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EXAMINING TEACHER CRITICAL THINKING, COMMUNICATION, COLLABORATION, AND CREATIVITY SKILLS ON WORK ACHIEVEMENT: MOTIVATION AS MEDIATOR

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ABSTRACT

This study addresses the critical research gap in understanding how 21st-century 4C skills (critical thinking, communication, collaboration, and creativity) operate in resource-constrained rural environments, where limited research has examined the specific mechanisms by which they influence teacher motivation and achievement. While extensive literature exists on the implementation of 4C skills in urban settings, our understanding remains limited of how these competencies translate into outcomes in rural contexts characterised by geographical isolation, limited resources, and structural challenges that may fundamentally alter skill-outcome relationships—employing Partial Least Squares Structural Equation Modelling (PLS-SEM) with data from 152 teachers via purposive sampling. Findings demonstrate three distinct operational mechanisms: comprehensive dual-pathway operation (critical thinking), direct performance enhancement (communication), and exclusive motivational mediation (collaboration and creativity). Critical thinking emerged as the most influential skill, affecting both motivation and achievement through reinforcing cycles of professional confidence and instructional effectiveness. Communication demonstrated mechanical operation, directly enhancing performance without motivational intermediation. Collaboration and creativity served as psychological resources that enhanced teacher well-being and intrinsic motivation, translating into improved achievement, whereas direct implementation faced environmental barriers. Results underscore that effective rural teacher development requires contextually sensitive approaches that recognise distinct operational pathways, providing a foundation for tailored interventions that enhance both effectiveness and well-being in challenging educational environments.

KEYWORDS: 4C Skills, Teacher Motivation, Work Achievement, Rural Education, Self-Determination Theory, Professional Development.

1. INTRODUCTION

In 2004, the National Education Association developed the Framework for 21st Century Learning, which highlighted 18 skills as essential themes for learning in the 21st century. It was then, in 2004, that the "Four Cs" were born (Powerschools, 2021). These skills are expected to be developed for teachers and students in an educational context. Teachers' 4C skills—critical thinking (CRT), creativity (CRE), collaboration (COL), and communication (COM)—are crucial and widely recognised as essential for designing effective 21st-century education that prepares students for complex, rapidly changing environments (Bedir & Capan, 2025; Thornhill-Miller et al., 2025). Teachers with strong 4C skills tend to achieve higher performance in teaching, but their impact is influenced by training, support, and contextual challenges. In rural schools, the barriers to implementing 4C skills are particularly pronounced and create unique challenges that significantly impact teacher performance and student outcomes. Hence, developing high-performing teachers are crucial to ensure that they can adapt and adhere to work guidelines according to the ever-changing and evolving scope of the teaching profession (İlğan et al., 2022; Qingyan et al., 2023; Supena et al., 2021). For instance, teachers' mastery of 4C skills directly determines curriculum quality and student preparation for future challenges (Herlinawati et al., 2024), enabling effective instructional design that fosters problem-solving and innovation (Herlinawati et al., 2024; Jaedun et al., 2022).

Nevertheless, the implementation of 4C skills in education faces several significant challenges that hinder effective integration in classrooms, e.g., insufficient training represents a primary obstacle, as teachers often lack systematic preparation in 4C integration methods (Almazroa & Alotaibi, 2023; Baharuddin & Burhan, 2025; Nurhayati et al., 2025). Limited resources and infrastructure create additional barriers, where inadequate facilities and technology prevent effective 4C-based teaching approaches (Haryani et al., 2024; Keane et al., 2016). Moreover, curriculum and assessment misalignment poses another challenge, as national curricula and assessment systems frequently fail to prioritise or adequately support 4C skills development (González-pérez & Ramírez-montoya, 2022; Thornhill-miller et al., 2025). Finally, teacher confidence and familiarity issues emerge when educators feel unprepared or lack sufficient confidence in implementing 4C strategies effectively in their teaching practice (Bedir, 2019; Herlinawati et al., 2024). This particularly happens to rural teachers in Indonesia, who often face unique contextual challenges, including multi-grade classrooms, limited parental support due to lower education levels, student brain drain to urban areas, and cultural resistance to educational innovation (Worldbank, 2020). These compounded barriers collectively constrain the cycle in rural schools, where teachers' potential for high performance through 4C skills is severely limited, resulting in widened educational inequities, reduced teacher retention, compromised student preparation for modern challenges, and the perpetuation of rural-urban achievement gaps despite the critical need for 21st-century skills in underserved communities.

Linnenbrink-Garcia and Wormington (2019) suggested that perceived competence, task values, and achievement goals represent fundamental domains for examining individual motivation through a comprehensive approach. In this scenario, having motivated teachers is fundamental to educational success because they serve as the driving force that transforms potential into performance, particularly in challenging contexts where 4C skills implementation faces significant barriers (Beltman & Poulton, 2025). When teachers are motivated, they demonstrate higher levels of persistence and resilience in overcoming obstacles such as insufficient training, limited resources, and systemic constraints, enabling them to find creative solutions and maintain their commitment to student learning despite adverse conditions (Samsudin et al., 2025). According to the self-determination theory (SDT), Deci and Ryan (1985) postulated that human behaviour is driven by three fundamental psychological needs—autonomy, competence, and relatedness—whose fulfilment is essential for psychological health, growth, autonomous motivation, and optimal functioning. Competence satisfaction leads to higher perceptions of self-efficacy and autonomy-supportive teaching practices (Brenner, 2022). In the context of teachers' 4C skills, this framework becomes highly relevant as critical thinking and creativity enhance teachers' sense of competence by providing them with sophisticated problem-solving and innovative instructional capabilities (Audrin & Hascoët, 2024; Beltman & Poulton, 2025), while collaboration and communication skills directly strengthen relatedness through improved connections with students, colleagues, and the broader educational community (Beltman & Poulton, 2025; Samsudin et al., 2025). Furthermore, mastery of all four skills collectively enhances teachers' autonomy by increasing their confidence to make independent pedagogical

decisions and adapt their teaching methods to diverse learning contexts, ultimately affecting teacher work achievement/performance.

Hasibuan (2016) states that an individual's work achievement is demonstrated by their seriousness in completing tasks based on skills, capabilities, experience, diligence, and time. Furthermore, other studies have found that a teacher's 21st-century skills and competencies influence their teaching performance (Mistareehi, 2020; Wrahatnolo & Munoto, 2018). For instance, it has been found that a teacher's critical-thinking ability can positively affect the quality of learning (Kadrija et al., 2022; Kanwal & Butt, 2021). Meanwhile, Parsi (2017) found no direct influence of teacher critical thinking on motivation. Additionally, communication skills play a significant role in influencing teacher work achievement (Moghtader & Aziz, 2019; Sulaiman & Ismail, 2020), as do teachers' collaboration abilities with others in achieving performance (Cravens & Hunter, 2021; Gamboa, 2023). Lastly, a teacher's creativity will influence their achievement by combining creative elements and engaging teaching methods or activities in the classroom (Serang et al., 2023). However, it should be emphasised that a teacher's ability to achieve quality work depends on professional, personal, methodological, and contextual development factors (Lorencová et al., 2019). Work motivation is an important personal factor that needs to be considered (Dar, 2020; Harsono et al., 2023). Implementing the 4C skills can positively influence teacher work motivation; for example, teachers who can identify problems in the learning process and find better solutions will be more motivated to make positive changes. Despite the recognized importance of 4C skills, there remains limited understanding of how these competencies influence teacher work achievement through motivational pathways.

