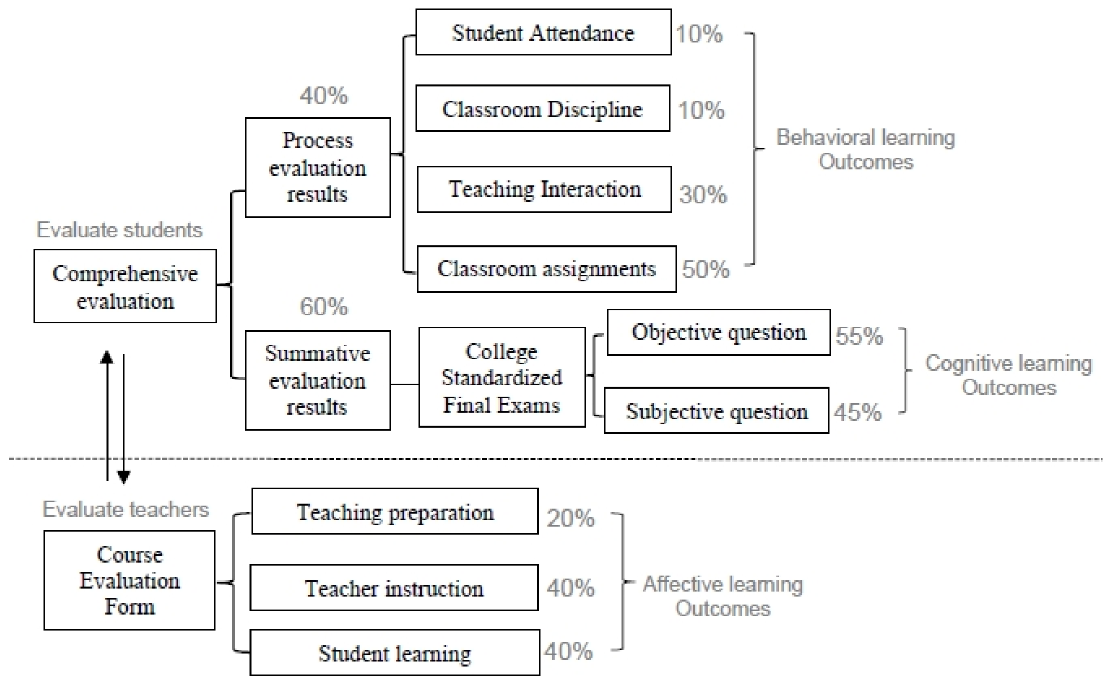

Figure 3 An evaluation rubric for the "Application Writing" course

Data Collection and Data Analysis

This paper employed a controlled experiment. During the experimental process, data were collected on students' participation in classroom activities, collaborative learning, assignments, and final grades before, during, and after class. Subsequently, these data were utilized to assess the impact of the Smart Classroom on students' learning outcomes. Before the beginning of the study, the researcher distributed an "Informed Consent Form" to the students, who expressed their knowledge and support for the study based on the "Applied Writing" course. Compare the differences in student learning outcomes in different classroom environments. The post-test was administered after the end of the teaching period, and students were organized to complete the final exam. The subject team corrected the test papers in strict accordance with the marking criteria. After obtaining the final grade data, the author used SPSS 22.0 to analyze the students' post-test scores statistically.

Results

In the applied writing course, participants hailed from hospitality management and digital operations majors, divided into a treatment class comprising 67 students and a control class with 66 students. As shown in Table 1.

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Demographic Information

Table 1 Demographics of Gender Information.

Age	Group	Frequency	Percentage	Percentage of Total
18-19 years old	Treatment	3	4.5%	3.7%
	Control	2	3.0%	
20-21 years old	Treatment	54	80.6%	83.5%
	Control	57	86.4%	
Above 21 years old	Treatment	10	14.9%	12.8%
	Control	7	40.6%	

Regarding age, the majority of participants fell within the 20-21 age bracket, with 80.60% in the treatment group and 86.40% in the control group falling into this category. Although there were a few respondents who were aged 18-19 or over 21, the age distribution remained relatively consistent across both groups. This indicates that the majority of the sample population was concentrated in the 20-21 age range. As shown in Table 2.

