A CASE STUDY OF THE IMPACT OF LEARNING SPACE DESIGN ON STUDENT COLLABORATIVE PERFORMANCE AT MINGDE POLYTECHNIC INSTITUTE

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FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF
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This Independent Study Has Been Approved as a Partial Fulfillment of the Requirements for the Degree of Master of Business Administration

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Title: A Case Study of the Impact of Learning Space Design on Student Collaborative Performance at Mingde Polytechnic Institute

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ABSTRACT

In the evolving landscape of higher education, the design of learning environments plays a critical role in shaping how students interact, collaborate, and perform. At Mingde Polytechnic Institute, a vocational institution in China, inconsistencies in group learning outcomes have raised concerns about whether current classroom designs effectively support collaborative learning. This study addressed the question of how learning space design influenced student collaborative performance, drawing on Environmental Psychology Theory to understand the behavioral impact of physical and digital educational environments.

The objectives of this study were to examine the relationship between classroom layout flexibility, availability of collaborative learning zones, access to digital learning tools, and student collaborative performance.

This study adopted a quantitative research design using a structured questionnaire to collect data from 280 full-time second- and third-year undergraduates enrolled in three academic departments. The sample was selected through stratified random sampling to ensure representation across disciplines. The questionnaire consisted of Likert-scale items corresponding to the study variables. Data were collected via an online survey platform and analyzed using descriptive statistics and Pearson correlation analysis.

The findings reveal that all three independent variables have a significant and positive relationship with student collaborative performance. Among them, the availability of collaborative learning zones shows the strongest correlation, followed by access to digital tools and classroom layout flexibility. These results confirm that

students are more likely to engage and perform well in group tasks when supported by adaptable, well-structured, and technology-enabled learning environments.

This study concludes that the physical and digital aspects of the learning environment play a meaningful role in enhancing student collaboration. Institutions should prioritize flexible classroom designs, invest in clearly defined collaborative zones, and ensure effective access and integration of digital learning tools. These recommendations serve as a foundation for improving collaborative learning outcomes and optimizing space planning in vocational education contexts.

Keywords: classroom layout flexibility, collaborative learning zones, digital learning tools, student collaborative performance

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HE YUANQI

DECLARATION

I, HE YUANQI, hereby declare that this Independent Study entitled “A CASE STUDY OF THE IMPACT OF LEARNING SPACE DESIGN ON STUDENT COLLABORATIVE PERFORMANCE AT MINGDE POLYTECHNIC INSTITUTE” is an original work and has never been submitted to any academic institution for a degree.

(HE YUANQI)
Nov 3, 2025

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Chapter 1 Introduction

1.1 Background of the Study

The design of physical learning spaces has become an increasingly significant factor in educational research, particularly in relation to its influence on student engagement and collaboration. As pedagogy continues to evolve toward more student-centered, active learning paradigms, the role of the learning environment has drawn closer attention from both scholars and educational institutions (Zhao & Wang, 2021).

Environmental Psychology Theory posits that human behavior is influenced by the interaction between individuals and their physical surroundings. In the context of education, this theory suggests that spatial design elements such as layout, lighting, seating arrangements, and access to technology can affect students' academic and social behavior (Gifford, 2019). Applying this theory to higher education, the design of learning spaces can be intentionally shaped to support collaboration, peer interaction, and knowledge construction.

In China, the modernization of higher education has placed an increasing emphasis on innovative learning spaces that promote interactive learning experiences. According to Xu and Li (2020), universities that have introduced flexible and technology-integrated classroom designs report improvements in students' group participation and collaborative task outcomes. Similarly, Chen and Zhang (2022) emphasized that well-defined collaborative zones in learning environments contribute to a sense of psychological safety, encouraging students to communicate and co-create more effectively.

The digitalization of education further complicates the relationship between learning space and performance. Digital learning tools such as shared online platforms, interactive whiteboards, and mobile collaboration apps are now integral parts of physical learning environments. As Yang (2023) noted, the integration of digital tools within collaborative zones not only improves communication efficiency but also stimulates cognitive engagement during group tasks. International studies echo similar findings. For instance, Haines et al. (2020) found that student collaboration improved significantly in digitally enhanced, flexible classrooms compared to traditional lecture-based settings.

Despite a growing body of research on learning space design, few studies focus on the combined effects of physical and digital elements within collaborative performance, especially in vocational and polytechnic institutions. Mingde Polytechnic Institute, a rapidly developing technical institution in China, has begun implementing modern classroom designs that integrate collaborative zones and digital resources. This research aims to investigate whether and how these spatial design innovations impact student collaborative performance, contributing to both theoretical discourse and practical guidance for institutional space planning.

1.2 Questions of the Study

In recent years, Mingde Polytechnic Institute has made significant efforts to modernize its teaching environment in response to evolving pedagogical needs and the Ministry of Education's emphasis on collaborative and competency-based learning (Liu & Zhang, 2021). New facilities have been introduced with upgraded classroom infrastructure, including modular desks, open collaboration zones, and integrated digital tools. However, internal assessments and student feedback reports have revealed that despite these investments, student performance in collaborative tasks across disciplines has remained inconsistent. Group projects often lack cohesion, student participation is uneven, and many teams struggle with communication and task integration, particularly in cross-major learning activities (Wang, 2022).

Preliminary focus group interviews with both faculty and students at Mingde Polytechnic suggest that the physical learning environment may not be supporting collaborative behaviors as effectively as intended. For instance, some classrooms, though designed to be flexible, are still arranged in traditional, forward-facing rows that hinder eye contact and spontaneous discussion. Other spaces lack clear boundaries or features that signal "collaborative zones," leading to confusion and underutilization (Chen & Hou, 2020). Additionally, while digital learning tools such as smartboards and shared tablets are available, students report inconsistent access and lack of guidance on how to use them collaboratively (Yan, 2023). These issues highlight a disconnect between space design and actual student behavior.

Environmental Psychology Theory provides a relevant lens for analyzing and addressing these challenges. According to this theory, spatial features can influence cognitive, emotional, and social behaviors in predictable ways (Gifford, 2019). Environments that are perceived as flexible and supportive can reduce stress and

increase social interaction, thereby enhancing collaborative performance (Zhao & Lin, 2020). Therefore, identifying the specific spatial and technological design elements that most effectively facilitate student collaboration becomes essential for improving educational outcomes in such institutions.

1. What is the impact of classroom layout flexibility on student collaborative performance at Mingde Polytechnic Institute?

2. What is the impact of the availability of designated collaborative zones on student collaborative performance at Mingde Polytechnic Institute?

3. What is the impact of access to digital learning tools on student collaborative performance at Mingde Polytechnic Institute?

1.3 Objectives of the Study

1. To examine the relationship between classroom layout flexibility and student collaborative performance at Mingde Polytechnic Institute.
2. To examine the relationship between availability of collaborative zones and student collaborative performance at Mingde Polytechnic Institute.
3. To examine the relationship between access to digital learning tools and student collaborative performance at Mingde Polytechnic Institute.