This research will employ structural equation modelling to examine the influence path of the 4C skills of teachers—namely, CRT, COM, COL, and CRE—on teacher's work achievement (TWA), mediated by teacher's work motivation (TWM). Several reasons and specific foundations underpin this decision. Firstly, there is currently a lack of exclusive studies examining the influence of teachers' 4C skills on work motivation, as highlighted in our earlier statements and literature. However, research by Yan et al. (2022) emphasises that teachers' competencies play a crucial role in enhancing their behaviour (work motivation). Secondly, although previous research has correlated these domains, a comprehensive study has not examined their mutual influences using path analysis, as we intend to do. Moreover, teachers in rural schools who will serve as subjects or samples in this study pose a crucial challenge for comprehensive discussion. Therefore, this study aims to address the critical research gap by investigating: (1) How do teachers' 4C skills predict work motivation (TWM) through SDT's psychological needs? (2) To what extent does teachers' work motivation mediate the relationship between 4C skills and work achievement? (3) What are the implications for supporting teacher work achievement (TWA) in challenging contexts? Understanding these relationships is essential for developing evidence-based interventions that can enhance teacher effectiveness, particularly in resource-constrained environments where motivated teachers are crucial for educational equity. This will provide inclusive recommendations to school principals, teachers, and policymakers to consider creating supportive school environments, professional development, and teacher education to help teachers enhance their capacity and performance by mastering the 4C skills for school improvement. The implications for future research are also crucial for sustaining efforts to improve uniform education quality, particularly in rural school areas.

2. LITERATURE REVIEW

This literature review examines the theoretical foundations and empirical evidence supporting the relationships between teachers' 21st-century skills (the "Four Cs": critical thinking, communication, collaboration, and creativity), work motivation, and work achievement. The review is structured around the proposed hypotheses and provides a comprehensive analysis of existing research to establish the theoretical framework for investigating these relationships in rural school contexts.

2.1. Theoretical Foundation

Self-Determination Theory (SDT) provides the essential theoretical framework for understanding how teachers' 4C skills influence motivation and achievement through three psychological needs—autonomy, competence, and relatedness (Deci & Ryan, 1985). Meta-analytical evidence demonstrates that satisfaction of these needs enhances motivation, well-being, and performance, with intrinsic motivation relating to student success and identified regulation linking to persistence (Howard et al., 2021). However, recent research reveals contextual complexity: Mammadov and Schroeder (2023) found that psychological needs-motivation relationships

vary significantly by implementation approach, while Chiu (2021) showed that motivation operates differently across learning environments, suggesting the relative importance of each need depends on educational context. Teachers experiencing higher autonomy, competence, and relatedness demonstrate greater intrinsic motivation, which associated with better teaching practices and sustained performance (Guay, 2022), though effectiveness depends on contextual support quality. Critically, Schweder and Raufelder (2022) revealed that motivational quality matters more than presence alone, with frequent profile transitions occurring during self-directed learning phases, suggesting the skills-motivation relationship is more dynamic and context-dependent than previously assumed—particularly relevant for rural teachers facing constant environmental transitions.

2.2. Critical Perspectives and Rural Schools Contextual Considerations

The implementation of 4C skills in rural educational contexts faces unique challenges that may significantly moderate the proposed relationships, with research revealing that rural teachers encounter distinct barriers including multi-grade classrooms, limited parental support, student brain drain, and cultural resistance to innovation that collectively constrain their potential for high performance through 4C skills (Liu, 2023; Zhao et al., 2024). Studies demonstrate that rural teachers often suffer from double marginalization, experiencing non-mainstream existence in both urban professional circles and rural communities, leading to poor working conditions characterized by lack of hope that significantly impacts their ability to translate skills into motivation and achievement (Chen et al., 2022). Recent research by Xiaoxia and Jin (2024) found that professional development for rural teachers encounters numerous challenges affecting both educational quality and teacher well-being, while Ingersoll and Tran (2023) indicated that teacher shortages in rural schools stemmed not from insufficient supply of educational resources but from social spillover problems caused by professional role adjustment needs. These findings challenge simplistic solutions focused solely on skill development and suggest that the relationships between 4C skills, motivation, and achievement may be fundamentally different in rural versus urban contexts, requiring contextual adaptations that account for the unique socio-economic and cultural factors that influence rural educational environments.

2.3. Teachers' Work Motivation (TWM) and Work Achievement (TWA)

The relationship between work motivation and work achievement is well-established in organizational psychology and educational research, with motivated teachers demonstrating higher levels of persistence, engagement, and effort in their professional responsibilities, which translates into better performance outcomes (Dar, 2020; Harsono et al., 2023). Motivation refers to something that drives an individual to make particular choices, engage in actions, try, and persevere in actions (Dörnyei & Ushioda, 2011). Motivation refers to the internal and external driving forces that energise individuals to fulfil their tasks and meet their expectations and needs. In the context of teacher work motivation, it is argued that a teacher can have a high level of work motivation if they are satisfied with their job, have enthusiasm, a sense of responsibility, and a strong drive (Karweti, 2010). Motivation activates motives into actions or behaviours to fulfil needs and achieve specific goals (Abednego et al., 2023).

Recent studies have reinforced this relationship, with comprehensive research by Al-Maalouf and Al-Baradhi (2024) finding that motivation significantly influences teachers' job performance, while Suyatno et al (2022) demonstrated that teacher motivation and professional development play crucial roles in enhancing teacher performance through managerial support and work conditions, while Danielson (2007) emphasises four domains of teaching responsibility where teachers must demonstrate work achievement through competent execution, subject knowledge, innovation, problem-solving, professional relationships, and time discipline. Teachers who are intrinsically and extrinsically motivated are more likely to engage in continuous professional development, implement innovative teaching practices, and maintain high standards of instruction even in challenging circumstances. However, recent empirical evidence reveals important nuances in this relationship, with studies showing that both self-determined and non-self-determined motivation significantly impact performance outcomes, suggesting that the quality of motivation, not just its intensity, matters for achievement (Al Maalouf & Al Baradhi, 2024).

Critical to understanding this relationship is recognising that motivation in educational contexts is often a complex mixture of intrinsic and extrinsic factors, with SDT distinguishing between regulated and independent motivation. Recent research by Aytaç et al. (2024) found that teachers' zest for work and teaching motivation are mediated by

achievement goals, while Wartenberg et al (2023) demonstrated, through a meta-analysis, that teachers' job satisfaction is positively related to high-quality teacher-student interactions, enhanced student motivation, and achievement. When teachers experience positive behavioural changes in their teaching through autonomous motivation, their level of understanding and interest increases, which can improve their job performance and foster harmony and prosperity within educational environments. However, this relationship may vary across contexts, particularly in challenging environments where unique factors may moderate the motivation-achievement relationship.

H9: TWM has a significant influence on TWA

2.4 Teachers' Four Cs Skills (CRT, COM, COL, and CRE)

The Framework for 21st Century Learning, developed by the National Education Association in 2004, identified critical thinking, communication, collaboration, and creativity as essential skills for contemporary education (Powerschools, 2021). These skills are crucial for both students and teachers, who must model and facilitate these competencies in their classrooms. While the OECD has made efforts to foster creativity and critical thinking through curriculum development, educational activities, and teacher support across all education levels, and multiple organisations have issued implementation guides for 21st-century skills, a critical gap remains between theoretical frameworks and practical implementation, particularly in challenging contexts such as rural schools.

