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Correlation Among Teacher ICT Teaching, Teacher Immediacy Behaviors, Teacher–Student Rapport, and Student Engagement in Smart Classroom Teaching

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Abstract: With the constant evolution of information and communication technology (ICT), smart classrooms have profoundly influenced Education for Sustainable Development (ESD) by presenting advanced ICT that markedly improved the effectiveness and quality of teaching and learning. Teacher communication technology teaching and immediacy behaviors are crucial for leading and reforming the teaching and learning process in smart classrooms. Meanwhile, teacher–student rapport and student engagement are also key factors that influence ESD. This study aims to investigate the correlation among teacher ICT teaching, teacher immediacy behaviors, teacher–student rapport and student engagement in smart classroom teaching. We surveyed 1032 Chinese university students using the questionnaire method and analyzed the data using structural equation modeling (SEM). The findings revealed that teacher ICT teaching and immediacy behaviors exerted a noteworthy positive impact on student engagement and teacher–student rapport. Meanwhile, teacher ICT teaching markedly positively correlated with verbal immediacy but markedly negatively correlated with nonverbal immediacy. These findings have practical implications for ESD: in smart classrooms, teacher ICT teaching and their immediacy behaviors serve as vital factors in augmenting teaching quality, encouraging student engagement and fostering harmonious teacher–student rapport. Thus, teachers must harness their ICT teaching skills, flexibly assimilate instant behaviors into the teaching process and interact with students in a richer and more diversified manner to effectively augment teaching quality and promote the overall and sustainable growth of students. Furthermore, this study can inform the expansion of smart classrooms, which in the future should not only offer teachers a convenient teaching and learning environment but also evade ICT that limits teacher nonverbal immediacy behaviors.

Keywords: smart classroom; teacher ICT teaching; teacher immediacy behaviors; teacher–student rapport; student engagement

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1. Introduction

Technology has become a potent catalyst for educational change in today's rapidly evolving digital setting [1], and the information and communication technology (ICT)-led alteration of learning environments has gained momentum in education for sustainable development (ESD) [2]. For students, a classroom is where they spend most of their school time and is one of the most direct and theoretically influential learning environments for their growth [3]. Accordingly, owing to their ability to create intelligent, sustainable, resource-efficient, personalized, and adaptive learning environments, smart classrooms are widely acknowledged as integral to executing the ESD process [2,4]. Therefore, multiple advantages of smart classrooms have stimulated education institutions to implement them to enable students to completely reap the benefits of the digital age [5]. Indeed, this has become a leading trend in the expansion of higher education institutions [6]. Although the physical environment of smart classrooms is provided by educational institutions, the teaching and learning process is dominated by teachers and students.

In the early stages, owing to limited ICT development, the correlation between traditional tools (e.g., chalk and slides) and the teacher was comparatively straightforward, focusing primarily on the simple content presentation. In today's smart classroom era of teaching, however, ICT has slowly become an active contributor to the teaching and learning practice, penetrating the teaching and learning process [7]. The pedagogical knowledge and ICT integration reflects the future course of conventional teaching methods [8]. Hence, teacher ICT teaching has become one of the indispensable competencies for modern teachers [9]. Advanced ICT offers several conveniences and innovations to teaching and learning practices; however, it might also adversely affect the quality of human interaction. Typically, classroom interpersonal interactions denote teacher–student communication as well as communication among students [10]. High-quality interactions can enhance the classroom climate and student engagement in learning, refining the quality of classroom teaching and learning [11]. In classroom teaching, teachers generally use verbal and nonverbal immediacy behaviors to partake in interpersonal–emotional interactions with students [12]. Nevertheless, the use of ICT tools could lead teachers to prioritize the presentation of ICT teaching resources, decreasing opportunities for verbal and nonverbal communication, possibly diminishing teacher–student emotional connection and interaction. Accordingly, this study aims to investigate the correlation among teacher ICT teaching, teacher immediacy behaviors, teacher–student rapport, and student engagement in smart classroom teaching. The primary focus of this study is to explore the impact of teacher ICT teaching on teacher–student rapport and student engagement, which is followed by the relationship between teacher ICT teaching and teacher immediacy behaviors. Perhaps this study will guide teacher ICT teaching practices to enable them to increase student engagement, enhance teacher–student rapport, and promote students' sustainable learning in smart classrooms so that education can contribute to the long-term growth of society.