1.4 Scope of the Study

This study was conducted within the context of Mingde Polytechnic Institute, a vocational higher education institution in China that has recently implemented spatial redesign initiatives aimed at improving collaborative learning outcomes. The focus of the research was limited to undergraduate programs across three departments: Applied Engineering, Digital Media, and Business Management, where collaborative coursework and group-based assessments are frequently utilized. The study specifically investigated how three elements of learning space design—classroom layout flexibility, availability of collaborative zones, and access to digital learning tools—influenced student collaborative performance.

The research was framed within the theoretical perspective of Environmental Psychology, which emphasizes the interaction between physical space and human behavior. The study was quantitative in nature and employed a survey questionnaire targeting full-time second- and third-year students, as they are more likely to have experienced both traditional and redesigned learning spaces. Data collection was

confined to the current academic semester, and the study did not include longitudinal tracking or cross-institutional comparisons. While the findings aimed to offer insights that may be valuable to other polytechnic institutions or similar educational environments, the results were interpreted specifically in the context of Mingde Polytechnic Institute.

Given its defined setting, the study did not explore other potential influences on collaborative performance, such as teaching style, personality traits, or curriculum design. It remained focused on spatial and technological variables to isolate their effects as clearly as possible within a controlled institutional environment.

1.5 Significance of the Study

This study holds both practical and theoretical significance in the field of educational space design and collaborative learning. From a practical perspective, the research provides data-driven insights that can inform institutional decision-making at Mingde Polytechnic Institute and similar vocational institutions in China. As many schools invest in physical infrastructure and digital tools to foster active and collaborative learning, understanding the specific elements of space design that contribute most significantly to student performance becomes crucial. The findings of this study may assist administrators, campus planners, and instructional designers in optimizing classroom layouts, improving the configuration of collaborative zones, and enhancing the strategic integration of digital learning tools. Ultimately, such improvements can lead to more effective team-based learning experiences and better preparation of students for real-world, collaborative work environments.

Theoretically, this research contributes to the growing application of Environmental Psychology Theory in the educational context. While environmental psychology has long emphasized the importance of physical surroundings on behavior, relatively few studies have operationalized its principles within vocational education settings in China. By empirically testing the relationship between specific environmental features and collaborative learning outcomes, this study deepens the understanding of how physical and digital components of the learning environment jointly shape student behavior. It also fills a gap in the literature by extending the theory's relevance to polytechnic institutions, where hands-on group work and task collaboration are central to pedagogy. The study's quantitative approach further

strengthens the empirical basis for future research on learning space effectiveness in diverse educational contexts.

1.6 Definition of Key Terms

Classroom Layout Flexibility

This refers to the degree to which the physical arrangement of classroom furniture and space can be easily modified to support various learning activities, such as group discussions, peer presentations, or collaborative projects. In this study, it is measured through student perceptions of the ease and frequency with which the classroom setup can be adapted for group-based learning.

Collaborative Zones

Collaborative zones are designated areas within or outside the classroom specifically designed to facilitate teamwork and group interaction among students. These zones may include round tables, whiteboards, movable seating, or open discussion spaces. The availability of such zones is assessed based on students' access to and actual use of these spaces during group learning activities.

Digital Learning Tools

Digital learning tools in this study refer to technology-based resources that support group learning and communication, including but not limited to interactive whiteboards, shared tablets, collaborative software platforms, and online file-sharing systems. The variable is measured by the accessibility, frequency of use, and perceived usefulness of these tools during collaborative tasks.

Student Collaborative Performance

This term represents the effectiveness and quality of students' participation in team-based learning activities. It includes equal contribution, task coordination, idea sharing, communication clarity, and overall group output. Student collaborative performance is measured through a self-reported questionnaire assessing individual experiences and perceived group outcomes.

Environmental Psychology Theory

Environmental Psychology Theory is the theoretical framework guiding this study. It focuses on the relationship between individuals and their physical surroundings, emphasizing how spatial design can influence behavior, emotions, and

interactions. In this research, the theory is applied to understand how classroom design features affect student collaboration in educational settings.

Chapter 2 Literature Review

This chapter reviews relevant literature to establish the theoretical and empirical foundation for the study. Following the theoretical overview, the chapter is organized around the four key variables of the study: Classroom Layout Flexibility, Collaborative Learning Zones, Digital Learning Tools, and Student Collaborative Performance. Within each section, both international and domestic literature is discussed to provide a comprehensive understanding of current knowledge, existing research gaps, and the contextual relevance to Mingde Polytechnic Institute. This chapter serves to clarify the conceptual definitions, empirical relationships, and justifications for the variables included in the study, thereby supporting the development of the research hypotheses.

2.1 Classroom Layout Flexibility

Classroom layout flexibility has emerged as a key focus in the discourse on learning space innovation, especially in the context of fostering student-centered and collaborative learning environments. Flexible layouts refer to the physical capacity of the classroom to support multiple configurations based on pedagogical needs—such as rearranging desks for group discussions, project work, or interactive presentations. As Zhao and Li (2021) pointed out, the traditional fixed-row seating arrangement limits face-to-face interaction and reduces student engagement, particularly in activities that require peer collaboration.

In China's vocational and polytechnic education settings, the shift toward active learning has placed increased emphasis on spatial adaptability. According to Wang and Chen (2022), many institutions have begun to implement modular furniture and open layouts that can be easily restructured to match the instructional format. Their study found that students in reconfigurable classrooms showed significantly higher levels of group participation and perceived collaborative effectiveness compared to those in conventional settings. Similarly, a large-scale survey by Liu (2023) concluded that flexible seating promotes more balanced group involvement, as students feel less constrained by physical barriers and hierarchies often reinforced by fixed seating positions.

International literature echoes these findings. For instance, Davies and Canwell (2020) argue that flexibility in classroom design enables seamless transitions between teacher-centered and learner-centered modes, thereby supporting more dynamic and responsive learning processes. Their research emphasized that when students are empowered to shape their own learning space, they tend to take greater ownership of collaborative tasks. Furthermore, Goh and Yeo (2021) observed that even minor layout adjustments—such as enabling students to form semi-circles or clusters—can lead to significant improvements in verbal interaction and joint problem-solving.

Despite growing support for layout flexibility, challenges remain in its implementation. Zhang and Hu (2020) noted that in many Chinese institutions, furniture may be movable but is often underutilized due to teacher habit, space limitations, or lack of institutional guidance. Therefore, layout flexibility must be supported not only by physical infrastructure but also by an instructional culture that encourages experimentation and student agency in space usage.

Classroom layout flexibility plays a foundational role in shaping collaborative learning experiences. The literature consistently demonstrates that adaptable environments contribute to greater interaction, improved communication, and enhanced team dynamics among students. In the context of this study, it is essential to examine how such spatial flexibility influences collaborative performance specifically within a polytechnic institutional setting like Mingde.