Critical thinking represents a fundamental cognitive skill enabling teachers to analyse complex situations, evaluate information systematically, and make informed decisions (Peter A. Facione, 2011). Paul and Elder's (2022) The critical thinking framework emphasises that effective critical thinkers can gather and assess relevant information using intellectual standards of accuracy and relevance, draw well-reasoned conclusions based on evidence and data, and complete tasks according to clear criteria and valid guidelines while maintaining intellectual integrity. Research demonstrates that teachers with strong critical thinking abilities—including completing tasks based on valid guidelines, teaching according to relevant content material, actively searching for primary research findings, understanding student abilities through assessment data, and addressing school issues systematically—experience greater confidence in their professional capabilities, which aligns with SDT's competence dimension and translates into higher motivation levels and improved performance outcomes (Audrin & Hascoët, 2024; Beltman & Poulton, 2025). Moreover, critical thinking empowers teachers to make effective instructional decisions that enhance their overall performance, as shown in studies by Kadrija et al. (2022) and Kanwal and Butt (2021) finding that teachers' critical-thinking abilities positively influence the quality of the learning outcomes they produce. This creates a virtuous cycle in which enhanced critical-thinking capabilities lead to improved perceptions of competence, which in turn foster higher motivation and professional achievement.

H1: CRT has a significant influence on TWM

H5: CRT has a significant influence on TWA

Effective communication skills are fundamental to teaching effectiveness and directly relate to the relatedness component of SDT, simultaneously enhancing both motivation and performance outcomes. Teachers with strong communication abilities—including using clear language with interlocutors, delivering material effectively, conveying ideas confidently, expressing opinions clearly with students and colleagues, and actively participating in professional forums—can better connect with students, colleagues, and parents, fostering positive relationships that enhance their sense of belonging, professional satisfaction, and work achievement (Beltman & Poulton, 2025; Moghtader & Aziz, 2019). There are four interconnected strands of effective communication—physical, linguistic, cognitive, and social—where teachers demonstrate competence through clear language use and opinion expression, effective material delivery, confident idea conveyance, and active participation in professional forums (Cambridge Univeristy, 2020). Study by Samsudin et al. (2025) further emphasised that teachers' linguistic clarity directly impacts student comprehension and engagement, while communication confidence across different contexts correlates with higher job satisfaction, motivation, and improved instructional delivery. Effective communication enables teachers to manage classroom dynamics more effectively and collaborate more successfully with colleagues and administrators, creating a synergistic effect where enhanced communication skills simultaneously boost motivation through improved relationships and work achievement through better instructional practices. However, effectiveness depends on clarity of interaction, understanding, satisfaction, efficiency, and contextual appropriateness.

H2: COM has a significant influence on TWM

H6: COM has a significant influence on TWA

Collaborative skills directly address the relatedness need in SDT while simultaneously enhancing performance outcomes through meaningful professional relationships and shared problem-solving opportunities. Teachers skilled in collaboration—including working responsibly with colleagues, respecting different perspectives in groups, establishing confident relationships with external parties, compromising to achieve pre-set goals, and actively collaborating beyond school boundaries—experience enhanced motivation and improved achievement through strengthened professional connections and effective practice sharing (Cravens & Hunter, 2021; Gamboa, 2023; Vangrieken et al., 2015). These studies demonstrate that teacher motivation (Vangrieken et al., 2015) and performance (Cravens & Hunter, 2021; Gamboa, 2023) are strongly influenced by perceptions of collaboration skills, as teachers who perceive themselves as effective collaborators capable of contributing to shared understanding and collective problem-solving experience experience increased motivation while simultaneously engaging in professional learning communities and implementing innovative instructional strategies. Stevens and Campion's (1994) teamwork competency framework emphasises collaborative effectiveness through interpersonal and self-management, in which teachers demonstrate teamwork competence by working responsibly with colleagues, respecting diverse perspectives, establishing relationships, compromising to achieve shared goals, and actively engaging in external partnerships. Collaborative work increases knowledge through interaction, leverages individual strengths to achieve better outcomes, and prevents teacher burnout while enhancing both motivation and achievement. However, the impact of collaboration depends on teachers' mastery of component skills, including goal setting, resource allocation, group decision-making, negotiation, conflict resolution, and team building.

H3: COL has a significant influence on TWM

H7: COL has a significant influence on TWA

Creativity enhances teachers' sense of autonomy and competence while simultaneously improving their performance outcomes by enabling them to develop innovative solutions to educational challenges and adapt teaching methods to diverse learning contexts. According to OECD's framework, teachers must demonstrate creativity skills through practical idea presentation, knowledge-based innovation, creative contribution to new situations, transforming passive situations creatively, and developing creative learning strategies (Vincent-Lancrin et al., 2019). Teachers who can present creative ideas practically, innovate based on existing knowledge, contribute to new work situations, transform passive situations into active ones, and create new learning strategies experience greater job satisfaction, motivation, and achievement through expressing their professional identity and implementing personalised instructional approaches that lead to improved student outcomes (Serang et al., 2023). Beghetto and Kaufman (2014) found that classroom contexts that support creative expression directly enhance teacher autonomy and competence satisfaction, while improving instructional effectiveness. Creative teachers demonstrate greater adaptability and innovation in their instructional approaches, creating a reciprocal relationship in which enhanced creativity leads to increased motivation through professional agency satisfaction and improved achievement through effective teaching practices and professional recognition. However, this relationship may include both successes and failures as teachers take creative risks in their educational practice.

H4: CRE has a significant influence on TWM

H8: CRE has a significant influence on TWA

2.5. Conceptual Mediation Effects of Motivation

The proposed mediation hypotheses are grounded in SDT and empirical research indicating that motivation is a key mechanism by which skills and competencies influence performance outcomes. Deci and Ryan's (1985; 2020) SDT emphasises three psychological needs—autonomy, competence, and relatedness—that drive intrinsic motivation, in which teachers demonstrate work motivation through enthusiasm for development, task confidence, voluntary participation, appreciation and recognition, and supported engagement. According to SDT, when basic psychological needs are satisfied through the development and application of professional skills, individuals experience enhanced motivation, which subsequently leads to improved performance, a process particularly relevant in educational contexts where external constraints may limit the direct expression of competencies in achievement outcomes (Brenner, 2022). Recent research by Siacor et al. (2024) found that teacher autonomy support helps meet psychological needs and ultimately stimulates motivation and engagement, while Zhang and Qian (2022) discovered that teacher autonomy support promotes academic engagement through the mediating role of basic psychological needs and

autonomous motivation. Furthermore, Xu (2024) demonstrated the mediating role of academic self-efficacy in the relationship between teacher support and academic achievement, while Evans and Martin (2024) found that teachers' load-reducing instructional strategies were positively associated with autonomous motivation, engagement, and achievement through reduced cognitive load.

The mediation framework is particularly relevant in educational contexts where external factors such as limited resources, administrative pressures, and challenging student populations may constrain the direct relationship between skills and achievement, with motivation serving as a crucial mediating variable that helps teachers translate their competencies into effective performance despite environmental challenges. However, the effectiveness of motivation as a mediating variable may depend on the type of motivation (autonomous versus controlled), the specific context, and the presence of supportive environmental factors, suggesting that the mediation hypotheses should account for contextual moderators that influence the strength and direction of the mediation effects.

