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Rethinking Academic Success in Relation to Teacher Competence, Learning Environment, and Motivation: What Are the Implications for a Posthumanist Research Agenda?

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Abstract

This study examines the relationships between teacher professional competencies (TPC), conducive learning environment (CLE), intrinsic learning motivation (ILM), and academic success (SAS) in International Islamic Boarding Schools through a posthumanist lens. Structural equation modeling of data from 425 11th-grade students revealed that TPC significantly enhances ILM but doesn't directly impact SAS, while CLE directly influences both SAS and ILM. Furthermore, ILM directly affects SAS and mediates between CLE and SAS, but doesn't mediate between TPC and SAS. These findings challenge conventional educational frameworks by suggesting teaching competencies operate as distributed phenomena emerging through human-technology-environment networks rather than direct transmission, while physical spaces function as active pedagogical agents rather than passive containers. Beyond traditional implications for teacher development and supportive environments, the study proposes a posthumanist research agenda exploring how educational processes materialize through entanglements of human and non-human elements within Islamic boarding schools, potentially transforming conceptualizations of teaching and learning in contemporary socio-technical systems. This approach recognizes education as emerging through complex assemblages rather than purely human efforts, offering new directions for research and practice.

Keywords: *Teacher Competence, Intrinsic Motivation, Student Academic Success, Supportive Environment, Posthumanism Perspective, And Structural Model.*

Introduction

The rapid advancement of science and technology has led to significant progress and offered various challenges in every facet of life. To face these challenges, it is necessary to have human

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resources that are not only skilled and competent but also possess strong character and high competitiveness. Education is crucial in this effort, as it aims to enhance intelligence, skills, and personal character (Birhan et al., 2021; González-pérez & Ramírez-montoya, 2022). Boarding schools are dynamic institutions that offer unique educational, social, and cultural benefits, enhancing students' exposure to diverse experiences while focusing on education and character development (Ahmad Maulana Safarudin, 2022; Bass, 2014). However, traditional humanist educational frameworks—centered exclusively on human agency, rationality, and individual achievement—are increasingly insufficient for understanding the complex realities of contemporary learning environments. A posthumanism perspective challenges us to recognize how human educational experiences are fundamentally shaped by and entangled with non-human actors, including technologies, physical environments, and institutional structures (Barad, 2007; Braidotti, 2019).

Islamic boarding schools, known as "Pesantren" in Indonesia, are traditional institutions combining Islamic teachings with general education, playing a pivotal role in shaping students' moral and intellectual growth (Hastasari et al., 2022). Islamic boarding schools have existed for centuries, with their roots deeply embedded in Islamic educational traditions. Historically, these schools have been centers for religious learning, focusing on the memorization and understanding of the Quran and other Islamic texts (Boyle, 2006). These institutions hold a unique and evolving role in shaping Indonesia's education system and Muslim development. Rooted in the Qur'an and Sunnah, they have historically served as ideological bastions and centers of character education, producing intellectual figures and inspiring national education models with a profound legacy in tradition and modernity (Ali, 2023) and have further evolved to integrate general education, balancing religious and worldly knowledge to produce well-rounded intellectual and moral leaders (Firmansyah & Amirudin, 2022).

Although its concept is traditional, some of these school types have been shifted to international quality, where international curricula such as Cambridge and IGCSE are integrated. International Islamic Boarding Schools students benefit from these curricula that meet global education standards, supporting academic and personal growth. From a posthumanist standpoint, these schools represent complex socio-technical systems where human learning is co-constituted through interactions with architectural spaces, technological infrastructures, and institutional temporalities that extend agency beyond purely human actors (Fenwick & Edwards, 2016). Moreover, these schools provide a structured environment with dormitory facilities that enhance social and leadership skills (Zhong et al., 2024). Living away from home and staying in a dormitory and Islamic boarding school environment encourages students to focus on academic and personal goals, self-exploration, and maintaining social relationships (R. S. Gunawan et al., 2024). However, International Islamic boarding schools are navigating complex challenges, including integrating technology, ensuring quality management, and adapting to post-pandemic educational needs. Therefore, it is crucial to focus on innovative solutions based on student perception to maintain their educational standards while fostering an environment supporting religious and general education, particularly for student academic success to face global challenges.

Our theoretical framework draws on several key theories that inform the relationships between our variables. Self-Determination Theory (Deci & Ryan, 1985) provides a foundation for understanding how intrinsic motivation emerges from the fulfillment of psychological needs for autonomy, competence, and relatedness, which are influenced by both teacher competencies and learning environments. Social Cognitive Theory (Bandura & Cervone, 1986) helps explain how

teacher modeling and environmental factors shape student motivation and academic behaviors through observational learning and self-efficacy development. Additionally, Ecological Systems Theory (Bronfenbrenner, 1979) offers a framework for understanding how various environmental layers, from immediate classroom interactions to broader institutional structures, interact to influence student development and academic outcomes.

In general, two categories of factors influence student academic success: internal factors, such as physical and psychological condition, and external factors, such as family influences, school environment, and social factors, like peer interactions and media influence (Prasetyo & Indriyani, 2021; Santoso & Pratiwi, 2023; Slameto, 2015). In this study, we explore the external factors, e.g., teachers' professional competencies and learning environment, and internal factors, e.g., students' intrinsic learning motivation, as a predictor for their academic success. Many previous studies and research have investigated these variables, like the relationship of teacher professional competence (Budirahayu & Saud, 2023; Gimbert et al., 2023; Jeno et al., 2023; König et al., 2021), learning environment (Bonem et al., 2020; Li et al., 2023; Mouratidis et al., 2022; Tian & Shen, 2023), and intrinsic motivation (Li et al., 2023; Meng & Hu, 2023) on student academic performance. Nonetheless, no study explicitly addresses these variable relationships in the context of International Islamic boarding schools, particularly by using the mediate relationship of student intrinsic learning motivation.

Teachers' comprehensive professionalism competencies—pedagogical, personal, social, and professional—are vital for enhancing students' achievement and shaping academic performance, social skills, and moral growth (Jihan et al., 2023; Mubarok, 2024), including their intrinsic motivation (Podungge et al., 2020). In addition, students' perception of their school environment, including its emotional climate and peer interactions, influences their motivation, learning strategies, and engagement—key factors for academic success (Cayubit, 2022; Edgerton & McKechnie, 2023). Nevertheless, studying in International Islamic boarding schools presents challenges, as strict rules—such as waking up at 4 a.m. and adhering to timely congregational prayers—may have led some students to transfer to other schools (Hastasari et al., 2022). These temporal and spatial structures represent non-human forces that actively shape student experiences, highlighting how architectural arrangements, scheduling technologies, and institutional rhythms function as co-educators alongside human teachers (Mulcahy, 2018). Furthermore, living in a boarding school separates students from their family environment, which requires support from institutions. To address these issues, creating a supportive learning environment and having professional teachers will be crucial in reducing student dropout rates. This is because, in a boarding school environment, where students spend most of their time at school, we believe that the role of teachers and the quality of the school environment become increasingly important to increase their intrinsic motivation in learning, leading them to succeed academically.