2. Literature Review

2.1. Teacher ICT Teaching, Student Engagement, Teacher−Student Rapport, and ESD

In smart classrooms, teacher ICT teaching directly amplifies the immediate efficacy of classroom teaching and exerts a profound and positive impact on ESD [13]. ICT in teaching has effectively overcome the confines of conventional teaching models, creating a myriad of more flexible and innovative teaching methods [14]. These methods not only markedly enhance the quality and efficiency of teaching and learning but also, more critically, offer indispensable support for students to cultivate the sustainable learning ability essential for advancing ESD [15]. Specifically, ICT teaching significantly enhances students' core literacy skills, such as innovative thinking, critical thinking, teamwork, and social responsibility, by aiding the integration and application of interdisciplinary knowledge and simulating problem solving in real-world settings [16,17]. These skills are not only the keystone of all-inclusive personal development but also the crucial elements needed for the goal of ESD [15]. Thus, in smart classrooms, teacher ICT teaching is both a revolution in teaching methods and a profound transformation in the education concept and talent cultivation mode. Precisely, it signifies that the education system is becoming more open, inclusive, and innovative, laying a solid foundation for educating future talents with global vision, innovative spirit, and sustainable growth skills.

Student engagement markedly influences the ESD. High-quality student engagement not only expressively enhances the current quality of education but also lays solid groundwork for the long-term growth of students and the sustainable progress of society [18]. Specifically, the effect of student engagement on ESD is echoed in the following aspects. First, student engagement directly correlates with their academic performance [19]. More engaged students generally exhibit stronger motivation to learn and, thus, attain better academic results [20]. This positive academic accomplishment not only brings a sense of fulfillment and self-confidence students [21] but also augments the educational efficiency [22]. Second, student engagement is a key cornerstone in nurturing self-directed learning ability. Student engagement markedly affects self-directed learning ability [23],

which is especially important in a rapidly evolving society, for it ensures that students can continually adapt to new environments and challenges and realize the shared progress of individuals and society [24]. Third, student engagement can augment the learning environment and promote its continuous optimization [25]. Students proactively engage in classroom activities, raising questions and sharing insights; this active interaction promotes effective teacher–student communication and fortifies cooperative learning among classmates [26,27]. The creation of such an atmosphere makes the learning environment more positive, further improving the overall quality of education.

Creating a harmonious teacher–student rapport is essential within ESD. In a harmonious teacher–student rapport, teachers tend to dedicate more enthusiasm and energy to teaching research and content innovation, while students experience teachers' care and motivation and are more actively involved in learning and exploration [28]. This positive feedback loop significantly endorses the overall upgrading of education quality. Second, a harmonious teacher–student rapport markedly contributes to students' overall growth and career preparation. In a harmonious teacher–student rapport, students can not only receive career development guidance from teachers but also constantly refine their communication skills in the interaction [29], which would accrue valuable experience and skills for their future career and social adaptation. A harmonious teacher–student rapport facilitates building an open and inclusive educational environment [30,31], wherein teachers and students can respect, understand, and support each other, creating an environment of equality, democracy, and free communication. In turn, this environment is conducive to nurturing students' sense of innovation and critical thinking so that they dare to challenge authority and explore unknown fields. Meanwhile, this environment can also promote exchanges and integration between students of diverse cultures and backgrounds as well as promote the diversified and inclusive progress of education.

2.2. Teacher ICT Teaching and Teacher—Student Rapport

"Rapport" often denotes a harmonious relationship between people, which is typically based on mutual trust, understanding, and respect. When two people or a group of people have good "rapport" in communication, they tend to better understand each other, collaborate, and solve problems [32]. The concept of rapport is extensively used and crucial in the field of education. Teachers make students feel safe and respected by fostering trusting relationships, in turn, promoting student engagement and impetus [33]. Teachers can augment their relationships with students in various ways; for example, teachers can call students by their first names [34], use humor [35], respect their ideas [36], and value their academic efforts [37]. Positive teacher–student rapport is not only crucial for attaining effective teachings [38,39] but also provides a good classroom environment [40]. By nurturing a relationship of trust, understanding, and support, teachers can create a positive, dynamic, and productive learning environment [41]. Nevertheless, a conflict exists between the "pure rationality" of technology and the profuse emotional acumen of human beings. Owing to the ICT intervention, the teacher–student interaction evolved into communication between symbols, causing the lack of contextual cues (e.g., body language) in real interaction, hampering the process of emotional interaction and emotion generation between teachers and students. Over time, the tacit understanding between teachers and students slowly weakened, and the teacher–student rapport became alienated [42].