2.2 Collaborative Learning Zones

Collaborative learning zones refer to intentionally designed physical areas within educational spaces that support group interaction, co-creation, and shared problem-solving. These zones may include round tables, shared whiteboards, movable chairs, and open-access technological resources, all arranged to facilitate communication and teamwork. In recent years, such spatial features have become increasingly recognized as critical components of student-centered learning environments. According to He and Zhang (2021), the presence of clearly defined collaborative zones in classrooms or learning commons significantly enhances students' willingness to participate in group activities, as they perceive the space as psychologically safe and conducive to open dialogue.

In the Chinese context, the concept of collaborative zones has gained popularity within newly constructed or renovated campuses, especially in polytechnic and applied science institutions. Tang and Liu (2022) reported that designated group work areas contribute to clearer task division and increased role accountability among vocational students. Their study also emphasizes that the visibility and accessibility of these zones are important—students are more likely to utilize spaces that are centrally located, well-lit, and supported by tools such as whiteboards or charging stations. However, they also note that without proper instructional integration, these zones may become underutilized or even disruptive.

Internationally, collaborative zones have been explored as part of larger learning space design reforms. Moffat and Reynolds (2020) highlighted that spatial proximity and layout cues—such as clustered seating or circular arrangements—signal behavioral expectations and group norms. In their study of Australian universities, students working in collaborative zones reported higher levels of mutual support and task ownership compared to those seated in traditional rows, even when performing the same assignment. Similarly, research by Kim and Lee (2021) demonstrates that when collaborative zones are equipped with shared visual tools and writable surfaces, students engage in more frequent ideation and joint decision-making.

Nevertheless, some challenges persist in the implementation of collaborative zones. Li and Sun (2020) pointed out that in many Chinese classrooms, the use of such zones is still superficial, with some students treating them as break areas rather than purposeful learning spaces. This reflects the need for pedagogical alignment—teachers must integrate the use of collaborative zones into their instructional design and task planning. Furthermore, institutional support is necessary to maintain and upgrade these spaces, ensuring their relevance and adaptability over time.

The literature confirms that collaborative learning zones play a vital role in shaping group dynamics and student collaboration. Their physical configuration, visibility, and technological support all contribute to the extent to which students perceive the space as enabling cooperative learning. In the case of Mingde Polytechnic Institute, evaluating the presence and usage of such zones offers valuable insights into how spatial design influences student collaborative performance in practice.

2.3 Digital Learning Tools

In the digital age, the integration of technology into collaborative learning environments has become indispensable. Digital learning tools refer to various technological resources that support communication, content sharing, co-creation, and task coordination among students. These tools may include interactive whiteboards, shared online platforms (e.g., Google Workspace, Microsoft Teams), collaborative software applications, and mobile devices. In the context of collaborative learning, such tools are not only supplementary but often serve as essential mediators of interaction and productivity. According to Zhou and Li (2021), students in Chinese polytechnic institutions who frequently utilize digital tools during group projects tend to exhibit higher levels of task clarity, mutual accountability, and engagement.

The utility of digital tools lies in their ability to extend collaboration beyond physical space and time. For instance, even when students are not co-located, platforms that support real-time document editing, asynchronous discussion, and multimedia exchange allow group tasks to progress smoothly. Fang and Wu (2022) found that students using cloud-based collaboration tools were more likely to divide responsibilities efficiently and provide constructive feedback. Their study also indicated that digital collaboration enhanced weaker students' participation by offering less intimidating modes of contribution, such as written comments or audio recordings, rather than direct confrontation in face-to-face settings.

International scholars have emphasized similar advantages. Chen and Chan (2020) argued that digital learning tools reduce hierarchical barriers within student groups by democratizing access to information and communication. Their research in Singaporean technical colleges revealed that students felt more empowered to express ideas and challenge others when supported by digital channels, compared to purely in-person interactions. Moreover, Sanders and Hall (2021) explored the role of digital whiteboards in collaborative design studios and concluded that these tools fostered iterative creativity and visual thinking, which are essential in problem-solving-oriented education.

Digital tools are not without limitations. Zhao (2023) observed that in many Chinese vocational colleges, access to digital resources remains inconsistent due to technical infrastructure, insufficient training, or unclear usage guidelines. Students often report that while digital tools are present, they are either underutilized or used

passively, such as displaying content rather than co-creating it. This disconnect between technological availability and effective usage underscores the importance of aligning digital tools with pedagogical objectives and equipping both students and instructors with adequate digital literacy.

Digital learning tools offer significant potential to enhance student collaborative performance by facilitating communication, resource sharing, and participation equity. Their effectiveness, however, depends on thoughtful integration into both the physical environment and instructional design. For Mingde Polytechnic Institute, understanding how students access and interact with these tools is crucial to evaluating the real impact of digital infrastructure on collaborative learning outcomes.

2.4 Student Collaborative Performance

Student collaborative performance refers to the extent to which students effectively engage in teamwork to achieve shared academic goals. It encompasses behaviors such as mutual participation, task coordination, open communication, shared decision-making, and the quality of collective outputs. As collaborative learning becomes increasingly embedded in vocational and higher education pedagogy, evaluating and improving student collaborative performance has gained growing importance (Huang & Liu, 2021). Particularly in polytechnic institutions, where project-based learning and interdisciplinary tasks are common, successful collaboration reflects not only academic engagement but also professional skill development.

In the Chinese vocational education system, several scholars have highlighted challenges in student collaboration, such as passive participation, unclear task division, and unequal contribution (Wen & Zhao, 2020). These issues are often exacerbated by rigid classroom structures and insufficient support mechanisms. However, when learning environments are intentionally designed to promote collaboration, students show improved communication and task outcomes. Zhang and He (2023) found that in redesigned classrooms featuring flexible seating and shared discussion zones, students reported higher levels of satisfaction with their group work and a stronger sense of collective responsibility.

International literature reinforces the multidimensional nature of collaborative performance. According to Müller and Jones (2021), effective collaboration is not simply the result of placing students in groups; rather, it requires structured

environments, clear roles, and accessible resources. Their research emphasized the importance of both physical space and digital tools in shaping collaborative dynamics. Furthermore, Hartley and Chu (2020) identified psychological safety and group cohesion as critical mediators of collaborative success, influenced in part by how comfortable and supported students feel within their learning environment.

Assessment of collaborative performance can take various forms, from peer evaluations to observational rubrics. In this study, student collaborative performance is measured through self-reported perceptions, focusing on indicators such as balanced contribution, coordination efficiency, idea sharing, and overall group output. This approach reflects current best practices in assessing soft skills in applied education contexts (Li, 2022). Moreover, as emphasized by Gao and Sun (2021), student perceptions provide valuable insights into the environmental and social conditions that either facilitate or hinder collaboration.

The literature suggests that student collaborative performance is both context-sensitive and design-dependent. Factors such as spatial configuration, technological accessibility, and group structure all interact to influence how well students work together. This reinforces the importance of investigating how these variables are addressed within the unique setting of Mingde Polytechnic Institute, where physical and digital learning environments are undergoing transformation.