Given the pivotal role of internal and external factors in addressing the challenges that exist, completing the theory and literature, this research is necessary because it fills a gap by assessing how students perceived teacher professional competencies, supportive and conducive environments, and mediator relationship of learning intrinsic motivation affect their academic success while studying in International Islamic Boarding Schools. Additionally, by adopting elements of posthumanist thinking as its implication, this study begins to map the complex assemblages of human and non-human educational forces that co-produce learning outcomes in these unique institutional contexts. Using structural equation modeling, we aim to better understand how the intersection of these variables, relationship assessment, cultural education,

and practical interventions for student success work together in this unique setting. Practically, our findings could help improve teacher training, school environments, and teaching strategies to boost student performance academically. Finally, this study opens the door for future work on how cultural and contextual factors influence learning in similar schools, such as International Islamic Boarding Schools, while also pointing toward posthumanist directions that recognize the distributed, material, and more-than-human nature of educational processes in these environments.

Literature Review

Student Academic Success (SAS)

Learning achievement refers to the skills and knowledge students gain through their learning experiences. Howard Kingsley (1942) divides learning outcomes into three types: a) skills and habits, b) knowledge and understanding, and c) attitudes and aspirations, all aligned with the curriculum. Skills and habits involve practical abilities and consistent behaviors like problem-solving, knowledge, and understanding, focus on acquiring and applying information, and attitudes and aspirations, shaping values and motivations like a love for learning. In Indonesia's education system, student academic success is based on Bloom's (1956) classification, which includes cognitive, affective, and psychomotor domains. Cognitive domains focus on knowledge and intellectual skills like analysis and problem-solving; affective domains involve emotions, attitudes, and values that drive motivation; and psychomotor domains emphasize physical skills and coordination needed for practical tasks. Islamic boarding schools also use a holistic education approach, covering these domains. While students may face challenges in cognitive understanding, the affective and psychomotor domains thrive due to the structured and supportive environment. Factors like innate ability are also crucial to shaping academic success across all domains (Owan et al., 2022). However, innate ability alone is not enough; it must be complemented by effort and opportunity to realize one's full potential in academic pursuits. Therefore, considering comprehensive factors e.g., internal and external factors, is crucial (Santrock, 2020).

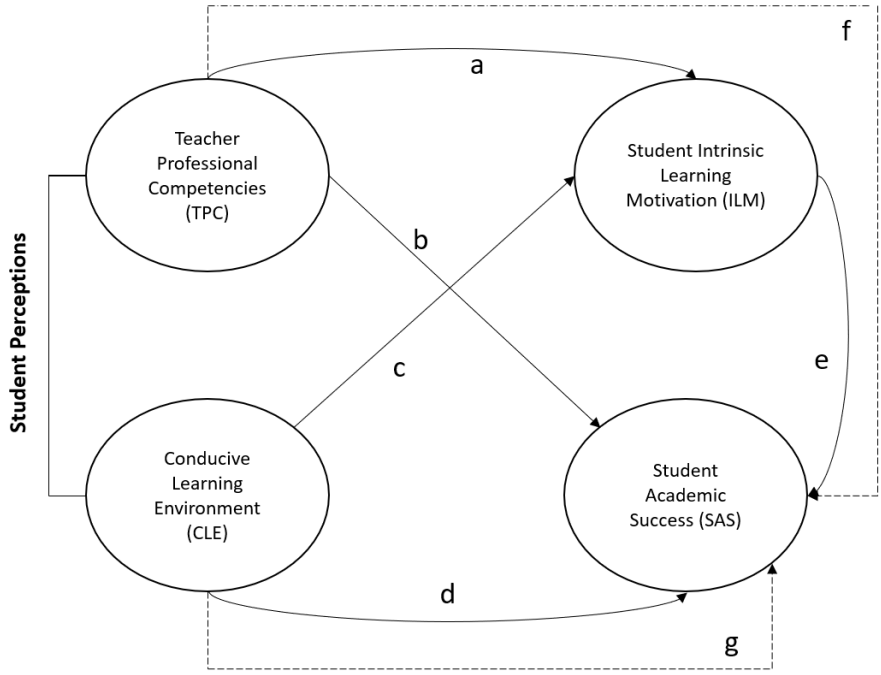

Figure 1. Conceptual Hypotheses Model

From a posthumanist standpoint, academic success can be reconceptualized as emerging not solely from individual human cognition but through complex entanglements with non-human elements (Barad, 2007). The traditional domains of cognitive, affective, and psychomotor achievement might be understood as distributed across human-technology-environment assemblages rather than contained within individual students. For instance, cognitive understanding emerges through students' interactions with digital learning platforms, textbooks, and architectural spaces rather than occurring exclusively "inside" student minds (Fenwick & Edwards, 2016). Similarly, affective domains involve complex emotional engagements with technological interfaces and institutional rhythms that extend beyond purely human feelings. Psychomotor skills develop through embodied intra-actions with material environments rather than through isolated human bodies (Hultman & Taguchi, 2010).

Student academic success in boarding schools is influenced by a combination of internal factors, such as motivation, physical and mental health, and self-efficacy, as well as external factors, including teaching quality (Jihan et al., 2023; Leithwood & Jantzi, 2020; Mubarok, 2024), the school environment (Woolfolk, 2021), and social relationships (Eccles & Roeser, 2021), all of which interact to shape their abilities and academic outcomes. Furthermore, a study found that cognitive performance is assessed through written and oral tests to evaluate students' understanding of the material, which requires teachers' professional competence (G. Gunawan et al., 2023). However, challenges persist as many students struggle to meet the assessment indicators in the cognitive domain (Bahari, 2023). Therefore, it is necessary to investigate further the comprehensive factors that influence students' academic success from their perspectives. The developed hypotheses will be explored in the next section based on this rationale and Figure 1.

Teacher Professional Competencies (TPC)

Teacher professional competence combines knowledge, skills, and behaviors teachers must learn and master to perform their jobs effectively (Mulyasa, 2013; Rasdiana et al., 2023). Mulyasa (2013) outlines a comprehensive set of competencies for professional teachers, including mastery of learning materials, the ability to manage class and learning programs, the use of educational technology, the development of an integrated curriculum, and professional commitment. Mastery of learning materials ensures that teachers deeply understand their subject, enabling them to deliver content clearly and effectively. Effective classroom and learning program management involves creating a structured, engaging environment that supports student learning and fosters positive behavior. In addition, using technology allows teachers to incorporate digital tools to enrich lessons, facilitate interactive learning, and meet the diverse needs of students.

Professional commitment reflects a teacher's dedication to continuous improvement, ethical conduct, and the pursuit of excellence, fostering a positive impact on students and the broader educational community. Similarly, recent literature emphasizes several competencies that teachers must have, including pedagogical content knowledge (Keller-Schneider et al., 2020), professional beliefs and enthusiasm (Moreira et al., 2023), technological competence (Rasdiana, Nurhadi, et al., 2024; Rasdiana, Wiyono, & Imron, 2024; Skantz-Åberg et al., 2022), self-regulation and motivation, and adaptive personal skills and qualities (Caena & Vuorikari, 2022). In the context of Islamic boarding schools, higher-order thinking skills (HOTS) in curriculum integration (Kosasih et al., 2022), technology utilization (Malla et al., 2023), recognition and professional identity as caregivers and moral guardians (Qoyyimah et al., 2023) are the main competencies they must own and develop for student academic success.