H10: TWM is a significant mediator in assessing the influence of CRT on TWA

H11: TWM is a significant mediator in assessing the influence of COM on TWA

H12: TWM is a significant mediator in assessing the influence of COL on TWA

H13: TWM is a significant mediator in assessing the influence of CRE on TWA

3. METHODOLOGY

3.1. Research Design

This research employed quantitative methods, specifically causal regression analysis using exploratory and cross-sectional studies (Creswell, 2012). Its primary aim was to evaluate and validate the extent to which theoretical models align with real-world data collected during the study. The main focus was on examining how structural factors related to teachers' 4C Skills (critical thinking, communication, collaboration, and creativity) influence their motivation and performance at work (Johnson et al., 2004).

3.2. Participants

The study focuses on six rural schools in Malang Regency, East Java, Indonesia. A purposive sampling technique was used to collect data from teachers meeting specific criteria. These criteria include being teachers in public high schools in Malang Regency with approximately 3 years of experience, or being certified and teaching in schools that have implemented the independent curriculum, with the requirement to apply the 4C skills in their teaching processes. The sample size calculation formula is adapted from Isaac and Michael's table for a specific population with an accumulated error rate of 5%, aiming to obtain optimal results (Isaac & Michael, 1981). The calculation results are based on the total number of teachers across six schools, comprising 277 individuals. Based on this calculation, with a 5% margin of error from the total N=277, 152 respondents will be identified. Typically, a sample size of 100 respondents is considered moderately sufficient, while 150 respondents can be viewed as somewhat larger (Dash & Paul, 2021). We present the participant profile in Table 1 based on these criteria and sampling techniques.

Table 1. The demographics of the recruited study participants.

Respondent Schools of Employment	Frequencies	Percentage (%)
SMAN 1 Sumber Manjing	26	17,1
SMAN 1 Bantur	22	14,5
SMAN 1 Tumpang	32	21,1
SMAN 1 Ngantang	15	9,9
SMAN 1 Singosari	20	13,2
SMAN 1 Dampit	17	11,2
SMAN 1 Lawang	20	13,2
Respondent Length of Employment		
3-10 Years	77	50,7
11-20 Years	45	29,6
21-30 Years	20	13,2
31-40 Years	10	6,6
N	152	100,0

Table 1 shows that, in terms of schools of employment, SMAN 1Tumpang has the highest participation of respondents (teachers) in this study, with a frequency of 32 (21.1%), while the lowest is from SMAN 1 Ngantang, with a frequency of 15 (9.9%). As for the length of employment, most participating teachers have been working for 3-10 years, with 77 teachers (50.7%) categorised as young teachers. Meanwhile, the minority of participating teachers fall within the 31-40 years of employment range and are categorised as senior teachers.

3.3. Data Collection

This research study utilises a questionnaire administered via Google Forms to collect data from respondents. Initially, we visited the schools selected as research sites to obtain permission from the appropriate authorities. After obtaining permission, we distributed the Google Form questionnaire link to teachers meeting the predetermined respondent criteria. Finally, after the teachers completed the

Google Form we distributed, the collected data was converted into an Excel dataset for further analysis.

3.4. Measures

The questionnaire utilised in this study was adapted from prior research theories and literature. After conducting research and extracting relevant components from existing literature, some modifications were introduced to tailor it to the specific context of the current investigation. Furthermore, efforts were made to enhance the questionnaire's applicability and effectiveness by converting the rating scale to a five-point Likert format. This Likert scale ranges from 1, indicating strong disagreement, to 5, indicating strong agreement, allowing for a comprehensive assessment of respondents' perspectives. Additionally, before distributing the questionnaire to the research participants, we conducted validity and reliability analyses using data obtained from schools with similar characteristics. For the dependent variable, TWA, we adapted from Danielson's work (2007). The validity of each item ranged from 0.000 to 0.90, with a reliability coefficient of 0.777. Then, the independent variables, namely the 4C skills of teachers consisting of CRT, COM, COL, and CRE, were adapted from several works (Cambridge Univeristy, 2020; Paul & Elder, 2022; Stevens & Campion, 1994; Vincent-Lancrin et al., 2019), with validity ranging from 0.000 to 0.087 and a reliability coefficient of 0.893. Furthermore, the moderator variable, the TWM, utilised works by Deci and Ryan (1985; 2020), with a validity range from 0.000 to 0.060 and a reliability coefficient of 0.812. Consequently, it can be concluded that the instrument reliability in this study meets the criteria, while items with validity exceeding the threshold (>0.050) are excluded from further analysis.

3.5. Data Analysis

In further analysis, we utilised social science analysis software, namely SPSS and AMOS for descriptive statistics assessment, and SmartPLS3 to conduct structural model testing to address the hypotheses we developed, following the procedures recommended by Hair et al. (Hair, Sarstedt, et al., 2021). Several procedures, including SPSS, were used to conduct validity and reliability tests on the research instruments. Subsequently, statistical descriptive statistics were employed by utilising AMOS, and the analysis of factor and structural models consisted of three main stages: reflective measurement, formative measurement, and structural analysis employing SmartPLS3 (Hair, Sarstedt, et al., 2021; Sarstedt et al., 2021).

4. RESULTS

4.1. Descriptive Statistics Assessment of Latent Variable

In this section, we present descriptions of latent variables, namely CRT, COM, COL, CRE, TWM, and TWA, measured regarding skewness, c.r, and kurtosis aspects using AMOS 25 software as an analytical tool. The standards for each aspect are as follows: the skewness value should be less than or equal to 1, the c.r should be less than 8, and the kurtosis should fall within the range of -10 to 10 (Collier, 2020).

Table 2: Descriptive Assessment of CRT, COM, COL, CRE, TWM, and TWA.

Variable Items	min	max	skew	c.r.	kurtosis	c.r.
TWA6	2	5	0.588	2.958	0.489	1.230
TWA5	2	5	0.472	2.374	0.159	0.401
TWA4	2	5	0.454	2.287	-0.032	-0.082
TWA3	2	5	0.360	1.812	0.267	0.671
TWA2	2	5	0.596	3.000	0.343	0.863
TWA1	2	5	0.583	2.932	0.223	0.561
TWM5	2	5	0.452	2.273	-0.150	-0.378
TWM4	2	5	0.342	1.720	-0.191	-0.480
TWM3	2	5	0.434	2.183	-0.064	-0.161
TWM2	2	5	0.749	3.771	0.174	0.438
TWM1	2	5	0.613	3.083	0.104	0.261
CRE1	1	5	0.180	0.903	0.127	0.318
CRE2	2	5	0.384	1.933	-0.073	-0.184
CRE3	1	5	0.136	0.684	0.373	0.94
CRE4	2	5	0.360	1.811	-0.154	-0.388
CRE5	1	5	0.119	0.600	0.100	0.252
COL1	2	5	0.464	2.337	-0.091	-0.228
COL2	2	5	0.473	2.383	-0.350	-0.881
COL3	2	5	0.391	1.968	-0.518	-1.303
COL4	2	5	0.277	1.395	-0.532	-1.339