2.3. Teacher ICT Teaching and Student Engagement

Student engagement denotes the level of attention, effort, and participation, comprising curiosity, interest, and enthusiasm, which students exhibit when learning or receiving instructions [43]; it encompasses students' participation in learning, their commitment to accomplishing learning goals [44], and their perseverance and satisfaction with learning [45]. Teachers play a vital role in rousing students' engagement in instructional activities, which they can attain by supporting positive learning behaviors, offering suitable learning resources, and partaking in interpersonal interactions [46]. To enhance students' engagement

in smart classrooms, teachers play a key role in successfully integrating ICT into the classroom, assisting in increasing learners' motivation, interest, self-regulation, and other factors that contribute to augmented engagement [47–49]. In addition, teachers create an inspirational and interactive learning environment by using multimedia, network resources, interactive tools, and other technical means to kindle students' interest and active engagement in learning as well as help them better understand and receive the knowledge acquired [50,51]. Nevertheless, ICT teaching is not essentially more effective than traditional teaching methods [52], as too many electronic devices and applications could cause information overload, distracting students and making it challenging for them to focus on their learning [53]. Meanwhile, teachers need to consider students' level of ICT when designing the ICT instructional content [54,55]. As students might differ in their ICT-using proficiency, educators must segregate instructions based on students' level of ICT competence when designing instructional activities. Only by comprehending students' ICT levels can teachers better adapt course content and teaching methods to ensure that instructional activities fully satisfy the needs and expectations of diverse learners.

2.4. Teacher ICT Teaching and Teacher Immediacy Behaviors

The extensive use of various ICT tools in the classroom can positively affect teaching and learning practices [56]. As ICT teaching is one of the key literacy skills for modern teachers, a growing number of teachers tend to use ICT in their teaching and learning process. However, the widespread use of ICT tools could affect teachers' behaviors in the classroom [57]. As one of the teachers' effective teaching behaviors [58], teachers' immediacy markedly affects teacher–student rapport [59], student engagement [35], learning motivation [60], and learning effect [61].

Teacher immediacy signifies the union of verbal and nonverbal behaviors [61]. Teacher verbal immediacy behaviors denote behaviors that construct positive relationships with students through verbal expressions along with using inspiring language, providing constructive feedback, probing interactions, and applauding students' performance [62,63]. These behaviors enable building trust and augment students' self-confidence and motivation to learn [64]. ICT can smoothen teacher–student interaction through interactive whiteboards, online discussion platforms, and instant feedback tools [65]. Teachers can ask questions, lead discussions, and provide instant feedback more frequently, creating additional opportunities for verbal immediacy behaviors.

Teacher nonverbal immediacy behaviors correlate with using tactics associated with chronology (time), acoustics (paralinguistic features), haptics (touch), kinesics (body movement), proximity (distance), visualization (eye contact), and classroom environment (arrangement) [66]. An over-reliance on technology might decrease face-to-face teacher–student interactions [67]. When using whiteboards, projection devices, or online learning platforms, teachers could be overly screen-oriented rather than directly interacting with students, minimizing the use of eye contact and body language. When using ICT, screens and devices could cause physical barriers between teachers and students, restraining the performance of nonverbal behaviors. For instance, teachers might not be able to communicate effectively nonverbally simultaneously while operating computers or adjusting equipment.

2.5. Teacher Immediacy Behaviors, Student Engagement, and Teacher−Student Rapport

Recent studies have established a positive correlation between immediate teacher behavior and student engagement [35,68–72]. Through immediacy behaviors, teachers build an environment of emotional support among students that nurtures feelings of respect and recognition. When students feel that they are in a respectful, caring, and supportive environment, they tend to more proactively engage in learning activities [72–74], nurturing trust and intimacy with the teacher and cultivating a positive teacher–student rapport. Teacher immediacy is a type of emotional support offered by teachers in the classroom [75], facilitating them to better comprehend students' learning needs and challenges and offer

personalized learning support [76]. Such effective teacher–student communication and relationships can ignite heightened enthusiasm and engagement in the learning process [77].