From a posthumanist viewpoint, teaching competencies emerge not solely from individual teachers but through complex socio-material networks that include technological systems, institutional structures, and material environments (Fenwick & Edwards, 2016). Teaching expertise might be understood as distributed across human-technology assemblages rather than contained within individual teachers. For example, the ability to manage a classroom effectively emerges through interactions between teacher intentions, architectural arrangements, scheduling technologies, and student behaviors rather than representing a discrete skill possessed by teachers alone (Mulcahy, 2018). Similarly, subject mastery involves entanglements with digital knowledge systems, textbooks, and institutional curricula that extend knowledge beyond individual human minds.

Research has proven that professional teachers who master this set of competencies influence student motivation and their learning experience to succeed academically. According to König et al. (2021) and Budirahayu and Saud (2023), teachers' pedagogical competence can influence cognitive activation, which is an indispensable part of the quality-oriented teaching-learning process for student academic progress—similarly, a study by Gimbert et al. (2023) highlights that teachers' social and emotional skills, such as self-awareness and relationship-building, are essential for student success and suggests that training programs should focus on improving these skills to enhance teaching and school-wide efforts—moreover, Jeno et al. (2023) and Bureau et al (2022) found that teachers with professional competence and support student autonomy positively influence students' motivation, boosting their vitality, reducing their intentions to drop out, and enhancing their academic achievement. Boarding schools, where students may feel isolated from their families, can potentially reduce feelings of homesickness

and improve academic success. In addition, professional teachers can be role models in influencing student success, as teachers who demonstrate professionalism, strong work ethics, and dedication motivate students to emulate these qualities, fostering discipline and commitment (Puspitasari & Setiawan, 2022). Drawing from this literature, two hypotheses can be built (Refer to Figure 1).

(a) H1: Teacher professional competencies directly affect student intrinsic learning motivation

(b) H2: Teacher professional competencies directly affect students' academic success

Conducive Learning Environment (CLE)

The school environment is the physical, social, and psychological setting that supports the learning and development of students, including its buildings, culture, interactions, and educational policies (Sarason, 1990). The physical environment includes the school's infrastructure, such as classrooms and facilities that support learning processes. The social environment covers relationships and interactions, fostering community and belonging. The psychological environment involves the emotional climate, ensuring students feel safe and supported. Finally, school culture and policies shape attitudes and behaviors, promoting inclusivity. A boarding school offers a distinctive environment with comprehensive facilities, such as dormitories, classrooms, sports areas, and recreational spaces, specifically designed to support students' learning, living, and development (Bryan & Peachey, 2017; Uline & Moran, 2020). Dormitory life is typically highly structured, with a strict daily schedule, rules, and supervision from teaching staff or dormitory managers, all aimed at creating a safe, organized environment that supports students' personal growth (Bryan & Peachey, 2017). A conducive school environment in boarding schools can be identified through indicators such as school discipline and organized learning system (Pratiwi et al., 2020), teacher-student relationships, student interactions (Xiao et al., 2023), and adequate school facilities (Berman et al., 2018; Loup, 1997; Sugiyono, 2017; Xiao et al., 2023).

Learning environments are not passive backdrops to human educational activities but active participants in educational processes (Mulcahy, 2018). Architectural spaces, technological infrastructures, and institutional temporalities possess forms of agency that shape educational experiences in ways that exceed human design intentions. For example, classroom arrangements actively structure possible interactions rather than simply containing pre-existing human activities. Similarly, digital learning platforms and scheduling systems actively participate in creating educational temporalities rather than merely organizing human time (Knox, 2016).

Recent research by Bonem et al. (2020), Mouratidis et al. (2022), and Tian and Shen (2023) found that environments supporting student autonomy, like offering help and clear expectations, enhance motivation, satisfaction, course evaluations, and academic success. Similarly, positive teacher-student interactions and relational support are crucial in influencing and maintaining high levels of student motivation and engagement, leading to academic success (Li et al., 2023). In addition, peer interactions, through feedback, play a key role in shaping students' mindsets and academic motivation, with process-focused praise reducing negative motivation and person-focused praise fostering a growth mindset (Zhang et al., 2020). Furthermore, the quality of the learning environment, including school facilities, also influences student motivation, as a well-equipped and supportive setting can boost students' intrinsic drive to learn and academic success (Owoseni et al., 2020; Zhang et al., 2022). Therefore, rooted in this literature, two hypotheses can be established (Refer to Figure 1).

(c) H3: Conducive learning environment directly affects students' intrinsic learning motivation

(d) H4: Conducive learning environment directly affects students' academic success

Students' Intrinsic Learning Motivation (ILM)

Learning motivation is the drive that encourages engagement in the learning process to achieve academic goals, influenced by internal and external factors such as interest, self-confidence, and rewards (Pintrich & De Groot, 1990, 2003). This study explores students' perceptions regarding their intrinsic motivation as a drive to enhance their academic success. Intrinsic motivation, fueled by personal interest and enjoyment, is closely associated with student success and well-being (Howard et al., 2021). Meeting psychological needs—relatedness, competence, and autonomy—is crucial for promoting self-determined motivation, and teacher autonomy support plays a key role in fulfilling these needs and enhancing student motivation (Bureau et al., 2022). Measures key components of intrinsic academic motivation, including interest, enjoyment, and perceived competence (Vo et al., 2021). Similarly, the key indicators of learning motivation, according to Uno (2021), include 1) desire to succeed, 2) drive and need to learn, 3) future aspirations, 4) rewards for effort, and 5) interest in learning activities. Desire to succeed reflects students' ambition to achieve goals and overcome challenges. Drive and need to learn involve the urge to acquire knowledge, while future aspirations inspire viewing education as a path to success. Rewards for effort, whether tangible or intangible, reinforce persistence, and interest in learning activities fosters curiosity and sustained focus, making learning enjoyable and effective.

Traditional educational psychology has located motivation primarily within individual students, treating it as an internal psychological state. Posthumanist perspectives challenge this internalization, suggesting instead that motivation emerges through complex affective networks involving human and non-human elements (Dernikos et al., 2020). Rather than asking whatmotivates students, posthumanist inquiry explores how motivation forms through engagements with technological interfaces, institutional rhythms, and material environments.

Based on previous research, intrinsic motivation is consistently linked to higher academic success and has been shown to predict long-term school success, even when accounting for initial performance levels (Howard et al., 2021; Liu et al., 2020; Rodríguez et al., 2020; Yarin et al., 2022). Furthermore, when students perceived the material interesting and valuable, they are likelier to put more tremendous effort and time into their studies (Li et al., 2023; Rodríguez et al., 2020). These findings related to teacher professional competence. In addition, supportive learning environments that nurture intrinsic motivation, including relational, instructional, and school support, can significantly enhance academic outcomes (Li et al., 2023; Meng & Hu, 2023).