COL5	2	5	0.264	1.327	-0.636	-1.600
COM6	2	5	0.369	1.859	-0.166	-0.419
COM5	2	5	0.413	2.077	-0.120	-0.301
COM4	2	5	0.211	1.061	-0.462	-1.162
COM3	2	5	0.304	1.529	-0.332	-0.837
COM2	2	5	0.443	2.228	-0.208	-0.522
COM1	2	5	0.430	2.163	-0.066	-0.165
CRT5	2	5	0.365	1.835	-0.445	-1.120
CRT4	2	5	0.276	1.388	-0.463	-1.164
CRT3	2	5	0.352	1.772	-0.336	-0.847
CRT2	2	5	0.438	2.204	-0.207	-0.522
CRT1	2	5	0.408	2.052	-0.046	-0.115
Multivariate					153.949	20.344

Table 2 shows that the highest skewness value among all variables under investigation is 0.749, less than 1. Additionally, the highest c.r. value is 3, which is less than 8. Finally, the kurtosis value falls between -0.032 and 0.489, indicating a range between -10 and 10. Therefore, the achievement of standard values, as referred to by Collier (Collier, 2020). The data's acceptable normality and compliance with existing standards are demonstrated in these three aspects.

4.2. Convergent Validity, Reliability, and VIF Assessment of Latent Variable

The measurement of validity, reliability, and collinearity in this section is conducted to assess the validity and consistency of the indicators and the uniqueness of each variable under investigation.

Table 3: Loading factor, AVE, C.R, and collinearity assessment of CRT, COM, COL, CRE, TWM, and TWA.

Latent Variable	Items	Loading Factor	Cronbach's Alpha	C.R	AVE	VIF
CRT (Paul & Elder, 2022)	I can complete tasks based on valid guidelines (CRT1)	0.868	0.919	0.939	0.756	2.705
	I can teach according to relevant and valid content material (CRT2)	0.852				2.509
	I am active in searching primary references like research findings to make decisions in my responsibility (CRT3)	0.887				3.110
	I can understand each student's abilities based on assessment data (CRT4)	0.875				2.964
	I can provide solutions to address school issues based on data (CRT5)	0.863				2.670
COM (Cambridge Univeristy, 2020)	I use clear language with my interlocutors (COM1)	0.879	0.921	0.938	0.716	5.187
	I deliver material to students effectively and efficiently (COM2)	0.786				2.427
	I am confident in conveying ideas both inside and outside the classroom (COM3)	0.901				4.796
	I am active in expressing ideas in a forum (COM4)	0.834				2.318
	I deliver material according to the Lesson Plan (RPP) in the classroom (COM5)	0.834				3.279
	I express opinions clearly with students and colleagues (COM6)	0.840				4.142
COL (Stevens & Campion, 1994)	I can work responsibly with colleagues (peers) (COL1)	0.875	0.918	0.938	0.754	2.881
	I can respect the different perspectives of others when working in groups (COL2)	0.867				2.856
	I am confident in establishing relationships with various external parties (COL3)	0.899				3.499
	I can compromise with external parties to achieve pre-set goals (COL4)	0.908				3.582
	I am actively collaborating with teachers in outside parties of school (COL5)	0.787				2.213
CRE (Vincent-Lancrin et al., 2019)	I can present creative ideas practically (CRE1)	0.710	0.885	0.912	0.678	1.364
	I can innovate based on existing knowledge (CRE2)	0.899				6.018
	I can creatively contribute to new work situations (CRE3)	0.881				5.691

	I can turn passive work situations into active ones (CRE4)	0.900				7.344
	I can create new learning strategies creatively (CRE5)	0.702				1.818
TWM (Deci & Ryan, 1985; Ryan & Deci, 2020)	I am enthusiastic about participating in workshops to develop my skills (TWM1)	0.800	0.904	0.929	0.723	1.932
	I feel confident because I can complete tasks with quality (TWM2)	0.836				2.228
	I am enthusiastic about actively carrying out tasks in school extracurricular activities (TWM3)	0.882				3.992
	I am enthusiastic to working when positive contributions are appreciated for the efforts I made (TWM4)	0.875				2.818
	I am enthusiastic about working more when supported in participating in scientific/academic activities (TWM5)	0.856				3.402
TWA (Danielson, 2007)	I can execute tasks very competently (TWA1)	0.836	0.897	0.921	0.660	3.729
	I have a deep understanding of the subjects I teach (TWA2)	0.841				3.889
	I am proactively providing innovative ideas to enhance teaching methods at school (TWA3)	0.809				2.236
	I can find solutions to problems calmly (TWA4)	0.820				2.207
	I can maintain good relations with superiors at school by maintaining ethics in interacting with them (TWA5)	0.764				3.161
	I instil a high dedication to time discipline (TWA6)	0.803				3.172

Convergent validity can be assessed using the AVE, which should be greater than 0.5 (Hair, Hult, et al., 2021). Indicator consistency refers to indicator reliability via outer loading values and internal consistency via Cronbach's alpha and composite reliability, all of which should be greater than 0.70 (Hair, Hult, et al., 2021; Sarstedt et al., 2021). Additionally, uniqueness is assessed using the VIF (Variance Inflation Factor), which should be less than 5/10 (Hair, Hult, et al., 2021).

Table 3 indicates that all aspects of measurement standards meet the criteria. This is evidenced by the values of each indicator's outer loading ranging from 0.702 to 0.908, all greater than 0.7. Furthermore, the Cronbach's alpha values range from 0.885 to 0.921, and the C.R values range from 0.912 to 0.939, all of which are also greater than 0.7. The AVE values range from 0.660 to the highest, all greater than 0.5. Lastly, the VIF values show that almost all variables are less than 5, except for two items that show values above 5, namely 6.018 and 7.344. However, these are still acceptable as they are less than 10. Thus, it can be concluded that the variables under investigation exhibit validity, consistency, and uniqueness that meet the requirements specified for further analysis.

4.3. Discriminant Validity

Besides VIF, discriminant validity is conducted to measure the extent to which a construct truly differs from other constructs based on empirical standards so that one construct captures phenomena not represented by other constructs in the model we built using the Fornell-Larcker criterion and the Heterotrait-Monotrait Ratio (HTMT) (Hair, Hult, et al., 2021). According to the Fornell-Larcker criterion, the square root of the Average Variance Extracted (AVE) for each construct should be greater than the correlations between that construct and all other constructs in the model (Fornell & Larcker, 1981).

Table 4: Fornell-Larcker Criterion Assessment.

	COL	COM	CRE	CRT	TWA	TWM
COL	0.868					
COM	0.218	0.846				
CRE	0.104	-0.068	0.823			
CRT	0.281	0.190	0.230	0.869		
TWA	0.339	0.262	0.216	0.722	0.812	
TWM	0.305	0.181	0.281	0.724	0.776	0.850

Table 4 shows that the coefficients of the reflective measurement model are lower than their square-root coefficients when correlated with other constructs. This suggests that the constructs of CRT, COM, COL, CRE, TWM, and TWA are unique, as their correlations with other constructs do not exceed their respective square roots.

Table 5: HTMT Assessment.