Table 2 Age of the Sample Students.

Admission Method	Group	Frequency	Percentage	Percentage of Total
Vocational College Independent Enrollment	Treatment	39	58.2%	48.4%
	Control	25	37.9%	
Gaokao	Treatment	28	41.8%	51.6%
	Control	41	62.1%	

In terms of admission method, 58.20% of treatment group respondents had entered through Vocational College Independent Enrollment, while 41.80% had come via Gaokao. Conversely, 37.90% of control group respondents had enrolled through Vocational College Independent Enrollment, with 62.10% entering through Gaokao. The detailed information is shown in Table 3.

Table 3 Admission Method Distribution.

Category	Group	Frequency	Percentage	Percentage of Total
Male	Treatment	29	43.3%	42.1%
	Control	27	40.9%	
Female	Treatment	38	56.7%	57.9%
	Control	39	59.1%	

Descriptive Statistics of Cognitive learning outcomes

Cognitive learning outcomes were described as students' mastery of course knowledge, assessed based on their final grades. The treatment group had achieved a higher average score (Mean = 82.37, SD

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= 6.075) compared to the control group (Mean = 77.41, SD = 9.081). As shown in Table 4.4, the Post-test and Improvement Mean for both the Treatment and Control Groups were analyzed.

Table 4 Post-test, and Improvement Mean for the Treatment and Control Groups.

Group	N	Mean	SD	Minimum	Maximum
Treatment	67	82.37	6.075	70	95
Control	66	77.41	9.081	60	90

Descriptive Statistics of Behavioral learning outcomes

Behavioral learning outcomes had been evaluated through students' classroom performance and assignment grades, encompassing Student Attendance, Classroom Discipline, Teaching Interaction, and Classroom Assignments scores. The treatment group had had better overall performance in behavioral learning outcomes (Mean = 85.96, SD = 7.698) compared to the control group (Mean = 80.62, SD = 12.341). As shown in Table 5.

Table 5 Behavioral learning outcomes for the Treatment and Control Groups.

Dimensions	Group	N	Mean	SD	Minimum	Maximum
Student Attendance	Treatment	67	9.72	0.545	8.5	10
	Control	66	8.80	1.955	5	10
Classroom Discipline	Treatment	67	9.75	0.636	8.5	10
	Control	66	9.88	0.373	9	10
Learning Performance	Treatment	67	25.76	1.947	20	28
	Control	66	24.45	2.894	18	28
Classroom Assignments	Treatment	67	40.73	6.748	30	50
	Control	66	37.48	8.846	25	50
Overall Behavioral	Treatment	67	85.96	7.698	70	100
	Control	66	80.62	12.341	55	95

Descriptive Statistics of Affective learning outcomes

The affective learning outcomes were assessed after the course ended, through anonymous ratings provided by students using the classroom evaluation scoring form that has been utilized by the institution for many years. The Smart Classroom group had a higher average score (Mean = 85.46, SD = 9.360) compared to the Traditional Classroom group (Mean = 79.56, SD = 11.121), with a mean difference of 5.90 and a significance level of $p < 0.001$, confirming a significant difference.

The scores for the treatment group in the dimensions of Teaching Preparation, Teacher Instruction, and Student Learning within the Behavioral learning outcomes were all higher than those for the control group.As shown in Table 6.

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Table 6 Affective learning outcomes for the Treatment and Control Groups.

Group	N	Mean	SD	Minimum	Maximum
Treatment	67	85.46	9.360	65	100
Control	66	79.56	11.121	55	95

Difference analysis of Cognitive learning outcomes

The results of the independent samples t-test for Cognitive learning outcomes showed that the treatment group (smart classroom) had a significantly higher mean score (M = 82.37, SD = 6.075, N = 67) compared to the control group (traditional classroom) (M = 77.41, SD = 9.081, N = 66). The mean difference was 4.96, with a significance level of $p < 0.001$, indicating that the treatment group had significantly better cognitive learning outcomes. As shown in Table 7.