2.5 Conceptual Framework

This study is grounded in Environmental Psychology Theory, which emphasizes the dynamic relationship between individuals and their physical surroundings. According to Gifford (2019), environments are not passive backgrounds but active agents that shape human cognition, behavior, and social interaction. In the context of education, classroom design and spatial arrangement can influence how students perceive collaboration, engage with peers, and contribute to group outcomes. This theoretical foundation supports the exploration of how spatial and technological features in learning environments affect student collaborative performance.

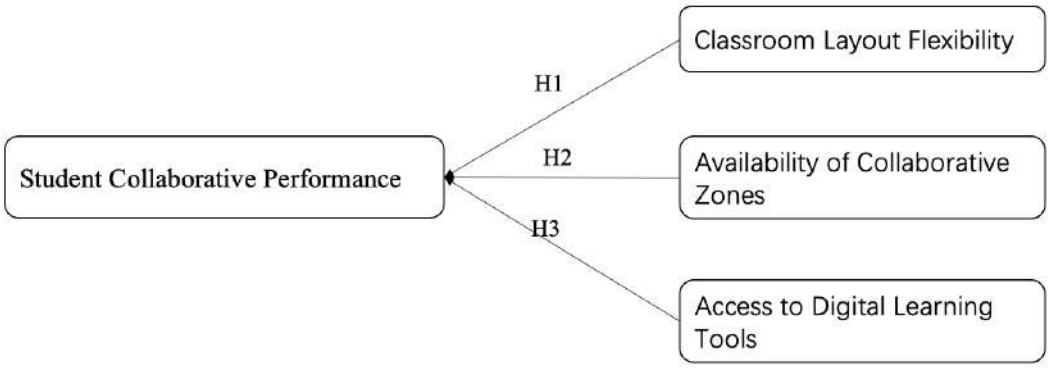

Figure 2.1 Conceptual Framework

Within this framework, the three independent variables—classroom layout flexibility, availability of collaborative zones, and access to digital learning tools—are conceptualized as environmental stimuli that influence student behavior in group learning situations. Flexible classroom layouts are expected to support mobility, eye contact, and communication flow, all of which are critical to collaborative engagement (Zhang & Liu, 2020). Collaborative zones, by contrast, are seen as psychologically defined spaces that encourage group identity and task ownership, facilitating better role distribution and interaction (Huang & Tang, 2021). Access to digital learning tools adds a technological dimension to the learning environment, enabling students to share resources, manage tasks, and sustain communication, even beyond the boundaries of the physical classroom (Chen & Xu, 2023).

Student collaborative performance, the dependent variable, is influenced by the degree to which the environment supports social interaction, information exchange, and group cohesion. Previous research indicates that when students perceive their environment as adaptable and supportive, they are more likely to contribute actively and communicate effectively within groups (Wang & Li, 2022). Thus, the conceptual framework of this study posits that the physical and digital characteristics of the learning space—when aligned with collaborative pedagogical intentions—positively impact student collaborative performance.

This framework integrates both spatial and technological dimensions within the lens of environmental psychology, offering a holistic view of how design decisions within educational institutions influence student outcomes. It serves as the foundation for hypothesis development and empirical testing in the following chapters.

Chapter 3 Research Methodology

3.1 Research Design

This study adopted a quantitative research approach to systematically examine the relationship between environmental design variables and student collaborative performance within the context of Mingde Polytechnic Institute. The purpose of employing this method was to obtain measurable and generalizable data that could reveal statistically significant patterns among the variables of interest. The study was guided by a positivist paradigm, under which observable data were collected through a structured questionnaire and subjected to inferential analysis to validate the proposed hypotheses.

A cross-sectional survey research design was chosen as the primary methodological framework. This design allowed the researcher to capture the perceptions and experiences of a broad sample of students at a single point in time, which aligned with the practical scope of the study. The decision to use a survey questionnaire was based on its efficiency in reaching a sizable population and its suitability for measuring abstract constructs such as spatial perceptions, technological access, and self-assessed collaborative performance. A structured questionnaire was developed consisting of closed-ended items measured on a five-point Likert scale ranging from “strongly disagree” to “strongly agree.” This format enabled the quantification of subjective responses while maintaining consistency in data interpretation.

The questionnaire was divided into four sections corresponding to the study’s key variables. Items measuring classroom layout flexibility assessed the adaptability and mobility of furniture arrangements. Collaborative zone availability was evaluated through students’ reported access to designated group spaces and the frequency of their usage. Digital learning tools were assessed in terms of accessibility, familiarity, and perceived usefulness in group contexts. Student collaborative performance was measured based on indicators such as task coordination, equal participation, and overall group effectiveness. The questionnaire items were adapted and refined from existing validated instruments in related studies, ensuring content validity and relevance to the vocational education context.

To further ensure the clarity and appropriateness of the instrument, a pilot test was conducted with a small group of students who had similar academic backgrounds but were not included in the final sample. Their feedback was used to make linguistic adjustments and improve item coherence. The finalized questionnaire was then administered to a larger sample, with responses systematically coded and analyzed through statistical software to examine correlations and test the research hypotheses.

This research design was selected to align both with the theoretical framework of environmental psychology and the practical need to assess spatial and technological factors in real learning environments. By employing a structured quantitative approach, the study aimed to produce reliable findings that could inform institutional strategies and contribute to the existing body of knowledge in educational space research.

3.2 Population and Sample

This study adopted a cross-sectional research approach, collecting data at a single point in time to analyze the relationship between classroom environment variables and student collaborative performance. The target population consisted of full-time undergraduate students enrolled at Mingde Polytechnic Institute, a vocational higher education institution located in eastern China. The focus was placed on students from three academic departments—Applied Engineering, Digital Media, and Business Management—as these departments regularly implemented group-based coursework and emphasized collaborative learning outcomes as part of their curriculum. Data collection took place during the second half of the spring semester, when students were actively engaged in project-based assignments.

At the time of the study, the total undergraduate population across the selected departments was approximately 1,200 students. This figure included all year levels, but to ensure participants had sufficient exposure to group learning environments and physical classroom infrastructure, only second- and third-year students were included in the sample frame. Based on institutional records, this narrowed the eligible population to roughly 800 students.

The required sample size was calculated using the standard formula for sample size estimation with a 95% confidence level, a 5% margin of error, and a response distribution of 50%, which is typically used when the actual distribution is unknown. Using this formula, the minimum sample size for a population of 800 was determined

to be approximately 260 respondents. To allow for potential incomplete responses and to enhance the reliability of the analysis, the sample size was slightly expanded, resulting in a final target of 280 distributed questionnaires.

The sampling method employed in this study was stratified random sampling. This method was selected to ensure representation from each academic department while preserving randomness within the strata. The eligible population was first divided into three strata based on departmental affiliation. Within each stratum, students were then randomly selected using a list provided by the academic registry. This technique allowed for proportional representation of different academic programs while reducing the risk of sampling bias. It also aligned well with the study's intention to generalize findings across the institution's most collaborative programs.

This structured and systematic approach to population and sampling ensured both the feasibility and credibility of data collection. It allowed the study to gather reliable and diverse insights from students across a range of collaborative learning experiences, thereby supporting the research objectives grounded in Environmental Psychology Theory.