	COL	COM	CRE	CRT	TWA	TWM
COL						
COM	0.234					
CRE	0.123	0.152				
CRT	0.306	0.193	0.218			
TWA	0.364	0.280	0.205	0.787		
TWM	0.330	0.184	0.265	0.792	0.856	

The HTMT measurement, which has a good fit when ≤ 0.90, implies that a specific construct is more related to its indicators than to indicators of other

constructs (Hair, Hult, et al., 2021). Table 5 shows that the HTMT values are all less than 0.90. Thus, it can be concluded that the constructs we have developed, namely CRT, COM, COL, CRE, TWM, and TWA, are within their respective arenas.

4.4. Structural Model Assessment of Latent Variable

Most outcomes from the model, especially the saturated model, as shown in Table 6 and Figure 1, meet the criteria specified by the estimated model. This implies that the model utilised in this study is in good accordance with the data available in the field (Henseler & Sarstedt, 2013). Consequently, further bootstrapping analysis could be conducted to explore relationships among variables with greater confidence in the model's suitability.

Table 6. Fit Model Assessment of CRT, COM, COL, CRE, TWM, and TWA.

	Saturated Model	Estimated Model	Model Fitness Decision
SRMR	0.066	< 0.10	Good Model
D_ULS	2.305	> 0.05	Good Model
d_G	1.314	> 0.06	Good Model
Chi-Square	1006.492	< 3.00	Marginal Fit Model
NFI	0.769	> 0.80	Marginal Fit Model

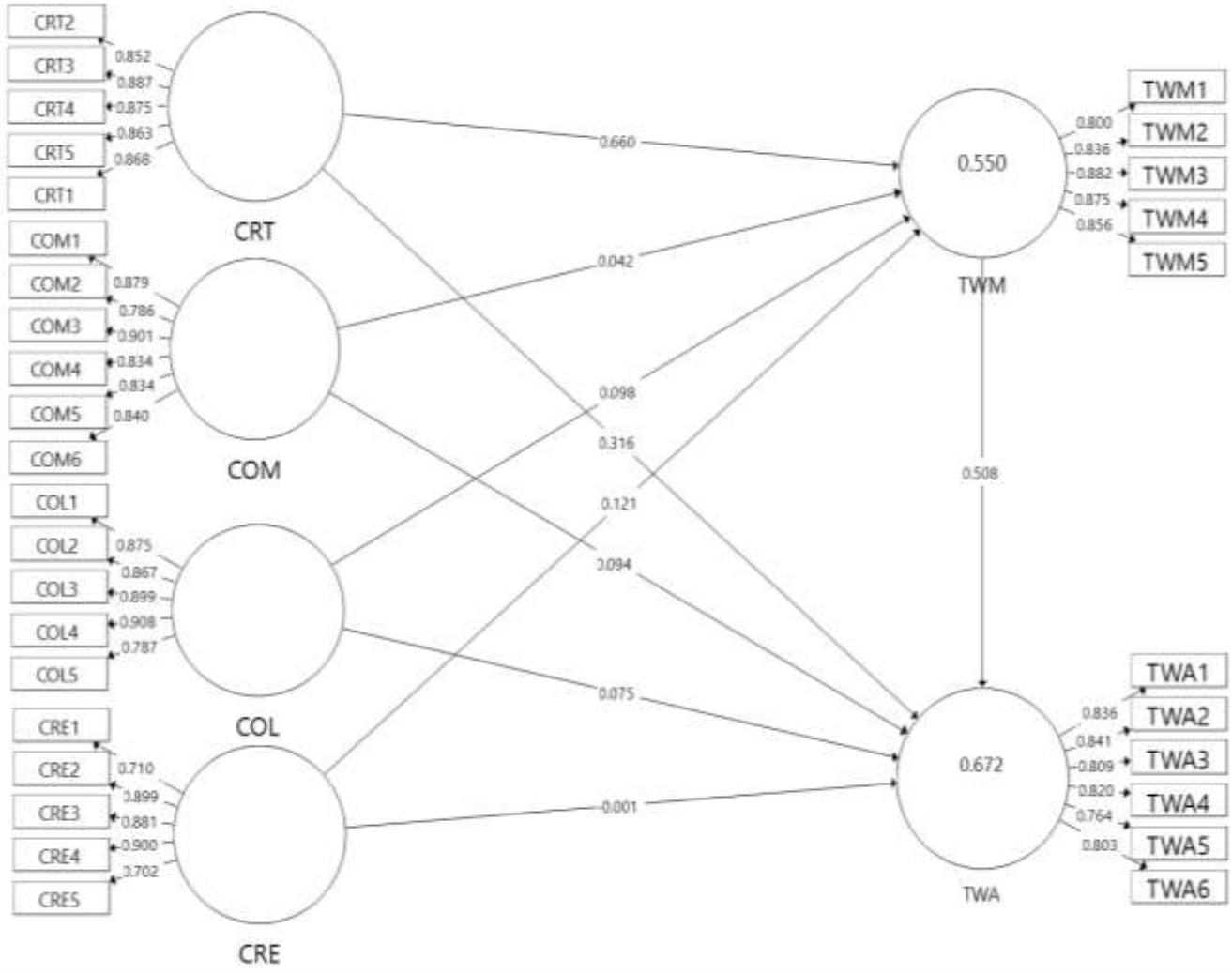

Figure 1. The result of the structural model.

4.5. Hypotheses Assessment of Latent Variable

To decide whether there is a direct or indirect influence based on p-values, they should be less than 0.05, and T-statistics are typically greater than 1.96 (Hair, Hult, et al., 2021).

Table 7: Hypotheses Summary of CRT, COM, COL, CRE, TWM, and TW

Hypotheses	Path	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Sig.
H1	CRT -> TWM	0.655	0.05	13.167	0.000	Yes
H2	COM -> TWM	0.046	0.055	0.776	0.219	No
H3	COL -> TWM	0.095	0.052	1.885	0.030	Yes
H4	CRE -> TWM	0.132	0.066	1.849	0.033	Yes
H5	CRT -> TWA	0.305	0.084	3.768	0.000	Yes
H6	COM -> TWA	0.095	0.052	1.816	0.035	Yes
H7	COL -> TWA	0.075	0.053	1.419	0.078	No
H8	CRE -> TWA	0.003	0.054	0.015	0.494	No
H9	TWM -> TWA	0.518	0.089	5.693	0.000	Yes
H10	CRT -> TWM -> TWA	0.341	0.070	4.784	0.000	Yes
H11	COM -> TWM -> TWA	0.025	0.030	0.723	0.235	No
H12	COL -> TWM -> TWA	0.049	0.029	1.742	0.041	Yes
H13	CRE -> TWM -> TWA	0.067	0.034	1.836	0.033	Yes

Based on Table 7, it can be interpreted that there are nine hypotheses where the null hypothesis (H0) is rejected, and four of them are accepted based on the obtained p-values. Although COM does not influence TWM directly, the skills of teachers in Critical Thinking (CRT), Collaboration (COL), and Creativity (CRE) have a direct influence on Teacher Work Motivation (TWM). Similarly, Critical Thinking (CRT) and Communication (COM) directly influence Teacher Work Achievement (TWA). Meanwhile, the teacher's COL skill does not influence TWA. Furthermore, TWM directly influences TWA. Finally, the indirect relationships indicate that Critical Thinking (CRT), Collaboration (COL), and Creativity (CRE) influence Teacher Work Achievement (TWA) through the mediation of Teacher Work Motivation (TWM). However, Communication (COM) does not mediate significantly through TWM. The relationships among these variables will be discussed further in subsequent sections with implications for practical fields and future research.