Therefore, student learning intrinsic motivation plays a vital role in directly influencing their academic success and is a significant mediator of teacher professional competence and learning motivation (Du et al., 2023; Karimi & Sotoodeh, 2020). Similarly, a supportive learning environment could affect students' academic success by enhancing their intrinsic learning motivation as a bridge (Shin & Bolkan, 2021; Vergara-Morales & Del Valle, 2021). Although many studies have investigated these variable correlations, limited studies have examined their relationships in the unique context of International Islamic Boarding Schools utilizing a cross-sectional model and viewing student perception in these domains' implementation. Henceforth, building on this literature, the following two hypotheses can be formulated (Refer to Figure 1).

(e) H5: Students' intrinsic motivation directly affects student academic success

(f) H6: Teacher professional competencies indirectly affect students' academic success through students' intrinsic motivation

(g) H7: A conducive learning environment indirectly affects students' academic success through students' intrinsic motivation

Methods

Research Design and Participant

This study employed a cross-sectional research design with structural equation modeling (SEM), which provides a comprehensive snapshot of the population, enabling the identification of patterns and relationships for further exploration. This design allows for direct observation of the phenomena under investigation and data analysis collected at a single point, producing faster results (Wang & Cheng, 2020). The study included 540 students from Malang City International Islamic Boarding Schools: IIBS Arrotri, IIBS Tsiput, IIBS Tamanshur, and IIBS Aliqo'. This study population focused on 11th-grade students who had already implemented the Merdeka Curriculum and had report card grades from three semesters (see Table 1). These grades, from the 1st and 2nd semesters of 10th and 1st semester of 11th grade, were used as indicators for the study.

No	Institutions	Population (Sample)	Total
	IIBS Arrotri	254 (183)	540 (425)
1.	IIBS Tsiput	165 (131)	
2.	IIBS Tamanshur	73 (65)	
3.	IIBS Aliqo'	48 (46)	

Table 1 Research Participants

Source: Author's Investigation

Random sampling was used to select the sample for the research. The sample selection procedure above used the Isaac and Michael table calculation formula with 1%, 5%, and 10% error margins. In this study, we applied a 1% error margin to achieve more precise results (Isaac & Michael, 1971). Based on the calculation in Table 1, with a 1% error margin from 540 students, 425 students were selected as respondents.

While structural equation modeling (SEM) enables the examination of complex relationships between variables, as discussed by Kline (2016) and Byrne (2016), it is important to acknowledge its limitations within our cross-sectional design. Although SEM identifies structural relationships between teacher competencies, learning environment, motivation, and academic success, it cannot definitively establish causality due to the constraints outlined by Schumacker and Lomax (2004)). The single-time measurement of variables makes it impossible to determine the temporal precedence needed for causal inference. Relationships identified represent statistical associations that may be influenced by unmeasured variables or bidirectional effects, as noted by Bollen (1989). Despite these constraints, SEM provides valuable insights into factors affecting student outcomes while recognizing that causal claims would require longitudinal or experimental research designs in future studies.

Instrumentation

The development of instruments in this study is based on the literature framework and previous

research (See supplementary material) emphasizing student perception in the assessed variables. The instrument testing analysis was conducted through the expert judgment phase and pilot study for the actual research analysis. A five-point Likert scale ranging from 1 to 5 (1 = strongly disagree to 5 = strongly agree) was used. Referring to the literature review, we structured and developed the variables into several sub-variables, indicators, and items representing students' perceptions of teacher professional competencies, a conducive learning environment, and intrinsic motivation toward their academic success. The total number of items tested was 102, along with the average student report card scores for semesters 1 to 3.

Teachers' Professional Competence (TPC) is mainly conducted by Mulyasa (2013) and several supporting existing recent literature (Caena & Vuorikari, 2022; Keller-Schneider et al., 2020; Qoyyimah et al., 2023; Rasdiana, Wiyono, Imron, et al., 2024), which consists of 5 sub-variables: mastery of subject matter standards (n = 5 indicators; 7 items), classroom management (n = 5 indicators; 9 items), use of digital media and learning resources (n = 4 indicators; 7 items), role modeling and leadership in teaching (n = 3 indicators; 7 items), and learning programs management (n = 3 indicators; 7 items). Conducive Learning Environment (CLE), fundamentally developed according to Sarason (1990) with supporting literature from Bryan and Peachey (2017) and Uline and Moran (2020) as well as recent research (Berman et al., 2018; Pratiwi et al., 2020; Xiao et al., 2023), which consists of 4 sub-variables: school discipline (n = 2 indicators; 9 items), social interaction (n = 3 indicators; 14 items), and school facilities (n = 1 indicator; 12 items). Intrinsic Learning Motivation (ILM) was primarily developed based on Uno (2021), Pintrich and De Groot (1990, 2003), and recent supporting literature (Li et al., 2023; Rodriguez et al., 2020; Vo et al., 2021) consisting of 4 sub-variables: learning interest (n = 2 indicators; 14 items), learning goals (n = 3 indicators; 9 items), and adaptability (n = 2 indicators; 7 items). Finally, Student Academic Success (SAS), based on Bloom's (1956) as seen from the average student scores over three semesters, classification consists of three sub-variables in the cognitive, affective, and psychomotor domains.

Validity and Reliability of the Instruments

Prior to the actual research analysis, we initially tested the validity and reliability of the instrument according to expert judgment guided by Miller and Lovler (2020), followed by pilot testing using Confirmatory Factor Analysis (CFA) utilizing SPSS v.25. In the expert judgment phase, we thoroughly tested content validity using inter-rater agreement (consisting of two experts in the related field) with an assessment scale ranging from 1 (not relevant) to 4 (strongly relevant) for each item developed. The content validity of the instrument was categorized based on scores: 0.00-0.25 for "Not Relevant (Low Validity)," 0.26-0.50 for "Somewhat Relevant (Moderate Validity)," 0.51-0.75 for "Relevant (High Validity)," and 0.76-1.00 for "Very Relevant (Very High Validity)" (Gregory, 2004). Once content validity was fulfilled, we conducted a practical evaluation of the instrument quality using Cohen's Kappa matrix with a scale range from 0 (unsuitable) to 1 (suitable) in total, consisting of 6 questions: (1) Does the test manual have a comprehensive manual guide?; (2) Is the test easy for respondents to answer?; (3) How clear are the administration's directions?; (4) How clear are the scoring procedures?; (5) Does the sample of respondents have specific qualifications to complete the test?; and (6) Does the test have face-field validity? The Cohen's Kappa scale for practical evaluation is interpreted as follows: scores less than 0.00 indicate "Poor," 0.00 to 0.20 indicate "Slightly Poor," 0.21 to 0.40 indicate "Fair," 0.41 to 0.60 indicate "Moderate," 0.61 to 0.80 indicate "Good," and 0.81 to 1.00 indicate Excellent (Landis & Koch, 1977). Based on the content validity matrix results in Table A1, the instrument validity can be calculated as follows.

$$Expert\ judgement\ index = \frac{D}{A+B+C+D} = \frac{99}{0+0+3+99} = 0{,}97$$

The calculation above resulted in an expert rating coefficient of 0.97, which falls within the 0.76-1.00 range, indicating "excellent." This means that the instrument's content created and developed by the researcher is highly relevant to the measured concept. Furthermore, according to Cohen's Kappa matrix for practical evaluation in Table A2, it can be calculated as follows.