3. Methods

3.1. Research Questions and Hypotheses

The core elements of ESD involve the continuous improvement of education quality while maintaining the long-term robustness, inclusiveness, and innovativeness of the education system. In smart classrooms, these core elements are specifically reflected in the teachers' ICT teaching skills, teacher immediacy behavioral strategies, the establishment of harmonious teacher–student rapport, and the enhancement of student engagement. This study formulates the following research questions and hypotheses based on the literature review:

Q1. *Is there a significant correlation between teacher ICT teaching and teacher immediacy behaviors in smart classroom teaching?*

Q2. *Does teacher ICT teaching significantly impact teacher–student rapport and student engagement in smart classroom teaching?*

H1. *Teacher ICT teaching negatively predicts teacher–student rapport in smart classroom teaching.*

H2. *Teacher ICT teaching positively predicts student engagement in smart classroom teaching.*

H3. *Teacher ICT teaching positively correlates with teacher verbal immediacy behaviors in smart classroom teaching.*

H4. *Teacher ICT teaching negatively correlates with teacher nonverbal immediacy behaviors in smart classroom teaching.*

H5. *Teacher verbal immediacy behaviors positively predict student engagement in smart classroom teaching.*

H6. *Teacher verbal immediacy behaviors positively predict teacher–student rapport in smart classroom teaching.*

H7. *Teacher nonverbal immediacy behaviors positively predict student engagement in smart classroom teaching.*

H8. *Teacher nonverbal immediacy behaviors positively predict teacher–student rapport in smart classroom teaching.*

3.2. Participants

Using convenience sampling, we enrolled 1200 Chinese university students via online social networking platforms from regions such as northeast China, northwest China, central China, and south China. The research process entailed the following. First, the researchers confirmed the participants' identities to certify they were college students. Second, participants voluntarily agreed to participate in the survey, and formal consent was gained from them before commencing the research process. Third, participants provided their fundamental personal information, such as gender, age, university name, and major. Fourth, using the research instrument, participants evaluated the level of immediacy and ICT use of their major course teachers in the classroom teaching process as well as their rapport with their major course teachers and learning engagement. To ensure the questionnaire's validity, the participants' major courses had to be conducted in the smart classroom, and the teachers' teaching content had to use ICT. Fifth, all samples were screened after participants completed the survey. After screening, invalid questionnaires, including those with missing answers, regular patterns in questionnaire responses, and excessively quick completion times, were removed. Finally, 1032 valid questionnaires were obtained. Table 1 describes the characteristics of this valid set of respondents.

Table 1. Characteristics of the valid respondents.

Factor	Option	Frequency	%
Gender	Female	495	48
	Male	537	52
Education	Undergraduate Student	836	81
	Graduate Student	196	19
Major	Pedagogy	468	45
	English	238	23
	Management	152	15
	Applied Psychology	102	9.9
	Other Majors	72	7
Region	Central China	398	38
	Northwest China	297	29
	Northeast China	175	17
	Southern China	162	16

3.3. Instruments

3.3.1. Teacher Immediacy Behaviors Questionnaire

The current research on teacher immediacy extensively uses the teacher immediacy behavior questionnaire developed by Gorham [64]. The questionnaire comprises 17 questions on verbal immediacy and 5 on nonverbal immediacy. In this study, we revised the questionnaire content and finalized a 10-item teacher verbal immediacy questionnaire and a 6-item teacher nonverbal immediacy questionnaire. We used a 5-point Likert scale to measure teacher verbal and nonverbal immediacy. In this study, the reliability of the teacher verbal behaviors immediacy questionnaire (Cronbach α coefficient = 0.91) and the teacher nonverbal behaviors immediacy questionnaire (Cronbach α coefficient = 0.934) was good.

3.3.2. Teacher–Student Rapport Questionnaire

The widely used teacher–student rapport questionnaire developed by Wilson et al. [78] explores the multidimensional components of good teacher–student rapport and assesses factors that contribute to positive rapport and relationship between teachers and students. This 5-point Likert scale comprises 34 items and determines learners' perceptions of teachers, curriculum, and learning. In this study, the teacher–student rapport questionnaire reliability was good (Cronbach α coefficient = 0.9).

3.3.3. Student Engagement Questionnaire

The student engagement questionnaire developed by Mazer and Joseph [79] emphasizes the research centered on assessing student engagement levels within the classroom setting. This uses a 7-point Likert scale (0 = never; 7 = always). After screening, we selected 6 items from the original scale. In this study, the student engagement questionnaire reliability was good (Cronbach α coefficient = 0.879).