5. DISCUSSION

This study examined the relationships between teachers' 4C skills (critical thinking, communication, collaboration, and creativity), work motivation, and work achievement in rural Indonesian schools. The findings reveal a complex pattern of direct and indirect relationships that both support and challenge existing theoretical frameworks, with significant implications for understanding how 21st-century skills operate in resource-constrained educational environments.

5.1 Direct Effects of 4C Skills on Work Motivation and Achievement

Critical thinking demonstrated the strongest influence on both teacher work motivation ($\beta = 0.655$, $p < 0.001$) and work achievement ($\beta = 0.305$, $p < 0.001$), strongly supporting H1 and H5. This result is consistent with our previous statement that teachers with critical thinking skills are more prepared to identify problems in the learning process and then formulate effective solutions. This substantial effect aligns with self-determination theory's competence dimension, as teachers who can complete tasks based on valid guidelines, actively search for primary research findings, and understand student abilities through assessment data experience enhanced professional confidence (Audrin & Hascoët, 2024; Beltman & Poulton, 2025). The dual impact of critical thinking on motivation and achievement creates a virtuous cycle in which enhanced analytical capabilities lead to greater perceived competence, fostering higher intrinsic motivation and, in turn, improving instructional effectiveness through better pedagogical decision-making. The magnitude of this relationship suggests that critical thinking is a foundational skill that shapes teachers' motivational states by equipping them with sophisticated problem-solving capabilities that directly address the required competence. Therefore, policymakers should establish critical thinking as a core competency requirement in teacher certification programs and allocate dedicated funding for sustained professional development initiatives, as demonstrated by Leibovitch et al. (2025) who found that teachers' adaptive beliefs about critical thinking developed significantly during a 12-month professional learning program that included foundational workshops and guided action research cycles, with teachers reporting enhanced student engagement and academic outcomes. School

principals should implement systematic critical thinking coaching programs using structured planning tools, while professional development coordinators should create feedback systems that help teachers connect their analytical skills to increased motivation levels through evidence-based reflection practices, supported by research showing that critical thinking development significantly enhances student learning outcomes through better instructional decisions (Ammar et al., 2024; Lee et al., 2024; Okolie et al., 2022).

Communication skills presented contrasting patterns across motivation and achievement outcomes. Contrary to theoretical expectations, communication skills did not significantly predict work motivation ($\beta = 0.046$, $p = 0.219$), rejecting H2, yet significantly influenced work achievement ($\beta = 0.095$, $p = 0.035$), supporting H6. This unexpected finding challenges the assumption that communication directly enhances satisfaction with relatedness in rural contexts. While previous research by Samsudin et al. (2025) emphasised the role of communication in fostering positive relationships, the rural setting may limit opportunities for diverse stakeholder interactions that typically strengthen relatedness. Rural teachers often face isolated working conditions and limited parental engagement due to lower education levels and fewer professional networking opportunities, which can reduce the motivational impact of communication skills compared to urban environments, where diverse professional interactions are more frequent. However, the significant achievement effects align with research by Moghtader and Aziz (2019) and Sulaiman and Ismail (2020), demonstrating that effective communication directly enhances instructional delivery and classroom management effectiveness. The pattern suggests that communication operates through performance-oriented pathways rather than motivational enhancement—teachers with strong communication abilities can deliver material more effectively, convey ideas confidently, and express opinions clearly with students and colleagues, directly improving their instructional outcomes regardless of motivational states. Hence, communication training in rural areas should prioritise infrastructure and professional networking over attempts to boost motivation, and be supported by investment in technology that enables meaningful professional connections. Communication skills assessment tools should focus on evaluating instructional delivery effectiveness, supported by funding for practical classroom application training, with regular training targeting clear instruction and professional interactions, as evidenced by Andersson et al. (2022) who showed that enhancing teachers' communication skills improves instructional delivery and student understanding, while Brinia et al. (2022) found that teachers' satisfaction with communication within their work environment is linked to perceptions of institutional effectiveness, suggesting that effective communication systems are crucial for the overall functioning and success of educational organizations, which can be applied into the context of teaching effectiveness.

Collaboration skills significantly influenced work motivation ($\beta = 0.095$, $p = 0.030$), supporting H3, but surprisingly did not significantly predict work achievement ($\beta = 0.075$, $p = 0.078$), rejecting H7. This finding aligns with SDT's relatedness dimension, as teachers who can work responsibly with colleagues, respect different perspectives, and establish relationships with external parties experience enhanced motivation through strengthened professional connections (Vangrieken et al., 2015). The modest effect size suggests that while collaboration enhances motivation, its impact may be limited in rural contexts, where opportunities for meaningful professional collaboration are constrained by geographical isolation and resource limitations. However, the lack of direct achievement effects contradicts previous research by Cravens and Hunter (2021) and Gamboa (2023) that demonstrated positive collaboration-performance relationships, reflecting rural schools' structural limitations where collaborative practices face barriers, including multi-grade classrooms, limited professional learning communities, and reduced opportunities for practice sharing with external partners. In such contexts, collaboration may enhance teachers' sense of connectedness and motivation without translating into measurable performance improvements due to environmental constraints that prevent effective collaborative implementation. Building on this, collaboration policies should include incentives such as professional development hours or salary increases, as well as inter-school grants to support joint projects and reduce rural isolation. Sustained collaborative initiatives can transform informal collaboration into systematic practice, as shown by Díaz-Sacco and Muñoz-Salinas (2024) in their study of Chilean teachers, with structured collaboration time, weekly team planning sessions, and facilitated processes for problem-solving and reflection being essential, while addressing structural barriers through resources for infrastructure and clear performance measurement systems (Bouchrika,

2025).

Creativity significantly influenced work motivation (β = 0.132, p = 0.033), supporting H4, but did not significantly predict work achievement (β = 0.003, p = 0.494), rejecting H8. This finding supports SDT's autonomy and competence dimensions, as teachers who can present creative ideas practically, innovate based on existing knowledge, and transform passive situations into active ones experience enhanced motivation through professional agency satisfaction (Beghetto & Kaufman, 2014). The relationship suggests that creative capabilities provide teachers with a sense of professional autonomy and innovative capacity that directly enhances their intrinsic motivation, even in resource-constrained environments. Creativity enhances intrinsic motivation by positively influencing teachers' well-being and mood, which in turn supports innovative thinking and professional fulfilment, as supported by previous studies showing that creativity is linked to higher well-being and can transform both positive and negative moods into creative energy, helping teachers maintain motivation even during challenging times and conditions (Bledow et al., 2024; Fiori et al., 2022). However, the lack of achievement effects contradicts research by Serang et al. (2023), which demonstrated that creativity positively impacts teacher performance. This discrepancy may reflect the structural constraints of rural contexts, where traditional teaching expectations, limited resources, and cultural resistance to educational innovation prevent creative expression from translating into measurable performance outcomes. Rural teachers may develop creative capabilities that enhance their sense of autonomy and motivation, but environmental factors constrain their ability to implement innovative approaches effectively, thereby limiting the direct impact of creativity on performance. Therefore, creativity assessment tools should be designed to capture rural-specific creative outcomes while addressing cultural barriers that hinder implementation, with support systems needed to help teachers translate creative ideas into measurable improvements through practical workshops that guide instructors in turning creative concepts into effective teaching strategies with clear student outcomes, as research on STEAM professional development shows that sustained creativity training improves results when paired with proper evaluation methods (W. Han & Abdrahim, 2023).