3.3 Hypothesis

H1: Classroom layout flexibility has a positive effect on student collaborative performance.

H2: Availability of collaborative zones has a positive effect on student collaborative performance.

H3: Access to digital learning tools has a positive effect on student collaborative performance.

3.4 Research Instrument

This study employed a structured questionnaire as the primary research instrument to collect quantitative data on the relationship between learning space design and student collaborative performance. The questionnaire was designed to measure the four main constructs derived from the theoretical framework of Environmental Psychology: classroom layout flexibility, availability of collaborative zones, access to digital learning tools, and student collaborative performance. Each of these variables was defined operationally and made observable through a series of measurement items

that reflected the behavioral and perceptual aspects associated with learning environments.

The questionnaire was divided into five sections. The first section gathered demographic information including gender, age, year of study, department, and prior experience with group-based coursework. This section was essential for the descriptive analysis and subgroup comparisons in later stages of data interpretation. The remaining four sections corresponded to the study's independent and dependent variables. Each of these sections included four to five items specifically developed to assess the respondents' perceptions and experiences related to that dimension of the learning environment.

Classroom layout flexibility was measured through items that assessed the physical adaptability of the classroom space, such as whether the furniture could be easily rearranged and whether the layout encouraged face-to-face interaction. The availability of collaborative zones was captured through items evaluating the existence, accessibility, and comfort level of designated group work areas. Access to digital learning tools focused on the availability, usability, and perceived usefulness of technologies that supported group collaboration, including digital whiteboards and online sharing platforms. The dependent variable, student collaborative performance, was measured based on indicators such as task coordination, equal participation, mutual support, and overall group effectiveness.

All measurement items used a five-point Likert rating scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), which allowed for the quantification of subjective opinions and ensured consistency in response coding. The Likert scale was selected due to its widespread use in attitudinal and behavioral research and its appropriateness for measuring latent variables such as perception and performance. The questionnaire was developed in English and later translated into Chinese using a back-translation method to maintain conceptual equivalence and clarity for participants.

The measurement items were constructed based on existing literature and previously validated instruments, and were adapted to fit the context of vocational higher education in China. The clarity, relevance, and internal consistency of the items were verified through expert review and pilot testing, ensuring that the final instrument was both theoretically grounded and practically reliable for use in the intended setting.

3.5 Reliability and Validity Analysis of the Scale

To ensure the questionnaire used in this study was both reliable and valid, statistical analyses were conducted to test its construct validity and internal consistency. A total of 280 valid responses were collected for this purpose. The results demonstrated that the questionnaire possessed strong psychometric properties, confirming its suitability for measuring the variables under investigation.

The construct validity of the questionnaire was evaluated using the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity. As shown in Table 3.1, the KMO value for the overall questionnaire was 0.879, which indicated that the sample was sufficiently adequate for factor analysis. According to Kaiser's (1974) standard, values above 0.80 represent meritorious sampling adequacy. Additionally, Bartlett's Test of Sphericity yielded a chi-square value of 2314.63 with a significance level of $p < 0.001$, which confirmed that the correlation matrix was not an identity matrix and that the data were suitable for factor extraction. These results supported the structural validity of the questionnaire and verified that the items had meaningful interrelationships suitable for factor-based analysis.

Table 3.1 KMO and Bartlett's Test of Sphericity for Construct Validity

Measure	Value
Kaiser-Meyer-Olkin (KMO)	0.879
Bartlett's Test of Sphericity (χ^2)	2314.63
Degrees of Freedom	300
Significance (p-value)	< 0.001

In addition to construct validity, the internal consistency of the questionnaire was assessed using Cronbach's Alpha for each of the four key variable scales. As summarized in Table 3.2, all alpha coefficients exceeded the commonly accepted threshold of 0.70, indicating good reliability. Specifically, the classroom layout flexibility scale had an alpha of 0.814, reflecting high consistency among its five items. The collaborative zones scale demonstrated an even stronger alpha of 0.861, suggesting the items were highly interrelated and measured a single construct. The digital learning tools scale also showed strong reliability, with a coefficient of 0.845. Finally, the dependent variable, student collaborative performance, had a Cronbach's alpha of 0.877, the highest among the four, reflecting stable and coherent responses across group performance indicators.

Table 3.2 Cronbach's Alpha Coefficients for Internal Consistency Reliability

Variable	Number of Items	Cronbach's Alpha
Classroom Layout Flexibility	5	0.814
Collaborative Learning Zones	5	0.861
Digital Learning Tools	5	0.845
Student Collaborative Performance	5	0.877

These reliability coefficients confirmed that the questionnaire consistently captured the underlying constructs and could be trusted for hypothesis testing. The results suggested that respondents interpreted the items in a consistent manner, and the scales were internally stable across the sample. Together with the strong KMO value and significant Bartlett's test, the reliability and validity analyses demonstrated that the questionnaire was both statistically sound and theoretically aligned with the study's conceptual framework.

3.6 Data Collection

The data for this study were collected during a three-week period from April 8 to April 28, 2024. The collection process was carefully planned and coordinated with academic staff from the Applied Engineering, Digital Media, and Business Management departments at Mingde Polytechnic Institute. Prior to distribution, ethical approval was obtained from the institutional review committee, and department heads were informed to ensure classroom-level cooperation.

The primary instrument used for data collection was a structured questionnaire, which had been designed to capture students' perceptions of their learning environment and their collaborative performance. The finalized questionnaire was converted into an online format using a secure and user-friendly platform—Wenjuanxing, which is widely used in Chinese academic research. A unique survey link was generated and distributed to students via the institutional WeChat groups and the university's online learning management system. Instructors assisted by making brief in-class announcements to encourage participation and by explaining the academic value of the study.

Participants were informed that their responses would remain anonymous and would be used solely for research purposes. The survey was open for three weeks, during which two reminder messages were sent to enhance response rates. A total of

302 responses were received by the deadline. After a thorough screening process, 22 incomplete or inconsistent responses were removed, resulting in 280 valid questionnaires, which met the sample size requirement established during the research design phase.

Table 3.3 Summary of Data Collection

Description	Quantity
Data collection period	April 8–28, 2024
Questionnaires distributed	302
Questionnaires returned	302
Incomplete/invalid responses	22
Valid responses for analysis	280
Response rate (valid/total sent)	92.7%

The use of an online platform facilitated a smooth, efficient, and contact-free data collection process, which was particularly suitable for reaching students across different classrooms and schedules. The high response rate reflected both the accessibility of the survey method and the relevance of the topic to the student participants. These 280 valid responses were subsequently coded and exported into SPSS for statistical analysis, as described in the following chapter.

3.7 Data Analysis

To examine the relationship between learning space design and student collaborative performance, this study employed a combination of descriptive and inferential statistical techniques. The data collected from 280 valid questionnaires were systematically entered into SPSS Version 26.0 for coding, cleaning, and statistical analysis. The selection of analytical methods was based on the structure of the data, the measurement scales used, and the study's objective of hypothesis testing under a quantitative framework.