Table 7 Means Summary and T-test for Cognitive Learning Outcomes.

Variable	Group	N	Mean	SD	Mean Difference	Sig.
Cognitive Learning Outcomes	Treatment	67	82.37	6.075	4.96	<0.001
	Control	66	77.41	9.081		

Difference analysis of Behavioral learning outcomes

Presented below is the analysis of Behavioral Learning outcomes between the treatment group and the control group. The treatment group showed a significantly higher mean score (M = 85.96, SD = 7.698) compared to the control group (M = 80.62, SD = 12.341) for Behavioral Learning outcomes, with a mean difference of 5.34 (p = 0.003). As shown in Table 8.

Table 8 Means Summary and T-test for Behavioral learning outcomes

Variable	Group	N	Mean	SD	Mean Difference	Sig.
Behavioral learning outcomes	Treatment	67	85.96	7.698	5.34	<0.001
	Control	66	80.62	12.341		

Difference analysis of Affective learning outcomes

Presented below is the analysis of Affective Learning outcomes between the treatment group and the control group. The treatment group exhibited a significantly higher mean score (M = 85.46, SD = 9.360) compared to the control group (M = 79.56, SD = 11.121) for Affective Learning outcomes, with a mean difference of 5.90 (p = 0.001). As shown in Table 9.

Table 9 Means Summary and T-test for Affective learning outcomes.

Variable	Group	N	Mean	SD	Mean Difference	Sig.
Affective learning outcomes	Treatment	67	85.46	9.360	5.96	<0.001
	Control	66	79.56	11.121		

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Summary of Hypothesis testing and results

This table10 objectively presents the research findings, demonstrating the impact of the smart classroom teaching method on different learning outcomes and highlighting the relationships between cognitive, behavioral, and affective learning outcomes. As shown in Table 10.

Table 10 Summary of Hypothesis testing and results.

Hypotheses	Statement	Result after Analysis
H_01	There is no significant difference in cognitive learning outcomes between the treatment group and the control group.	Reject
H_02	There is no significant difference in behavioral learning outcomes between the treatment group and the control group.	Reject
H_03	There is no significant difference in affective learning outcomes between the treatment group and the control group.	Reject

Discussion

Cognitive Learning Outcomes in a Smart Classroom

This paper categorizes the effectiveness of classroom application into cognitive learning outcomes, behavioral learning outcomes, and affective learning outcomes for students based on the three major domains of instructional objectives proposed by Bloom's Taxonomy Theory. Based on the results of a 10-week quasi-experimental study, it is evident that smart classrooms have a positive impact on students' academic performance at a moderately high level compared to traditional classrooms. It shows that being in a smart classroom environment is more likely to promote students' academic performance. The study finds that the teaching mode based on smart classrooms is significantly more effective than the traditional classroom teaching mode in enhancing students' cognitive learning outcomes. This finding is consistent with the research results of Shi et al. (2018), Sevindik (2010), Menon et al (2015), and Celestin Ngendabanga et al. (2021), all of which indicate that the smart classroom teaching mode can effectively improve students' learning performance and comprehension ability.

Behavioral Learning Outcomes in a Smart Classroom

One of the principal challenges in the classroom, as highlighted by Saini & Goel (2019), is maintaining students' engagement through focus and receptiveness. Vocational college students commonly exhibit low levels of learning autonomy, motivation, attendance, and interaction. However, studies have revealed that behavioral learning outcomes, such as attendance, classroom discipline, academic performance, and assignment completion, are significantly higher in smart classrooms compared to traditional settings. Student attendance is a paramount concern for educators (Ojo et al.). Traditionally, attendance was tracked through roll call or signatures (Enugala & Vuppala, 2018), but in this research, teachers utilized the Seewo Smart Classroom's AI camera system to efficiently monitor attendance, reducing the time required and facilitating random selection of students for classroom activities. Additionally, the interactive software, Seewo-pinco, facilitated engagement through activities like independent learning, group quizzes, in-class tests, and real-time comments. This approach accounts for the disparity in behavioral learning outcomes between traditional and smart classrooms, aligning with the findings of Yu et al. (2022) and Lim et al. (2022).