5.2 Indirect Effects: Mediation of Work Motivation

The mediation analysis revealed sophisticated pathways through which 4C skills influence achievement, providing insights into the psychological mechanisms underlying skill-performance relationships in rural educational contexts. Work motivation significantly predicted work achievement (β = 0.518, p < 0.001), strongly supporting H9 and reinforcing the well-established motivation-performance relationship in educational contexts, supporting recent research by Richter et al. (2025) and Layek and Koodamara (2024). This substantial effect demonstrates that motivated teachers, regardless of context, demonstrate higher levels of persistence, engagement, and effort that translate into superior performance outcomes, validating SDT's premise that when teachers experience enhanced motivation through need satisfaction, they are more likely to engage in continuous professional development and maintain high instructional standards even in challenging rural environments.

Work motivation significantly mediated the critical thinking-achievement relationship (β = 0.341, p < 0.001), supporting H10. This substantial mediation effect, combined with the strong direct effects previously discussed, confirms critical thinking's unique dual-pathway operation. Beyond its direct impact on instructional decision-making, critical thinking enhances teachers' sense of professional competence, motivating deeper engagement in their work and creating a reinforcing cycle of improved performance. This comprehensive operation distinguishes critical thinking from other 4C skills. Policymakers should design integrated professional development programs that capitalise on both pathways, while school administrators should establish feedback systems helping teachers recognise how their analytical capabilities simultaneously enhance both their confidence and effectiveness (Leibovitch et al., 2025). On the contrary, work motivation did not significantly mediate the communication-achievement relationship (β = 0.025, p = 0.235), rejecting H11. This finding reinforces the mechanical nature of communication's operation identified in the direct effects analysis. Unlike skills that operate by satisfying psychological needs, communication functions purely through operational efficiency—immediately improving instructional delivery and classroom management without psychological intermediation. This confirms that communication training should emphasise technical skill development and immediate application rather than

motivational enhancement approaches (De Nobile & Bilgin, 2022).

Work motivation significantly mediated the collaboration-achievement relationship (β = 0.049, p = 0.041), supporting H12. Given collaboration's lack of direct achievement effects, this mediation reveals that collaboration operates exclusively through motivational pathways in rural contexts. The relatedness satisfaction derived from collaborative experiences translates into motivation, which then drives improved performance. This exclusively psychological operation contrasts sharply with communication's purely mechanical function and requires collaborative structures designed primarily to enhance motivation rather than to achieve immediate performance gains (Díaz-Sacco & Muñoz-Salinas, 2024). Similarly, work motivation significantly mediated the creativity-achievement relationship (β = 0.067, p = 0.033), supporting H13. As with collaboration, the lack of direct achievement effects, combined with significant mediation, indicates exclusive operation through motivational pathways. Creative capabilities serve as motivational resources by enhancing autonomy and competence satisfaction, which subsequently drives performance improvement. This psychological-only operation necessitates creativity programs focused on professional agency and intrinsic motivation rather than direct instructional innovation (Dogbe et al., 2024; Zhou & Peng, 2025).

6. IMPLICATION

These findings have important theoretical, practical, and research implications. Theoretically, they extend Self-Determination Theory by demonstrating that each 4C skill fulfils psychological needs through distinct mechanisms: critical thinking enhances competence via both performance and motivational pathways; collaboration fosters relatedness through motivational mechanisms; creativity supports autonomy via motivational mediation; while communication functions outside SDT through purely mechanical performance enhancement. Consequently, this challenges the universality of SDT and supports contextual moderation theory, emphasising that rural environments redirect the effects of skill toward motivational mediation, necessitating context-specific models of teacher competency. In practice, this necessitates a shift from uniform 4C training toward differentiated professional development tailored to each skill's function: critical thinking programs should integrate motivational components; communication training should focus on technical execution and immediate classroom use; and collaboration and creativity initiatives should prioritise teacher well-being and retention over direct performance gains. Moreover, rural education policy should position critical thinking as the foundational competency, invest in communication infrastructure to mitigate isolation, and treat collaboration and creativity as essential to motivation and sustainability. Accordingly, future research should examine how these skill mechanisms evolve over the course of teaching careers, whether observed patterns hold across contexts, and how differentiated development models compare with traditional ones. Furthermore, new assessment tools are required to capture rural-specific manifestations and the motivational value of skills often overlooked by performance-centric evaluations.

7. LIMITATION

This study is subject to several limitations that may affect the interpretation and generalizability of its findings. Methodologically, the cross-sectional design precludes causal inference, as simultaneous measurement precludes confirmation of the temporal ordering among 4C skills, motivation, and achievement. Additionally, reliance on self-reported data introduces potential common method bias, with responses possibly shaped by social desirability or self-enhancement tendencies. Although purposive sampling effectively targeted rural Indonesian teachers, it limits representativeness and may skew results toward more motivated participants. Contextually, the study's focus on six schools in Malang Regency constrains transferability, as rural educational environments vary significantly across regions and cultures; Indonesian-specific factors—such as hierarchical school structures, collectivist norms, and resource limitations—may influence skill enactment differently than in other global settings. Furthermore, measurement tools adapted from broader contexts may inadequately capture rural-specific manifestations of collaboration and creativity, while conventional achievement indicators may overlook contextually relevant outcomes such as cultural responsiveness or community engagement. Analytically, the exclusive use of quantitative methods restricts deeper exploration of underlying mechanisms and omits rich contextual insights. At the same time, the absence of objective performance data weakens the validation of self-reported outcomes. Additionally, the mediation analysis remains correlational rather than causal, leaving alternative explanations unaddressed. The study's scope is also limited by its

focus on individual-level variables, its neglect of systemic factors such as school leadership, policy support, and community dynamics, and its exclusion of novice teachers, which limits understanding of developmental trajectories across career stages. Nevertheless, these limitations underscore the need for future research employing longitudinal, mixed-method, and cross-context designs to deepen understanding of how 4C skills function within rural educational systems and to refine measurement tools that capture both performance and motivational dimensions of teacher effectiveness.

8. CONCLUSION

This study investigated the relationships between teachers' 4C skills, work motivation, and work achievement in rural Indonesian schools, uncovering three distinct operational mechanisms that challenge the universality of 21st-century skills frameworks. Critical thinking emerged as a comprehensive skill, enhancing both motivation and achievement through dual pathways that support professional growth. Communication showed a mechanical function, improving instructional performance without motivational influence. In contrast, collaboration and creativity acted as psychological competencies, boosting intrinsic motivation, professional identity, and well-being, especially in environments where structural barriers hinder direct performance outcomes. These findings highlight the need for differentiated professional development aligned with each skill's operational role: integrating motivation into critical-thinking training, focusing on technical effectiveness in communication, and prioritising well-being in collaboration and creativity programmes. The study refines Self-Determination Theory by identifying distinct pathways of psychological need satisfaction, supports contextual moderation theory by illustrating how rural settings shape skill function, and proposes a tripartite framework of comprehensive, mechanical, and psychological competencies. Future research should employ longitudinal and mixed-method approaches, test differentiated development models, and create rural-sensitive assessment tools to better capture the diverse impacts of 4C skills on teacher effectiveness and sustainability in underserved educational contexts.

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