Descriptive statistics were first used to summarize and describe the characteristics of the respondents and the distribution of responses across each variable. Measures including frequency and percentage were applied to the demographic data, including gender, age, year of study, and department affiliation. For the four main variables—classroom layout flexibility, collaborative learning zones, digital learning tools, and student collaborative performance—means and standard deviations were calculated to describe central tendencies and variability in student perceptions.

To test the study's three hypotheses, inferential statistics were applied. Pearson's correlation coefficient was used to examine the strength and direction of the linear relationship between each independent variable and the dependent variable. This method was appropriate due to the continuous nature of the Likert-scale data and the assumption of linearity between variables. Each of the three correlations—between classroom layout flexibility and collaborative performance, between collaborative zones and collaborative performance, and between digital tools and collaborative performance—was tested for significance at the 0.05 level.

All statistical results were interpreted with attention to significance levels (p-values), correlation strength (r values), and effect sizes where applicable. These analyses provided the empirical basis for evaluating the proposed hypotheses and for drawing conclusions about the role of environmental factors in shaping student collaboration outcomes at Mingde Polytechnic Institute.

Chapter 4 Findings and Discussion

4.1 Findings

4.1.1 Demographic Characteristics of Respondents

To provide contextual understanding of the data collected, this section presents the demographic profile of the respondents as well as summary statistics for each of the key variables. Descriptive statistics helped to establish the background of the sample and reveal general trends in student perceptions of learning space design and collaborative experiences at Mingde Polytechnic Institute.

Table 4.1 Demographic Characteristics of Respondents

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	142	50.7%
	Female	132	47.1%
	Other / Prefer not to say	6	2.1%
Age	Under 18	12	4.3%
	18–20	145	51.8%
	21–23	101	36.1%
	24 and above	22	7.8%
Year of Study	Year 2	148	52.9%
	Year 3	132	47.1%
Academic Department	Applied Engineering	96	34.3%
	Digital Media	92	32.9%
	Business Management	92	32.9%
Group Learning Experience	Yes	273	97.5%
	No	7	2.5%

As shown in Table 4.1, the sample was relatively balanced in terms of gender, with 50.7% male and 47.1% female participants. Most students (87.9%) were between the ages of 18 and 23, which was typical for full-time undergraduate students in Chinese vocational institutions. More than half (52.9%) were in their second year of study, and all three academic departments were nearly equally represented, indicating good distribution across disciplines. Notably, 97.5% of respondents had prior experience

with group-based coursework, confirming the relevance of collaborative performance as a measurable outcome.

In addition to demographic information, descriptive statistics were computed for the four main variables of the study: classroom layout flexibility, availability of collaborative zones, access to digital learning tools, and student collaborative performance. Each construct was measured using 5-point Likert-scale items, and Table 4.2 presents the mean and standard deviation for each variable.

Table 4.2 Descriptive Statistics of Variables

Variable	Number of Items	Mean (M)	Standard Deviation (SD)
Classroom Layout Flexibility	5	3.84	0.67
Collaborative Learning Zones	5	3.91	0.72
Digital Learning Tools	5	3.76	0.65
Student Collaborative Performance	5	4.02	0.58

From Table 4.2, students generally held favorable perceptions of all three aspects of the learning environment. The highest mean score was observed for Student Collaborative Performance (M = 4.02, SD = 0.58), suggesting that students overall felt positively about their experiences in teamwork and group learning outcomes. Collaborative Learning Zones had the second-highest average (M = 3.91), indicating a strong appreciation for designated group areas. Classroom Layout Flexibility and Digital Learning Tools also received relatively high ratings (M = 3.84 and 3.76, respectively), with modest variability as indicated by the standard deviations. These findings suggest that the majority of students recognized the learning environment as conducive to collaboration, thus setting a suitable context for further hypothesis testing in the subsequent sections.

4.1.2 Classroom Layout Flexibility and Student Collaborative Performance

To test Hypothesis 1, which states that classroom layout flexibility has a positive effect on student collaborative performance, Pearson's correlation coefficient was used to assess the strength and direction of the relationship between the two variables. Both

variables were measured using Likert-scale items and treated as continuous data, which met the assumptions required for Pearson correlation analysis.

Table 4.3 Pearson Correlation Between Classroom Layout Flexibility and Student Collaborative Performance

Variables	Mean	SD	1	2
1. Classroom Layout Flexibility	3.84	0.67	1	
2. Student Collaborative Performance	4.02	0.58	**.426** ($p < .001$)	1

As shown in Table 4.3, the Pearson correlation coefficient ($r = .426$, $p < .001$) indicated a moderate positive relationship between classroom layout flexibility and student collaborative performance. This result was statistically significant at the 0.01 level, which provided strong evidence to support Hypothesis 1.

The positive correlation suggested that students who perceived their classroom layout as more flexible tended to report higher levels of engagement, coordination, and effectiveness in group activities. In other words, the ability to easily rearrange classroom furniture and adapt the physical environment appeared to facilitate more productive and interactive collaborative experiences. This finding was consistent with the theoretical proposition of Environmental Psychology, which emphasizes that spatial features can influence interpersonal behavior and cognitive functioning in learning settings.

The moderate strength of the correlation implied that while classroom layout flexibility contributed to collaborative performance, it was not the sole influencing factor. This reinforced the multi-dimensional nature of collaborative learning, which may also be shaped by instructional design, peer dynamics, and access to resources.

The data supported Hypothesis 1. The results confirmed that classroom layout flexibility had a statistically significant and positive effect on student collaborative performance at Mingde Polytechnic Institute.

4.1.3 Collaborative Learning Zones and Student Collaborative Performance

To test the second hypothesis, which posites that the availability of collaborative learning zones has a positive effect on student collaborative performance, a Pearson correlation analysis was conducted. This statistical method was chosen due to the

continuous nature of the Likert-scale data and the goal of examining the linear association between students' perceived access to collaborative zones and their reported performance in group tasks.

Table 4.4 Pearson Correlation Between Collaborative Learning Zones and Student Collaborative Performance

Variables	Mean	SD	1	2
1. Collaborative Learning Zones	3.91	0.72	1	
2. Student Collaborative Performance	4.02	0.58	**.489** ($p < .001$)	1

As shown in Table 4.4, the Pearson correlation coefficient between collaborative learning zones and student collaborative performance was $r = .489$, with a p-value less than .001, indicating a moderately strong and statistically significant positive relationship. This results supported Hypothesis 2.

The analysis revealed that students who reported greater access to and frequent use of designated collaborative zones—such as open discussion corners, round-table spaces, or shared whiteboard areas—also tended to report higher performance in group learning tasks. The availability of such zones appeared to promote a more psychologically supportive and interaction-friendly atmosphere, encouraging students to participate more actively, communicate more freely, and contribute more effectively to group outcomes.

This finding aligned closely with prior research emphasizing the environmental cues embedded in collaborative spaces. According to environmental psychology principles, clearly structured and visibly distinct spatial zones can shape behavior by signaling expectations for interaction, cooperation, and shared responsibility. In this study's context, the presence of such collaborative learning zones not only served as physical spaces for task completion but also enhanced students' sense of purpose and group belonging, which are essential for successful collaboration.