3.3.4. Teacher ICT Teaching Questionnaire

The Chinese Ministry of Education (2022) released the "Teachers' Digital Literacy Standards" as part of the Chinese Teachers' Professional Development Standards, which define teachers' digital literacy in five dimensions [80]. Per the Teachers' Digital Literacy Standards, we selected five indicators of teachers' ICT use as the items. The questionnaire used a 5-point Likert scale to assess teachers' competency in ICT teaching. In this study, the teacher ICT teaching questionnaire reliability was good (Cronbach α coefficient = 0.857).

4. Results

The presentation of research results adheres to a structured process. Initially, an analysis was conducted to assess the reliability and validity of the research instruments

with the objective of confirming their stability and ensuring their reliability. Subsequently, descriptive statistics were computed for the sample data, which was followed by normality tests to verify the suitability of the data for parametric statistical analysis. On this foundation, the correlation between the variables was further scrutinized. Ultimately, SEM was employed to assess the model's fit, explore the pathway relationships, validate the research hypotheses, and offer a comprehensive evaluation of the model's explanatory capability.

4.1. Reliability and Validity

Cronbach α coefficient was used for reliability analysis, and the KMO test and Bartlett's test of sphericity were used to analyze the validity analysis. Of note, KMO > 0.5 signifies a correlation between the question variables and fulfills the criteria of factor analysis. However, if it is signed by Bartlett's test ($p < 0.05$), factor analysis can be performed [81]. Table 2 shows that the reliability and validity of each questionnaire were acceptable.

Table 2. Reliability and validity of the questionnaires.

Questionnaires	Item	Cronbach α	KMO	Bartlett's Test of Sphericity		
				p	Approximate χ^2	df
Teacher verbal immediacy	10	0.91	0.885	***	3006.448	45
Teacher nonverbal immediacy	6	0.934	0.845	***	1449.794	15
Teacher ICT teaching	5	0.857	0.704	***	578.309	10
Teacher–student rapport	34	0.98	0.912	***	4960.379	120
Student engagement	16	0.879	0.717	***	827.793	10

ICT, information and communication technology. Notes: *** $p < 0.01$.

4.2. Descriptive Statistics and Normal Analysis

Table 3 presents the descriptive statistics and normal distribution test for this study. As our sample size was <5000, the Shapiro−Wilk test was used to measure the normality of the data distribution; it established that the data were normally distributed. The descriptive statistics demonstrated that 1032 students participated in this study along with the mean (M) and standard deviation (SD) of teacher verbal immediacy (M = 3.82, SD = 0.65), teacher nonverbal immediacy (M = 3.70, SD = 0.74), teacher ICT teaching (M = 3.77, SD = 0.50), teacher–student rapport (M = 3.99, SD = 0.438), and student engagement (M = 5.48, SD = 0.80).

Table 3. Descriptive statistics and normal analysis.

Variables	Number	Mean	SD	S-W
Teacher verbal immediacy	1032	3.82	0.65	***
Teacher nonverbal immediacy	1032	3.70	0.74	***
Teacher ICT teaching	1032	3.77	0.50	**
Teacher–student rapport	1032	3.99	0.43	**
Student Engagement	1032	5.48	0.80	**

ICT, information and communication technology; SD, standard deviation; S-W, Shapiro−Wilk test. Notes: *** $p < 0.01$; ** $p < 0.05$.

4.3. Correlation Analysis

As the preliminary analysis of the sample conformed to a normal distribution, Pearson correlation was used (Table 4). Using the Pearson product–moment correlation coefficient, we explored the correlation among teacher verbal immediacy, teacher nonverbal immediacy, teacher ICT teaching, teacher–student rapport, and student engagement. The results revealed a significant positive between the following: teacher ICT teaching and teacher–student rapport (r = 0.577, $p < 0.001$), teacher verbal immediacy and student engagement (r = 0.702, $p < 0.001$), teacher nonverbal immediacy and student engagement (r = 0.838, $p < 0.001$), teacher ICT teaching and student engagement (r = 0.543, $p < 0.001$), and teacher ICT teaching and teacher verbal immediacy (r = 0.415, $p < 0.001$). Therefore, H3 is validated.

In addition, a significant positive correlation was noted between teacher verbal immediacy and teacher–student rapport (r = 0.827, $p < 0.001$) and between teacher nonverbal immediacy and teacher–student rapport (r = 0.785, $p < 0.001$), but there was a significant negative correlation between teacher nonverbal immediacy and teacher ICT teaching (r = −0.386, $p < 0.001$). Therefore, H4 is validated. Furthermore, a significant positive correlation was observed between student engagement and teacher–student rapport (r = 0.493, $p < 0.001$).