Pr(a) = (5+1)/6= 1

Pr(e) = (5/6) * (5/6) + (1/6) * (1/6) = 0,69 + 0,027 = 0,717

K = Pr (a) – Pr (e)/(1-Pr(e))

= (1 – 0,717)/(1-0,717)

= 0,283/0,283

= 1

Based on Cohen's Kappa calculation, the coefficient of 1, which falls within the 0.81-1.00 range, indicates an excellent category, meaning the instrument developed by the researcher is highly practical, consistent, and reliable. Finally, pilot testing in the field was conducted with 50 students as respondents across MAN 1 Malang, which was considered to have the same characteristics as the measured schools using confirmatory factor analysis (CFA) (Stevens, 2009). Based on Table A3, the instrument shows strong reliability and is well-suited for factor analysis. Most sub-measured variables have high factor loadings, meaning they are closely related to their underlying factors. The KMO values are well above the recommended threshold, confirming that the data is appropriate for analysis (Reddy & Kulshrestha, 2019). The Cronbach's Alpha values also reflect excellent internal consistency, particularly in the TPC domain, which ranges from 0.887 to 0.962, and solid consistency in the CLE and SAS domains. However, one item each in the Learning Goals and Interaction sub-variables under ILM has a lower factor loading, suggesting refinement. Overall, the instrument is reliable and valid, though a few areas could benefit from minor adjustments. Henceforth, the total items included for further analysis is 100, with 3 additional sub-variables in SAS.

Data Collection and Analysis

The research instruments were distributed directly to participants at the selected international Islamic boarding schools, following approval from the local education authority (Dinas Pendidikan Kota Malang) and the principals and vice-principals of the schools. A research intent letter from the State University of Malang was provided in advance. Only 11th-grade students who voluntarily agreed to participate were included in the study. Data were collected between June 14th and August 24th, 2024. After data collection, we analyzed the data using Partial Least Squares Structural Equation Modeling (PLS-SEM) with Smart PLS version 4, as recommended in prior research, due to its ability to handle multiple variables and test theoretical relationships (Hair et al., 2020; Sarstedt & Cheah, 2019; Zeng et al., 2021). Before testing the structural model, we performed Confirmatory Factor Analysis (CFA) using SPSS to validate the measurement

model for the instrument pilot testing (Shrestha, 2021; Watkins, 2020). We then assessed convergent validity (AVE > 0.50), internal consistency (Cronbach's alpha > 0.70), discriminant validity (Fornell-Larcker Criterion) (Fornell & Larcker, 1981), collinearity (VIF <5), and model fit (SRMR ≤ 0.10, d_ULS ≥ 0.05, d_G ≥ 0.05, chi-square ≤ 3.00 or preferably small, and NFI ≥ 0.80) using Smart PLS 4. Once the measurement model met the necessary thresholds, we used bootstrapping to analyze the structural model and test the significance of the path coefficients.

Results

Prior to hypothesis testing, through Smart PLS 3, we conducted a post-assessment of instrument pilot testing concerning convergent validity and internal consistency (Table 2), discriminant validity (Table 3), collinearity assessments (Table 4), and goodness of model fit (Table 5). Table 2 presents the reliability and validity of the constructs based on Cronbach's Alpha and Average Variance Extracted (AVE), meeting the required thresholds. Cronbach's Alpha values range from 0.987 to 0.995, significantly exceeding the threshold of 0.70, demonstrating excellent internal consistency for all constructs. Similarly, the AVE values, ranging from 0.955 to 0.990, are well above the threshold of 0.50, indicating convergent solid validity and confirming that the constructs explain a substantial proportion of the variance in the items. These results suggest that the measurement model is robust, with reliable and valid constructs suitable for further analysis.

	Cronbach's Alpha	**Average Variance Extracted (AVE)**
CLE	0.995	0.955
ILM	0.987	0.986
SAS	0.994	0.989
TPC	0.993	0.990

Table 2 Convergent Validity and Internal Consistency

	CLE	**ILM**	**SAS**	**TPC**
CLE	0.977			
ILM	0.234	0.993		
SAS	0.242	0.187	0.995	
TPC	0.283	0.173	0.153	0.995

Table 3 Fornell-Larcker Criterion

Furthermore, Table 3 confirms that the constructs in the model are distinct, showcasing discriminant solid validity. The diagonal values, which represent the square root of the AVE, are all impressively high (CLE = 0.977, ILM = 0.993, SAS = 0.995, and TPC = 0.995), meaning that each construct strongly relates to its indicators. Compared to the correlations between constructs (ranging from 0.153 to 0.283), these diagonal values stand out as higher, confirming that each construct is more closely tied to its measures than any other construct. For example, CLE's relationship with its items (0.977) is much stronger than its modest correlations with ILM (0.234), SAS (0.242), or TPC (0.283). This pattern is consistent across all constructs, demonstrating that they measure unique aspects of the studied phenomenon.

	CLE	ILM	SAS	TPC
CLE		1.087	1.130	
ILM			1.072	
SAS				
TPC		1.087	1.101	

Table 4 Inner VIF Values for Collinearity Assessment

Finally, the inner Variance Inflation Factor (VIF) values in Table 4 show no multicollinearity issues in the model. All the VIF values are comfortably below the threshold of 5, ranging from 1.072 to 1.130, which means the constructs in the model are not excessively correlated. For example, CLE's VIF values of 1.087 and 1.130 show that other constructs do not overly influence it, and similarly, ILM's VIF of 1.072 and TPC's VIF values of 1.087 and 1.101 are also well within the acceptable range. This low VIF confirms that each construct provides unique and independent insights, ensuring the model's relationships are stable and reliable. Henceforth, all the measurement model criteria have been met, confirming its validity and reliability and indicating that proceeding to the structural model using bootstrapping is suitable.

It is important to interpret these statistical findings considering SEM's analytical limitations. Although our model demonstrates strong measurement properties (high-reliability coefficients, appropriate AVE values, and satisfactory discriminant validity), the identified pathways and relationships represent statistical associations rather than proven causal links.

Structural Model for Hypothesis Testing

After the reliability and validity of the measurement model were confirmed using PLS-SEM, the structural model was assessed, and the hypotheses concerning direct relationships were tested. The findings are presented in Table 5.

	Path Analysis	Original Sample (O)	Sample Mean (M)	T Statistics (|O/STDEV|) > 1.96	P Values (< 0.05)	Total Effects	Decision
H 1	TPC -> ILM	0.116	0.115	2.381	0.000	0.116	Sig.
H 2	TPC -> SAS	0.077	0.076	1.596	0.000	0.092	No
H 3	CLE -> ILM	0.201	0.202	4.010	0.005	0.201	Sig.
H 4	CLE -> SAS	0.190	0.190	3.936	0.018	0.216	Sig.
H 5	ILM -> SAS	0.129	0.131	2.824	0.111	0.129	No
H 6	TPC -> ILM -> SAS	0.015	0.015	1.785	0.098	0.015	No
H 7	CLE -> ILM -> SAS	0.026	0.026	2.285	0.023	0.026	Sig.