Affective Learning Outcomes in a Smart Classroom

The Affective learning outcomes refers to the three manifestations of students responding as surrender, willingness, and satisfaction after the teaching and learning had stimulated the content. Student evaluation of the classroom serves as a key component of instruction and a source of emotional learning outcomes for students. Course Evaluation Form scores for smart classrooms were overall higher than Course Evaluation Form scores for traditional classrooms. However, age, male and female, and difference in Admission Method did not have a significant difference on affective learning outcomes. This agrees with Dai's (2023) satisfaction survey results, Lu et al.'s, (2023) study on smart classroom seating having a

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motivating effect on student engagement, and Lee et al.'s (2018) study investigating student motivation towards smart classrooms through focus groups.

Conclusion

After research and analysis on the differences in cognitive learning results, behavioral learning results, and emotional learning results between students in smart classrooms and traditional classrooms, it was found that teaching in a smart classroom environment helps achieve cognitive, behavioral, and emotional teaching goals. At the cognitive level, students showed deeper knowledge understanding and application abilities, indicating that academic performance results based on summative evaluation were significantly higher in the smart classroom context than in the traditional classroom context. At the behavioral level, students' participation enthusiasm was enhanced, attendance times, self-regulated learning times, and classroom homework correctness rates were significantly improved, indicating that the process-based evaluation-based usual performance was improved. At the emotional level, students' evaluations of teacher teaching, student learning, and teaching preparation in smart classrooms were higher than those in traditional classrooms, reflecting the recognition of vocational students for course learning in a smart classroom environment.

Overall, these findings highlight the potential benefits of smart classrooms in enhancing various aspects of student learning and suggest that further exploration and implementation of smart classroom technologies could lead to improved educational outcomes.

Recommendation

In considering the widespread implementation and potential impact of smart classrooms, it is crucial to examine the various levels at which they can influence educational outcomes.

First, at the social level, an open attitude towards smart classrooms should be maintained. Although the current level of technology and equipment may not have achieved fully satisfactory results or significantly improved student learning outcomes, the existence and application of smart classrooms is an inevitable trend for future educational development. It is expected that with technological advancement and deeper pedagogical research, the current unsatisfactory areas will gradually be improved and enhanced. Researchers should not just be satisfied with keeping up with the times, but should keep an open mind and actively explore the application of smart classrooms and grow with their development.

Secondly, from a national perspective, it is necessary to increase investment in vocational education and develop guidelines for the construction of smart classrooms. Given that the development of smart classrooms is an important trend, both public and private schools should attach great importance to it and invest more money in the construction of smart classrooms in order to upgrade hardware and software facilities. These guidelines should clarify the direction and objectives of smart classroom construction to avoid duplication of construction and ineffective investment.

Third, at the school level, smart classrooms should be boldly explored and gradually promoted. Although current research shows that students are more receptive to smart classrooms than traditional classrooms and that teaching and learning are effective, full implementation or a conservative attitude is not recommended. Instead, smart classrooms should be applied gradually, starting with specific grades, subjects and chapters. The selection of grades and subjects should also be included in the study of smart classrooms. Schools in the lower grade bands should also fully respect parental views and actively communicate and engage parents. Through communication, schools can gain parents' support and understanding, take the initiative to invite parents to participate in the construction of Smart Classroom, and motivate parents to actively cooperate with the construction of Smart Classroom in schools.

Fourth, at the teacher level, learning and adaptation to changes should be strengthened. School teachers should strengthen their own learning, innovate education and teaching reform, and adapt to the application of smart classroom in the new era. Before teachers enter the smart classroom to teach, they should familiarize themselves with its internal facilities, understand how to specifically operate these technical devices and combine them with their own teaching content. Therefore, in terms of the smart

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classroom, schools can first train teachers to help them clarify the use of technical equipment and familiarize themselves with the teaching environment in order to promote orderly teaching.

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