Table 4. Correlation analysis.

Variables	1	2	3	4	5
Teacher verbal immediacy	1				
Teacher nonverbal immediacy	0.761 ***	1			
Teacher ICT teaching	0.415 ***	−0.386 ***	1		
Teacher–student rapport	0.827 ***	0.758 ***	0.577 ***	1	
Student engagement	0.702 ***	0.838 ***	0.543 ***	0.493 ***	1

ICT, information and communication technology. Notes: *** $p < 0.01$.

4.4. SEM Model Path Relationship Hypothesis Validation Results

In this study, we used χ^2/df, GFI, CFI, and RMSEA. To obtain the fitted model, χ^2/df should be <3, GFI, CFI, and NFI should be >0.90, and RMSEA should be <0.08. Table 5 shows that each of the goodness-of-fit indices is within a reasonable range. Hence, the model has acceptable validity. We observed the standardized estimates to test the strength of the causal relationship between the components. Table 6 and Figure 1 show the model of the interrelationships between the variables. As teacher ICT teaching was a significant positive predictor of teacher–student rapport (β = 0.401, $p < 0.001$), H1 is not validated. As teacher ICT teaching was a significant positive predictor of student engagement (β = 0.785, $p < 0.001$), H2 is validated. As teacher verbal immediacy was a significant positive predictor of student engagement (β = 0.378, $p < 0.001$), H5 is validated. As teacher nonverbal immediacy was a significant positive predictor of student engagement (β = 0.659, $p < 0.001$), H7 is validated. As teacher verbal immediacy was a significant positive predictor of teacher–student rapport (β = 0.557, $p < 0.001$), H6 is validated. As the teacher nonverbal immediacy was a significant positive predictor of teacher–student rapport (β = 0.386, $p < 0.001$), H8 is validated.

Table 5. Model fitting results.

Model	CMIN/DF	DF	*p*	RMSEA	CFI	GFI
Default model	1.811	1763	0	0.029	0.927	0.962
Saturated model		0			1	1
Independence model	7.166	1830	0	0.077	0	0.082

Table 6. Standardized regression weights.

			Estimate	S.E.	C.R.	*p*
Teacher–student rapport	<---	Teacher verbal immediacy	0.557	0.043	5.681	***
Teacher–student rapport	<---	Teacher nonverbal immediacy	0.386	0.056	2.298	***
Teacher–student rapport	<---	Teacher ICT teaching	0.401	0.067	2.347	***
Student engagement	<---	Teacher ICT teaching	0.785	0.037	18.287	***
Student engagement	<---	Teacher verbal immediacy	0.378	0.117	6.196	***
Student engagement	<---	Teacher nonverbal immediacy	0.659	0.056	11.428	***

ICT, information and communication technology. Notes: *** $p < 0.01$.

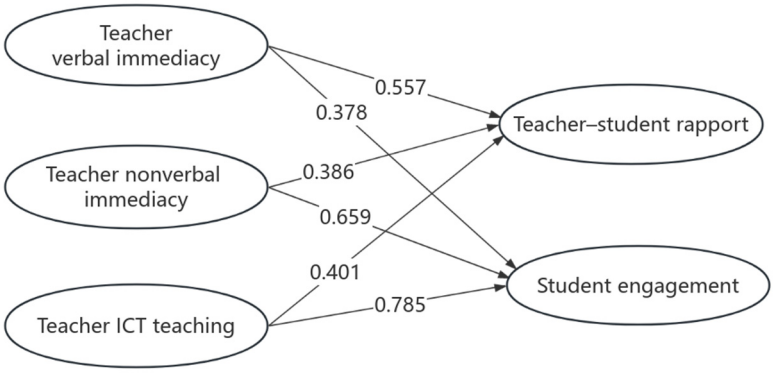

Figure 1. The path coefficients of the model.