Table 5 Hypotheses Testing

Several significant relationships emerge based on the T-statistics and p-values from Table 5. For H1 (TPC -> ILM), the T-statistic of 2.381 and the p-value of 0.000 indicate a strong and significant relationship, confirming that the null hypothesis is rejected. Similarly, H3 (CLE -> ILM) and H4 (CLE -> SAS) show significant relationships, with T-statistics of 4.010 and 3.936, respectively, and p-values of 0.005 and 0.018, supporting these relationships. However, H2 (TPC -> SAS) and H5 (ILM -> SAS) do not meet the criteria for significance (the null hypotheses accepted). The T-statistics for both are below 1.96 (1.596 for TPC -> SAS and 2.824 for ILM -> SAS), and the p-values are higher than the threshold of 0.05, meaning these paths are not statistically significant. The indirect path H6 (TPC -> ILM -> SAS) also does not reach significance, with a T-statistic of 1.785 and a p-value of 0.098, indicating it does not have a significant relationship. Finally, H7 (CLE -> ILM -> SAS) has a T-statistic of 2.285 and a p-value of 0.023, showing that this indirect relationship is significant. Overall, the results suggest that while several direct relationships are significant, some paths, particularly the indirect relationships and the relationship between ILM and SAS, are not supported statistically.

The significant paths observed between variables (TPC -> ILM, CLE -> ILM, CLE -> SAS, and CLE -> ILM -> SAS) indicate meaningful statistical relationships, but the cross-sectional nature of our data means we cannot conclusively determine whether these relationships represent true causal mechanisms. For instance, the significant mediating effect of ILM in the relationship between CLE and SAS (H7) suggests but does not prove that learning environment improvements cause increased motivation, which then causes better academic performance. These statistical relationships provide valuable insights into how these educational factors interact, while acknowledging that establishing definitive causality would require additional longitudinal or experimental approaches in future research.

Discussion

The study's first finding is that students perceived that teacher professional competencies (TPC) have a significant direct relationship on students' intrinsic learning motivation (ILM) **(H1).** This finding indicates that teachers' mastery of subject matter builds student trust and sparks curiosity, while effective classroom management creates a focused and secure atmosphere for learning. In addition, digital media and diverse resources make lessons engaging and relevant, increasing student adaptability and interest. Finally, teachers' role modeling inspires students to pursue meaningful goals, and well-managed learning programs provide clarity and direction, helping students stay motivated. This finding confirmed previous studies (Bureau et al., 2022; Jeno et al., 2023). Besides innate ability, external factors such as teacher professional competencies encompass subject mastery, classroom management, capability in using various digital media and learning processes, managing teaching programs, and leadership skills, which are vital in enhancing students' intrinsic motivation in the learning process (Leithwood & Jantzi, 2020; Owan et al., 2022; Santrock, 2020).

In an International Islamic Boarding School (IIBS), where students face the challenges of being away from home, as stated by Hastasari et al (2022), teachers' professional skills, including their communication strategies, are crucial to keeping students motivated. A teacher's deep knowledge of the subject makes lessons exciting and helps students connect with the material, sparking their curiosity (Usak et al., 2022). Good classroom management creates a safe, focused environment, helping students feel comfortable and reducing stress, which is especially important for students dealing with homesickness (Usak et al., 2022). Teachers skilled in digital

tools and varied teaching methods can make learning more engaging and adaptable, helping students adjust to new learning styles (Rasdiana, Wiyono, Imron, et al., 2024). Well-organized teaching programs help students set clear goals and track their progress. At the same time, strong leadership from teachers provides guidance and emotional support, making students feel valued and motivated to continue learning despite the difficulties of boarding school life. To support these domains, teachers are encouraged to engage in professional development to enhance these skills that motivate students, particularly in the challenging setting of an international Islamic boarding school (Fauzi et al., 2022; Masnawati et al., 2019).

While our analysis shows a significant relationship between teacher professional competencies and students' intrinsic motivation, we should be cautious about claiming a direct causal link. Our cross-sectional data captures these variables at a single point in time, making it difficult to determine if improved teacher competencies actually cause increased student motivation, or if other factors are at play. For example, already-motivated students might perceive their teachers more positively, or unmeasured factors like school culture could influence both variables. To establish true causality, future studies should implement experimental designs where teacher competencies are deliberately enhanced to observe subsequent effects on student motivation over time. Furthermore, future research should reconceptualize teaching competencies as distributed phenomena emerging through human-technology-environment networks rather than individual skills. This calls for studies examining how digital platforms and physical spaces in Islamic boarding schools co-produce what we recognize as "teaching competence," and for developing professional development approaches that acknowledge teaching as a socio-material practice rather than purely human expertise.

The second result found that student perception toward teacher professional competencies (TPC) do not directly affect students' academic success (SAS) **(H2).** This finding highlights the complexity of academic achievement, encompassing cognitive, affective, and psychomotor domains. While TPC lays the foundation for effective teaching and learning, factors such as students' intrinsic learning motivation, external support systems, and hands-on practice likely mediate this relationship. This suggests that academic success depends on a combination of teacher influence, student effort, and broader environmental factors, emphasizing the need for a holistic approach to education. This is inconsistent with prior studies regarding teachers' competence, which is relevant to their cognitive activation in the mastery of subject matter, use of digital media, and effective learning program management (Budirahayu & Saud, 2023; König et al., 2021; Kulakow, 2020).

Besides, teachers' emotional skills, which were investigated by previous studies, were related to their role modeling and leadership in teaching and classroom management is crucial in nurturing student academic performance (Gimbert et al., 2023; Puspitasari & Setiawan, 2022). Furthermore, teachers' emotional and social skills are crucial as leaders and role models because impacting student success in cognitive, psychomotor, and affective areas by showing empathy, self-regulation, and social awareness in implementing Islamic values like patience and respect. These emotional skills help students engage more deeply in their learning and develop practical skills (Li et al., 2023; Zhong et al., 2024). Additionally, emotionally skilled teachers manage the classroom effectively, promoting discipline and trust while guiding students' emotional growth per Islamic principles.

Therefore, one limitation of this approach is that, despite the importance of teachers' professional competence in fostering holistic student development, challenges may arise in ensuring

consistent and effective implementation of these competencies in the context of international Islamic boarding schools. Teachers might struggle with balancing the integration of psychomotor, cognitive, and affective domains while also adhering to national and international curriculum standards, which can sometimes be rigid or not fully aligned with Islamic educational values. Additionally, there may be disparities in teachers' subject knowledge and ability to cater to the diverse needs of students, especially in schools that lack adequate professional development opportunities. As a result, students may not experience the full breadth of intended holistic development, particularly in emotional and character-building aspects, which are crucial for aligning with Islamic values.

Our finding that teacher professional competencies do not directly affect academic success highlights the complexity of educational outcomes. However, this cross-sectional SEM analysis cannot definitively rule out causal connections that might emerge over time or through different pathways. The lack of a significant relationship in our model might be due to timing (effects could appear later), measurement limitations, or the presence of moderating variables not captured in our study. Longitudinal research tracking both teacher competencies and student outcomes over multiple academic terms would provide stronger evidence about whether causal relationships truly don't exist or simply require time to develop. Moreover, we challenge researchers to map non-linear educational pathways where teaching influences learning through complex assemblages rather than direct transmission. Future studies should develop methodologies tracing how teaching effects materialize through technological systems, architectural spaces, and institutional structures that bypass conventional causal models, particularly in Islamic boarding schools where religious and academic domains intersect.