The statistically significant and positively directed correlation confirmed the validity of Hypothesis 2. The data demonstrated that the availability and quality of collaborative learning zones positively influenced how students perceived and performed in group-based academic tasks.

4.1.4 Access to Digital Learning Tools and Student Collaborative Performance

To test the third hypothesis, which states that access to digital learning tools has a positive effect on student collaborative performance, Pearson's correlation analysis was again utilized. This method was suitable for measuring the strength of association between two continuous variables based on Likert-scale data, and it aligned with the analytical approach used in the previous hypotheses.

Table 4.5 Pearson Correlation Between Access to Digital Learning Tools and Student Collaborative Performance

Variables	Mean	SD	1	2
1. Access to Digital Learning Tools	3.76	0.65	1	
2. Student Collaborative Performance	4.02	0.58	**.457** ($p < .001$)	1

As shown in Table 4.5, the Pearson correlation coefficient was $r = .457$, with a p-value $< .001$, indicating a moderate and statistically significant positive correlation between access to digital learning tools and student collaborative performance.

This result confirmed that students who had easier access to digital tools—such as smartboards, tablets, online document-sharing platforms, and collaborative apps—tended to demonstrate stronger performance in group-based academic tasks. The digital tools not only provided convenience in communication and file management but also appeared to enable more equal participation and more efficient collaboration within student teams.

In the context of environmental psychology, this relationship can be interpreted as a technologically mediated environmental factor that shapes student behavior and engagement. When students perceive the digital infrastructure as supportive, accessible, and aligned with collaborative needs, they are more likely to engage in meaningful academic interaction. Moreover, the integration of technology within physical learning spaces blurs the boundary between spatial and cognitive environments, enabling students to extend their collaborative efforts beyond traditional time and location constraints.

The findings offered empirical support for Hypothesis 3. The statistically significant correlation demonstrated that digital learning tools played a facilitative role

in shaping student collaboration quality. This emphasized the importance of equipping modern learning environments not only with flexible space but also with responsive technological infrastructure that supports interactive, team-based learning.

4.2 Discussion

4.2.1 Results

The findings from the hypothesis testing provided clear and consistent evidence supporting the theoretical assumption that the physical and digital learning environment significantly influences student collaborative performance at Mingde Polytechnic Institute. All three hypotheses were confirmed through statistically significant and positively directed correlations, indicating that each of the environmental design elements studied contributed meaningfully to students' experiences and outcomes in group-based learning tasks.

The first hypothesis, which proposed a positive relationship between classroom layout flexibility and student collaborative performance, was supported by a moderate correlation coefficient ($r = .426$, $p < .001$). This finding suggests that when students perceive the physical layout of their classrooms as adaptable—such as having movable furniture, flexible seating arrangements, or group-friendly configurations—they are more likely to engage productively in collaboration. This aligns with the understanding from environmental psychology that physical openness and adaptability can reduce social barriers, increase eye contact, and foster better communication, all of which are essential components of successful teamwork.

The second hypothesis, regarding the availability of collaborative learning zones, yielded the strongest correlation among the three variables ($r = .489$, $p < .001$). This indicates that the presence of clearly defined, accessible, and comfortable collaborative spaces plays a particularly influential role in shaping students' group performance. These spaces likely provide not only the physical infrastructure but also the psychological signal that encourages cooperative behavior. The stronger relationship found here may reflect the cultural and pedagogical importance of having a "designated" space for collaborative activities in vocational education settings, where hands-on teamwork is emphasized.

The third hypothesis tested the impact of access to digital learning tools on collaborative performance and was also confirmed by a significant positive correlation

($r = .457$, $p < .001$). This demonstrates that the integration of digital tools—such as interactive whiteboards, cloud-based platforms, and communication apps—enhances the efficiency and quality of collaboration. Digital access appears to support task coordination, reduce communication delays, and create more inclusive opportunities for all group members to contribute, even those who may feel less confident in traditional face-to-face settings.

Taken together, these results highlight the interconnected roles of spatial flexibility, physical collaboration infrastructure, and digital support in promoting effective student collaboration. Rather than acting in isolation, these three environmental features work in tandem to create a holistic learning atmosphere that supports both the logistical and social dimensions of teamwork. The findings also reinforce the value of Environmental Psychology Theory as a lens through which to understand how thoughtfully designed educational environments can positively shape student behavior and learning outcomes.

4.2.2 Discussion of the Results

The results of this study provided strong empirical support for the proposed conceptual framework, affirming that key features of learning space design—classroom layout flexibility, availability of collaborative zones, and access to digital learning tools—are positively associated with student collaborative performance. The findings suggest that the physical and technological conditions of the classroom environment do not merely serve as passive backdrops but function as active elements that shape students' engagement, communication, and group productivity.

The consistent strength and significance of the correlations observed indicate that collaborative performance is a highly context-sensitive construct. Students who perceive their classrooms as flexible, well-equipped, and purposefully structured for collaboration tend to exhibit stronger team behavior and task outcomes. These environmental affordances appear to encourage mutual accountability, ease of coordination, and inclusive participation—factors identified as essential to high-functioning student teams. This supports the core assumption of Environmental Psychology Theory: the environment influences not only emotional and cognitive states but also social interaction patterns.

The results align with and extend findings from previous research. For instance, the observed positive relationship between classroom layout flexibility and collaboration echoes the work of Zhang and Liu (2020), who noted that flexible furniture arrangements promote peer-to-peer interaction and reduce physical barriers to communication. Similarly, the significance of collaborative zones reinforces the conclusions drawn by He and Zhang (2021), who found that the visibility and accessibility of group spaces improved students' sense of group identity and engagement. The importance of digital learning tools is also in line with studies by Chen and Chan (2020), who argued that technology enables more equitable and efficient group work, particularly among diverse learners.

While the findings largely met expectations, one slightly unexpected observation was that the correlation between digital learning tools and student collaboration, though positive and significant, was marginally weaker than the correlation for collaborative zones. Given the rapid expansion of educational technology, it might have been anticipated that digital tools would show the strongest influence. One possible explanation for this outcome could be that while digital platforms offer many technical affordances, their effective use still depends on students' familiarity, training, and integration into course design. If students are provided with digital tools but lack structured guidance on how to use them collaboratively, the tools may remain underutilized or be used in superficial ways.

Another potential explanation lies in the nature of vocational education settings, such as Mingde Polytechnic Institute, where students may still rely more on face-to-face collaboration in physical spaces, especially in hands-on or project-based tasks. In such environments, physical spatial design—such as collaborative zones—may have a more immediate and visible impact on group behavior than digital interventions, particularly when students are working in real-time and on-site.

The findings of this study not only confirmed the research hypotheses but also offered deeper insights into the practical and psychological mechanisms by which learning environments affect student collaboration. These results provide a strong foundation for both future research and institutional decision-making related to learning space planning and technological integration.