5. Discussion

5.1. Teacher ICT Teaching and Student Engagement in Smart Classroom Teaching

The findings demonstrated that teacher ICT teaching positively envisages student engagement. This result can be attributed to several factors. Firstly, prior research has shown that the classroom environment positively influences student engagement [82,83]. With its advanced technology and profuse teaching resources, smart classrooms provide an efficient platform for teachers to teach. Teachers can better utilize these resources and design more attractive and interactive teaching content as well as a more immersive classroom environment, which directly affects student engagement and learning motivation in the classroom [84]. Second, by using ICT, teachers can revolutionize the content and form of teaching to make teaching more vivid and interesting. For instance, through multimedia teaching, virtual experiments, and online interaction, teachers can display more intuitive and visual teaching materials to kindle students' interest in learning. Meanwhile, these novel forms of teaching offer students additional opportunities for participation, such as online discussions, group work, and instant feedback, further enhancing student engagement. Third, smart classrooms have data analysis and feedback functions [85], which can record students' learning behavior and data in real time. Teachers can use these data to comprehend students' learning progress and challenges as well as promptly adjust teaching strategies and methods. Teachers can then use these data to offer students tailored learning advice and feedback to enable them to better master their knowledge and skills. This immediate feedback and tailored instruction can motivate students and increases their engagement [86]. Briefly, in smart classroom teaching, teacher ICT teaching exerts a significant predictive impact on student engagement improvement. This requires teachers to constantly refine their ICT teaching skills, fully use the advantages and resources of smart classrooms, and innovate the content and form of teaching to provide students with higher-quality and more efficient teaching.

5.2. Teacher ICT Teaching and Teacher Immediacy Behaviors in Smart Classroom Teaching

The results established a significant positive correlation between teacher ICT teaching and teacher verbal immediacy behaviors. The characteristics of teacher–student interactions in smart classrooms are categorized into the following: student-centered teaching principles, the harmonious emotional communication between teachers and students, the effective utilization of open-ended questions to stimulate students' exploratory desires, and a commitment to fostering a harmonious learning atmosphere [87]. To achieve these objectives, teachers must fully harness the potential of ICT to meticulously plan and design a series of teaching activities. The design of these activities should closely align with the established instructional objectives while also deeply understanding and respecting students' individualized interests and cognitive development patterns. This ensures that through active participation, each student not only acquires knowledge but also experiences the profound joy and sense of achievement in learning. During this process, teachers tend to adopt verbal immediacy behaviors to convey instructional intent and emotion

more effectively. Verbal immediacy behaviors not only bring teachers and students closer together but also stimulate students' interest in learning [88]. Thus, there is a significant positive correlation between teacher ICT teaching and teacher verbal immediacy behaviors in smart classroom teaching. By integrating ICT teaching and verbal immediacy, teachers can more effectively stimulate students' learning interest and motivation, enhance teaching effectiveness, and increase student satisfaction, achieving effective classroom interaction.

The results established a significant negative correlation between teacher ICT teaching and teacher nonverbal immediacy behaviors. Nonverbal immediacy behaviors, such as a teacher's facial expressions, body language, and eye contact with students, are inherently immediate and intuitive [89]. Consequently, the effectiveness of these nonverbal immediacy behaviors significantly hinges on students' perception of them [68]. If students in the classroom fail to perceive their teachers' nonverbal immediacy behaviors, then the impact and effectiveness of these behaviors will be significantly reduced or potentially rendered completely ineffective. In traditional classrooms, the teaching interaction primarily centers on the teacher–student interaction. However, in smart classrooms, there has been a notable transformation in teaching interactions. Apart from the traditional teacher–student interaction, new forms of interaction have emerged, such as teacher–technology interaction and student–technology interaction, and these technology-related interactions constitute a considerable proportion of the teaching activities [87]. When teachers frequently utilize ICT in smart classrooms, their attention tends to become more concentrated on operating technological devices, presenting diverse multimedia content, or engaging with students via technological means. This heightened emphasis on teaching with technology may result in a decrease in the teachers' display of nonverbal immediacy behaviors. Furthermore, teachers who possess high-quality ICT teaching skills often design and deliver instructional content of a superior standard. This superior content is typically innovative, swiftly grabbing students' attention. Thus, this presents a potential issue: while students are fully engrossed in these instructional contents, they may unconsciously overlook the teacher's nonverbal immediacy behaviors. However, balancing ICT teaching and nonverbal immediacy behaviors can be a challenge for teachers. In the construction of future smart classrooms, educational institutions must fully consider the potential impact of ICT on nonverbal immediacy behaviors and optimize ICT devices to ensure they are easy and intuitive to operate, minimizing the distractions caused by complex operations and allowing teachers to have more opportunities to demonstrate nonverbal immediacy behaviors.