The third result revealed that student perception regarding a conducive learning environment (CLE) significantly influences students' intrinsic learning motivation (ILM) **(H3).** This finding underscores the importance of school discipline, social interaction, and facilities in fostering engagement. A disciplined environment provides structure and security, allowing students to focus on learning. Positive social interactions among peers and teachers create a sense of belonging, encouraging students to invest in their education. Furthermore, well-maintained school facilities offer the resources for engaging and interactive learning, sustaining students' curiosity. This result is persistent with previous research (Bonem et al., 2020; Mouratidis et al., 2022; Tian & Shen, 2023). Although challenges are there, including living in a dormitory and away from family, CLE indicators in IIBS, such as school discipline, provide structure and clarity, reduce distractions, and allow students to focus on learning (Pratiwi et al., 2020). In addition, social interaction helps build a sense of community, offers emotional support, and makes learning more enjoyable through peer connections, as stated by previous studies (Xiao et al., 2023; Zhang et al., 2020). Besides, school facilities were found in past studies to discover that well-equipped classrooms, libraries, and extracurricular spaces enhance the learning experience and encourage students to explore their interests (Owoseni et al., 2020). This discovery ultimately aligned with the fourth finding, which revealed that CLE affects students' academic success, resembling the earlier studies (Eccles & Roeser, 2021; Woolfolk, 2021; Zhang et al., 2020).

Our results suggest that a conducive learning environment influences students' intrinsic motivation, but we should interpret this relationship carefully. Since students contribute to and are affected by their learning environment, the direction of influence could run both ways – motivated students might help create a more positive environment, further enhancing motivation. Our cross-sectional approach cannot disentangle these bidirectional effects.

Experimental studies that systematically modify specific aspects of the learning environment (like introducing new discipline structures or enhancing facilities) would provide stronger evidence of causal influence on student motivation. Also, environmental design should acknowledge physical spaces and technological systems as active pedagogical agents rather than passive containers. Research should investigate how prayer spaces, dormitory arrangements, and digital infrastructures in Islamic boarding schools generate motivational states through material-discursive configurations, shifting from creating "motivating environments" toward cultivating agential spaces that participate in educational engagement.

Similarly, students' perception toward conducive learning environment (CLE), characterized by precise school discipline, positive social interactions, and well-equipped facilities, significantly impacts students' academic success (SAS) **(H4)** in cognitive, psychomotor, and affective areas. Precise discipline helps students focus on mastering academic content, while collaborative learning and peer support enhance cognitive skills like critical thinking and problem-solving. Quality facilities, such as well-equipped classrooms, libraries, and extracurricular spaces, promote psychomotor development through hands-on activities that improve physical coordination and creativity. Positive social interactions and emotional support foster a sense of belonging, boosting students' motivation and emotional engagement with their studies.

While we found a significant pathway from the learning environment to academic success, the nature of our SEM analysis limits causal claims. Students with prior academic success might be placed in more conducive environments, creating a selection effect that our cross-sectional data cannot account for. Additionally, unmeasured variables like family support or student personality might influence environmental perceptions and academic outcomes. Future research using random assignment of students to different environmental conditions (where ethically possible) or tracking environmental changes and subsequent academic performance would strengthen causal inferences about this relationship. Besides, academic achievement should be reconceptualized as emerging through specific environmental arrangements rather than solely from human effort. Future studies should explore how the unique integration of religious and academic spaces in Islamic boarding schools produces distinctive forms of success through human-nonhuman entanglements, leading to assessment frameworks that recognize environments as co-producers rather than contexts for achievement.

Moreover, the fifth hypothesis confirmed that based on their perception, students' intrinsic learning motivation (ILM) directly affects their academic success (SAS) **(H5).** This result emphasizes that motivated students are more engaged, persistent, and self-driven in their learning. Intrinsically motivated students will likely demonstrate better cognitive, affective, and psychomotor outcomes as they approach challenges enthusiastically, develop positive attitudes toward learning, and refine their skills. Prior meta-analysis and research investigations have shown its reliability with this study's finding (Bureau et al., 2022; Howard et al., 2021; Rodríguez et al., 2020; Yarin et al., 2022). In an International Islamic Boarding School (IIBS), students' intrinsic motivation plays a crucial role in their success, especially as they can balance academic, spiritual, and personal growth away from home. When students are motivated by personal interest or a desire for self-improvement, they engage more deeply with their studies, whether in secular subjects or religious learning, leading to better academic success, as founded by Li et al. (2023). This motivation also drives them to participate in physical activities, like sports or spiritual practices, helping them develop coordination, endurance, and a stronger connection to their faith. Emotionally, intrinsic motivation helps students stay positive and resilient, even when facing the challenges of homesickness, by living in a dormitory or adjusting to new social norms.

By staying focused on their growth, students in an IIBS can thrive academically, spiritually, and emotionally despite the challenges of living in a boarding school environment.

Our finding that intrinsic motivation influences academic success aligns with previous research, but our SEM analysis cannot confirm the causal direction with certainty. The relationship between motivation and achievement likely involves reciprocal causation – success may boost motivation just as motivation enhances performance. Without time-sequenced measurements, we cannot determine which comes first. Experimental studies that attempt to enhance intrinsic motivation through specific interventions and then measure subsequent academic performance would provide more substantial evidence for the causal direction proposed in our model. Additionally, motivational theory should shift from individual psychology toward mapping distributed affective networks. Research should explore how motivation emerges through engagements with technological interfaces, religious practices, and institutional rhythms in Islamic boarding schools, developing conceptual frameworks that trace motivational flows across human-nonhuman assemblages rather than locating motivation exclusively within students.

In addition, according to student perception, the sixth study result found that intrinsic learning motivation (ILM) was not a significant mediator in the relationship between teachers' professional competencies (TPC) and students' academic success (SAS) **(H6).** This suggests that while TPC positively impacts students' learning experiences and motivation, it does not directly translate into academic success through ILM alone. Other factors like study habits, self-regulation, and external influences like family support may play a more significant role in bridging the gap between TPC and SAS. This finding challenges the assumption that motivation is the key mediator, highlighting the need for a more nuanced understanding of how various elements contribute to academic achievement. This finding contradicts previous research that suggested intrinsic motivation plays a critical role in bridging teacher competencies and student outcomes (Du et al., 2023; Karimi & Sotoodeh, 2020).

The absence of a significant mediating effect of intrinsic motivation between teacher competencies and academic success is an important finding, but our cross-sectional SEM approach limits definitive conclusions. Complex educational processes often unfold over time, and mediation effects might emerge over more extended periods than our study captured. Additionally, the relationships might involve feedback loops or operate differently for various student subgroups. Future research should develop methodologies capturing how teaching materialises through unexpected configurations in Islamic boarding schools, revealing connections between teaching and learning that traditional variable-based approaches miss by tracing distributed agencies across socio-technical systems.