Chapter 5 Conclusion and Recommendation

5.1 Conclusion

This study set out to examine how the elements of learning space design influence student collaborative performance in the context of Mingde Polytechnic Institute, a vocational higher education institution in China. The central issue addressed in this research was the observed inconsistency in group learning outcomes, despite recent investments in classroom modernization and digital learning infrastructure. It was hypothesized that specific environmental design features—namely classroom layout flexibility, the availability of collaborative zones, and access to digital learning tools—might contribute to shaping students' ability to collaborate effectively in academic tasks.

To investigate this relationship, the study employed a quantitative research design based on Environmental Psychology Theory. Data were collected through a structured questionnaire distributed to 280 second- and third-year undergraduate students from three academic departments. The questionnaire measured students' perceptions of their learning environment and their self-reported collaborative behaviors. Statistical analysis, including descriptive and inferential techniques, was conducted using SPSS. Pearson correlation analysis served as the primary method for hypothesis testing, supported by reliability and validity assessments to ensure data quality.

The findings of the study provided consistent evidence supporting all three proposed hypotheses. Students who perceived their classroom layout as more flexible were more likely to report positive collaborative outcomes. Likewise, the presence of clearly designated collaborative zones was positively associated with improved group coordination and participation. Finally, access to digital learning tools also showed a significant positive correlation with students' collaborative performance, though slightly less pronounced than spatial design elements. These results confirmed that the physical and digital components of the learning environment play a meaningful role in shaping how students interact, contribute, and succeed in group-based academic activities.

The study clearly demonstrated that thoughtfully designed learning environments—both in terms of physical layout and technological integration—can

significantly enhance student collaboration. By addressing the three research questions through empirical analysis, the study not only contributed to the theoretical application of Environmental Psychology in educational contexts but also provided practical insights for institutional leaders and classroom designers seeking to optimize collaborative learning outcomes.

5.2 Recommendation

Based on the findings of this study, several practical and academic recommendations emerge that may inform institutional practices, classroom design, and future research. The results highlight the importance of spatial and technological factors in shaping student collaborative performance, which calls for a more deliberate approach to the planning and implementation of learning environments in vocational higher education.

First, academic institutions should prioritize flexibility in classroom design by adopting modular and mobile furniture that can be easily reconfigured to support group interaction. Fixed rows and rigid layouts limit students' ability to communicate and work collaboratively. Classrooms that allow for circular or cluster-based seating arrangements encourage more direct communication and participation, which in turn enhances collaborative learning outcomes.

Second, institutions are encouraged to invest in and clearly define collaborative learning zones within both classrooms and common areas. These zones should be visually distinct, accessible, and equipped with group-friendly resources such as writable surfaces, shared tables, and comfortable seating. When students can identify and occupy spaces intended for teamwork, they are more likely to engage meaningfully in collaborative processes.

Third, access to digital learning tools must be supported not only through infrastructure but also through user training and pedagogical integration. Tools such as smartboards, collaborative platforms, and shared digital workspaces are only effective when students know how to use them to enhance their collaboration. Faculty training and curriculum alignment are critical in ensuring that these tools are used as instruments of inclusion, creativity, and task management.

5.3 Further Study

While this study has provided valuable insights into the relationship between learning space design and student collaborative performance, several areas remain open for further exploration. Future research may benefit from adopting a longitudinal approach to investigate how long-term exposure to flexible and technology-rich learning environments influences student collaboration over multiple semesters or academic years. Such studies could help determine whether the effects observed in this research are sustained over time or subject to novelty effects.

Researchers should also consider incorporating qualitative methods, such as classroom observation, focus group interviews, or student reflective journals, to gain deeper insights into the behavioral mechanisms through which learning space elements affect collaboration. A mixed-methods approach might offer a more nuanced understanding of student experiences and help capture the contextual and emotional dimensions of teamwork that quantitative surveys alone cannot reveal.

In addition, future studies may expand the scope by comparing different institutional settings, such as public versus private universities, or polytechnic colleges versus comprehensive universities, to examine whether the effects of learning space design vary by institutional type, teaching culture, or student demographic characteristics. Research could also investigate the role of teacher behavior and instructional strategies as mediating or moderating factors in the relationship between environment and collaboration.

Lastly, further study should explore how specific technological tools—such as AI-assisted collaboration platforms or immersive virtual environments—impact student teamwork in both physical and hybrid learning contexts. As education becomes increasingly digitized, understanding how emerging technologies interact with spatial design and student behavior will be essential for the development of future-ready learning environments.

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Appendix

Survey Questionnaire

Dear Participant,

You are invited to participate in a research study exploring how learning space design affects student collaborative performance at Mingde Polytechnic Institute. The information you provide will be used solely for academic research purposes. Your responses will remain anonymous and confidential, and the questionnaire will take approximately 10 minutes to complete. There are no right or wrong answers—please answer honestly based on your own experiences. Thank you for your valuable contribution!

Please select or fill in the most appropriate answer.

1. Gender:

   ☐ Male ☐ Female ☐ Other ☐ Prefer not to say

2. Age:

   ☐ Under 18 ☐ 18–20 ☐ 21–23 ☐ 24 and above

3. Year of Study:

   ☐ Year 1 ☐ Year 2 ☐ Year 3 ☐ Year 4

4. Department:

   ☐ Applied Engineering

   ☐ Digital Media

   ☐ Business Management

   ☐ Other: _____

5. Have you ever participated in group-based coursework or collaborative classroom activities?

   ☐ Yes ☐ No

Please indicate how much you agree or disagree with the following statements.

(1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree)

6. The classroom furniture can be easily rearranged to support group discussions.

   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

7. I often work in groups where the seating layout is different from a traditional lecture format.

   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

8. Flexible arrangements in the classroom help improve communication within my group.

   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

9. I feel more engaged in group tasks when the classroom setup supports face-to-face interaction.

   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

10. The current classroom layout allows smooth transitions between individual and group work.

    ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

11. There are clearly designated group work areas in my learning environment.

    ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

12. I often use shared spaces (e.g., round tables, open discussion corners) for teamwork.

    ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

13. The presence of collaborative zones encourages me to participate more actively in group tasks.

    ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

14. These zones provide a comfortable and supportive environment for collaboration.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

15. I find that group projects are more effective when conducted in designated collaborative spaces.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

16. My classroom is equipped with digital tools that support group work (e.g., smartboards, tablets).

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

17. I have access to online platforms that allow real-time collaboration with my peers.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

18. Digital tools make it easier to organize and divide responsibilities within my group.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

19. I feel confident using technology to contribute to group assignments.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

20. Digital tools improve the quality and efficiency of our group outcomes.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

21. In most group tasks, every member contributes equally to the final outcome.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

22. My group usually works well in coordinating tasks and managing deadlines.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

23. I am comfortable sharing ideas and giving feedback in a team setting.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

24. My groups tend to produce high-quality work when collaboration is involved.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

25. I find group activities to be a valuable part of my learning process.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Thank you for your participation. Your responses are greatly appreciated and will help improve learning space design to better support student collaboration at Mingde Polytechnic Institute.