5.3. Teacher ICT Teaching and Teacher–Student Rapport in Smart Classroom Teaching

The findings established that teacher ICT teaching is a significant positive predictor of teacher–student rapport. Teacher ICT teaching has altered teaching methods and the teaching environment, rendering education further personalized and interactive, augmenting teacher–student communication and collaboration as well as fostering a closer teacher–student rapport. Meanwhile, through ICT, teachers can also comprehend students' learning promptly, offer bespoke guidance and feedback, and augment the teacher–student trust and intimacy, nurturing a better teacher–student rapport. Nevertheless, ICT use also has some adverse impacts. For example, an over-reliance on ICT could result in less authentic teacher–student interaction, declining the teacher–student emotional connection and communication quality. Moreover, for some students with deficient technical skills or who lack the pertinent equipment, ICT use could cause unequal learning resources, exacerbating the digital divide between teachers and students. Overall, teachers' ICT teaching in classroom practice has exhibited both noteworthy positive impacts on teacher–student rapport and some potential negative impacts. In light of this complexity, teachers should adopt strategies that both make full use of the advantages of ICT and minimize its negative impacts to promote harmonious teacher–student rapport and to ensure that teaching and learning effects are optimized.

6. Conclusions and Implications

This study indicates that teacher ICT teaching exerts a positive predictive effect on teacher–student rapport and student engagement. A significant positive correlation exists between teacher ICT teaching and teacher verbal immediacy, whereas a significant negative correlation exists between teacher ICT teaching and nonverbal immediacy. Furthermore, teacher immediacy behaviors exert a positive impact on student engagement and teacher–student rapport.

In smart classrooms, teacher ICT teaching can markedly enrich and optimize educational resources and make the teaching process more vivid and stimulating [90]. In this process, teachers' skillful amalgamation of verbal immediacy can more effectively capture students' attention, meaningfully amplify student engagement, and further encourage the building of a harmonious teacher–student rapport. Notably, while ICT facilitates teaching, it might also hinder teacher nonverbal immediacy to a certain extent. These nonverbal immediacy behaviors play a key role in conveying emotions, building trust, and augmenting instructional efficacy [91]. Thus, in smart classrooms, teachers must pay attention to and balance the use of nonverbal immediacy while fully exploiting the advantages of ICT.

This study has practical implications for ESD. Precisely, teacher ICT teaching is a vital element in influencing teaching quality in smart classrooms [92]. Thus, firming teacher ICT teaching ability not only directly endorses the substantial enhancement of the teaching effect but also promotes the digitization process of education and the crucial driving force of ESD. Teachers must recognize the significance of integrating ICT teaching with immediacy behaviors. Immediacy behaviors not only condense the psychological distance between teachers and students and construct a more harmonious teaching environment but also markedly kindle the fervor of students to participate in the classroom and encourage them to proactively engage in practical activities [93,94]. This two-pronged teaching strategy optimizes the teaching effect and significantly enriches students' learning experience.

This study also offers valuable reference information for the future expansion of smart classrooms. A substantial negative correlation was established between teacher ICT teaching and their nonverbal immediacy behaviors in the classroom; this finding signifies that when using ICT teaching, teachers might decrease the display of nonverbal immediate behaviors. Thus, the design of future smart classrooms should be highly humanized and act as a bridge between technological innovations and conventional teaching methods to attain a harmonious symbiosis between the two, enabling teachers to take full advantage of ICT in smart classroom teaching, improving the efficiency and diversity of information delivery while upholding the immediacy of conventional teaching.

7. Limitations and Future Directions

The data in this study were obtained from self-reported questionnaires, posing the risk of self-reporting bias. Therefore, future research could use mixed methods and qualitative approaches. Notably, in this study, the extent of impact on teacher–student rapport followed: teacher verbal immediacy > teacher ICT teaching > teacher nonverbal immediacy. ICT teaching exerted a marginally higher impact on teacher–student rapport than teacher nonverbal immediacy. With the swift update and iteration of ICT, whether the extent of impact of ICT on teacher–student rapport will surpass teacher verbal immediacy in the future is a research direction that warrants further investigation. Furthermore, in prior research on teacher immediacy, verbal immediacy and nonverbal immediacy were the key dimensions of teacher immediacy, and it is worth investigating whether "teachers' ICT teaching immediacy" can be used as a dimension of teacher immediacy in the future.

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