Finally, on the contrary, students perceived that ILM was found to be a significant bridge to a conducive learning environment (CLE) to students' academic success (SAS) **(H7),** emphasizing the essential role motivation plays in turning a supportive environment into academic achievement. While factors like school discipline, social interaction, and facilities create a foundation for learning, ILM drives students to fully engage, persist through challenges, and actively seek success. This suggests that a positive learning environment alone is insufficient; students' intrinsic motivation unlocks the full potential of the CLE, making it a key factor in determining academic outcomes. This discovery is consistent with previous studies, which emphasized that a supportive learning environment, such as a condition where students feel competent, engaged, and integrated into the academic community, is more likely to develop

intrinsic motivation and ultimately enhance their academic success (Shin & Bolkan, 2021; Vergara-Morales & Del Valle, 2021).

Therefore, environmental design should recognize motivation not as a psychological mediator but as emerging through specific material configurations. Research should investigate how environmental-motivational-achievement assemblages in Islamic boarding schools simultaneously generate engagement and success rather than affecting them sequentially, developing approaches that cultivate socio-material arrangements producing distinctive forms of educational experience.

While our SEM results support motivation as a mediator between learning environment and academic success, establishing true causal mediation requires more than cross-sectional data. The identified pathway suggests but does not prove that environmental improvements cause motivation increases, which then cause better academic performance. Alternative explanations remain possible – for instance, academically successful students might perceive their environment more positively and report higher motivation. Sequential intervention studies that first enhance environmental factors and then measure changes in motivation before tracking academic outcomes would provide more substantial evidence for the causal mediation proposed in our model.

Conclusion

This study reveals seven key insights about student success in International Islamic Boarding Schools while opening pathways for posthumanist research. Teacher professional competencies significantly enhance students' intrinsic motivation but surprisingly don't directly impact academic success, suggesting teaching competencies function as distributed phenomena emerging through human-technology-environment networks rather than direct transmission. The conducive learning environment proves crucial both in fostering intrinsic motivation and directly contributing to academic success, pointing toward conceptualizing physical spaces and technological systems as active pedagogical agents rather than passive containers. While intrinsic motivation directly drives achievement, the absence of mediation between teacher competencies and success, contrasted with the significant mediating role of motivation between environments and success, calls for alternative models beyond linear causal chains. These findings not only emphasize developing effective teaching and supportive environments but invite a posthumanist research agenda recognizing education as emerging through complex entanglements rather than purely human efforts, with International Islamic Boarding Schools—integrating religious traditions, modern curricula, and technologies—offering an exceptionally rich site for exploring these dimensions and potentially transforming educational conceptualizations in contemporary socio-technical systems.

Implication

This study offers significant implications that bridge traditional educational frameworks with posthumanist perspectives. Beyond reinforcing Self-Determination Theory by showing how teacher competencies enhance intrinsic motivation, our findings invite reconceptualization of teaching as distributed phenomena emerging through complex human-technology-environment networks rather than individual skills. This suggests teacher development programs, particularly in International Islamic Boarding Schools (IIBS), should prepare educators to collaborate effectively with technological systems and physical environments as co-educators rather than merely tools. Similarly, our findings on learning environments challenge policy makers to

recognize physical spaces, technological infrastructures, and institutional rhythms as active pedagogical agents that generate motivation and achievement through specific material configurations. Rather than simply creating "supportive environments," schools should cultivate agential spaces that participate directly in educational processes. The surprising absence of direct teacher-to-success pathways, alongside the significant environmental mediation effects, suggests educational policies should move beyond linear causal models toward recognizing education as emerging through complex socio-material assemblages. For IIBS contexts, this means integrating Islamic values not merely as cultural content but as active elements within technological systems and architectural spaces that co-produce distinctive forms of motivation and achievement. Policy initiatives should therefore support innovative approaches to environmental design, technological integration, and assessment practices that acknowledge the distributed nature of educational agency across human and non-human domains, potentially transforming not only student support within these institutions but broader conceptualizations of teaching, learning, and achievement in contemporary educational ecosystems.

Limitation

This study's limitations extend beyond its specific focus on International Islamic Boarding Schools (IIBS). From a posthumanist perspective, our conventional research methodology presents a fundamental limitation by maintaining artificial boundaries between human and non-human educational factors. While valuable for identifying relationships, our variable-based structural equation modeling approach inherently reduces complex educational assemblages to discrete human-centred variables, potentially missing how educational processes emerge through distributed networks of human and non-human actors. Additionally, our reliance on self-reported student perceptions privileges human interpretation while potentially overlooking how technological systems, architectural spaces, and institutional structures actively participate in educational processes beyond human awareness. The cross-sectional design captures only a momentary snapshot of these complex relationships, missing how educational assemblages evolve through ongoing material-discursive intra-actions. Future research should employ mixed-method approaches that can trace educational agency across human-technology-environment networks, potentially including ethnographic observations of socio-material arrangements, analysis of how digital platforms mediate educational relationships, and exploration of how architectural spaces actively structure learning experiences within the unique context of Islamic boarding schools. Such approaches would move beyond identifying what drives student motivation and success toward understanding how these educational phenomena materialise through complex entanglements that conventional research methodologies often render invisible.

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Conflicts of Interest

We want to confirm that we have no financial interests or affiliations with any organization that may have a direct or indirect interest in the subject matter discussed in the manuscript.

Appendices

Table A1 Inter-Rater Agreement of Experts for Content Validity

		Rater 1	
		Not relevant (1-2)	Strongly relevant (3-4)
Rater 2	Not relevant (1-2)	A (0)	B (0)
	Strongly relevant (3-4)	C (3)	D (99)

Note: A: low relevance from experts 1 and 2; B: high relevance from expert 1 and low relevance from expert 2; C: low relevance from expert 1 and high relevance from expert 2; and D: high relevance from both expert 1 and 2.

Table A2 Cohen's Kappa Matrix for Practical Evaluation

		Rater 1		Total
		Suitable	Unsuitable	
Rater 2	Suitable	5	0	5
	Unsuitable	0	1	1
Total		5	1	6

Table A3 Pilot testing in the field of Instrument using CFA SPSS v.25 (n = 102 items and 3 items of SAS)

Measured Variables	Sub-measured variables	Factor loading (>0.50)	KMO (>0.50)	C.A each sub variables	C.A per variables
TPC	Mastery of subject matter standards	0.616 - 0.838	0, 893	0.887	0.962
	Classroom management	0.686 - 0.802	0,925	0.906	
	Use of digital media and learning resources	0.680 - 0.853	0,888	0.878	
	Role modeling and leadership in teaching	0.752 – 0.847	0.898	0.913	

	Learning programs management	0.752 – 0.802	0.890	0.890	
CLE	School discipline	0.597 – 0.783	0.893	0.871	0.951
	Social interaction	0.471 – 0.836	0.922	0.914	
	School facilities	0.473 – 0.839	0.925	0.859	
ILM	Learning interest	0.550 – 0.724	0.836	0.873	0.958
	Learning goals	0.268 – 0.806	0.880	0.832	
	Adaptability	0.600 – 0.790	0.855	0.822	
SAS	Semester 1	0.876	0.717	0.873	
	Semester 2	0.925			0.873
	Semester 3	0.880			

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