

**DESIGN GUIDELINE CRITERIA FOR LEARNING
SPACES: CASE OF PRIMARY SCHOOLS IN
SHANDONG PROVINCE, CHINA**

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**DESIGN GUIDELINE CRITERIA FOR LEARNING
SPACES: CASE OF PRIMARY SCHOOLS IN
SHANDONG PROVINCE, CHINA**

by

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LIST OF ABBREVIATIONS

MOE	Ministry of Education of the People's Republic of China
LSDG	Learning space design guideline
CEED	China Education Expert Database
ADI	Architecture Design Institute
HVAC	Heating, Ventilation and Air-conditioning
WBDG	Whole Building Design Guide
T&L	Teaching and Learning
SCT	Social Cognitive Theory
SIN	Stimulation, Individualisation and Naturalness
IAQ	Indoor air quality
PE	Physical Education
STEM	Science, Technology, Engineering, Mathematics
I-CVI	Content validity of individual items
S-CVI	Content validity of the scale
ACP	Average congruency percentage
PMV	Predicted Mean Vote
PPD	Predicted Percentage of Dissatisfied
SLCs	Small Learning Communities
UGR	Unified Glare Rating
FLE	Flexible Learning Environments
DSLR	Digital Single-Lens Reflex
PISA	Programme for International Student Assessment

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**KRITERIA GARIS PANDUAN REKA BENTUK UNTUK RUANG
PEMBELAJARAN: KES SEKOLAH RENDAH DI WILAYAH SHANDONG,
CHINA**

ABSTRAK

Reka bentuk ruang pembelajaran memainkan peranan penting dalam pengalaman pendidikan pelajar, terutamanya untuk pelajar sekolah rendah. Ruang pembelajaran mesti disesuaikan untuk memupuk kemahiran yang pelbagai, membolehkan pelajar menyesuaikan diri dengan piawaian yang berkembang dan keperluan untuk bakat masa depan. Walau bagaimanapun, reka bentuk ruang sedia ada sering mempamerkan ketegaran dan penyederhanaan yang berlebihan, yang bercanggah dengan pedagogi berpusatkan pelajar yang mengutamakan kepelbagaian dan kepelbagaian. Kajian ini bertujuan untuk membangunkan dua model: model Naturalness, Individualization, and Stimulation (SIN) dan model (MoPLE 21). Melalui kajian literatur, tiga prinsip reka bentuk, tujuh parameter reka bentuk, dan dua puluh satu elemen reka bentuk telah diperiksa untuk mewujudkan Garis Panduan Reka Bentuk Ruang Pembelajaran (LSDG) secara konsep. Selain itu, kajian kes telah dijalankan melalui persampelan bertujuan melibatkan empat sekolah rendah di Shandong, China. Pemerhatian dan temu bual berkumpulan telah dijalankan dengan pengguna (72 pelajar dan 18 guru) merentasi empat kes untuk mengenal pasti isu yang berkaitan dengan ruang pembelajaran semasa. Selain itu, temu bual dengan sembilan pereka telah dijalankan untuk menangani isu ini dan menyemak LSDG konseptual. Data temu bual dianalisis secara manual menggunakan proses analisis tematik enam langkah. Dapatan kajian menunjukkan bahawa suhu tinggi dan komponen tidak selamat sering disebut sebagai faktor yang secara langsung mempengaruhi

pengalaman pembelajaran pelajar. Kedua-dua guru dan pelajar menyatakan keperluan untuk penambahbaikan dalam keadaan ruang pembelajaran. Pereka bentuk mencadangkan bahawa kerajaan perlu meningkatkan pelaburan dalam kemudahan bilik darjah dan menekankan kepentingan pengurusan sekolah yang berkesan dalam meningkatkan persekitaran pembelajaran. LSDG yang disemak telah disahkan oleh tujuh pakar mata pelajaran menggunakan dua indeks analisis kandungan, Indeks Kesahan Kandungan Tahap Item (I-CVI) dan Indeks Kesahan Kandungan Tahap Skala (S-CVI). Kajian ini menyumbang kepada pemurnian garis panduan reka bentuk ruang pembelajaran dalam konteks China.

DESIGN GUIDELINE CRITERIA FOR LEARNING SPACES: CASE OF PRIMARY SCHOOLS IN SHANDONG PROVINCE, CHINA

ABSTRACT

The design of learning spaces plays a critical role in students' educational experiences, particularly for primary school students. The learning space must be tailored to cultivate diverse skills, enabling students to adapt to the evolving standards and requirements for future talents. However, existing space designs often exhibit rigidity and oversimplification, which contradicts student-centred pedagogies that prioritize variety and plurality. This study aims to develop two models: the Naturalness, Individualization, and Stimulation (SIN) model and Model of 21st century physical learning environment (MoPLE 21) model. Through literature review, three design principles, seven design parameters, and twenty-one design elements were examined to conceptually establish the Learning Spaces Design Guideline (LSDG). Additionally, case studies were conducted through purposive sampling involving four primary schools in Shandong, China. Observations and group interviews were conducted with users (72 students and 18 teachers) across four cases to identify issues related to the current learning space. Additionally, interviews with nine designers were conducted to address these issues and revise the conceptual LSDG. The interview data were manually analysed using a six-step thematic analysis process. The findings indicate that high temperatures and unsafe components are frequently mentioned as factors that directly affect students' learning experiences. Both teachers and students expressed the need for improvements in learning space conditions. Designers suggested that the government should increase investment in classroom facilities and highlighted the importance of effective school management in enhancing the learning environment.

The revised LSDG was validated by seven subject experts using two content analysis indices, the Item-Level Content Validity Index (I-CVI) and the Scale-Level Content Validity Index (S-CVI). This study contributes to the refinement of learning space design guidelines in the context of China, which can be applied for the designers in the design of future schools and the renovation of existing ones. This guideline gives suggestions for the teachers and students to decorate the interior learning spaces and assists architects in creating high-quality environments that meet the demands and learning styles of the 21st century.

CHAPTER 1

INTRODUCTION

1.1 Research Background

This thesis focuses on the physical learning spaces, especially identifying interior space design guidelines. The contextual background of the current research is briefly explained in the following section.

1.1.1 The 21st century education and pedagogy paradigm

A paradigm shift in education is necessary, as the 21st century is often referred to as the "Third Evolutionary Wave," also known as the Information Age (Chetry, 2024; Gidley & Gidley, 2016, p. 137; Kennedy et al., 2015, p. 80; Khalilurrahman, 2023). The traditional educational paradigm is heavily criticized for its passive learning, emphasis on academic knowledge and teacher-centred learning (Kennedy et al., 2015). Moreover, SDG4 aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all people (United Nations, 2024). However, many educational systems in both developed and developing countries continue to primarily rely on passive learning, which emphasizes memorization and direct instruction, rather than utilizing interactive teaching strategies that foster the critical and autonomous thinking required in the contemporary innovation-driven economy (World Economic Forum, 2020), as shown in Figure 1.1.

The outdated educational system is unable to cope with the fast-evolving world of "liquid modernity" (Bauman, 2013) and "digital natives" (Samala et al., 2024). This perspective is supported by Rubino (2021), who stated that individuals are likely to place greater value on acquiring new knowledge than on retaining existing knowledge, with just-in-time learning becoming the norm. Y. Li & Ho (2024) and Zheng et al. (2024) bemoaned that there is creative potential scarcity among the Chinese because

of this. They insisted that this circumstance has essentially hindered change in the Chinese educational system, although Chinese students score first rank on the Programme for International Student Assessment (PISA).

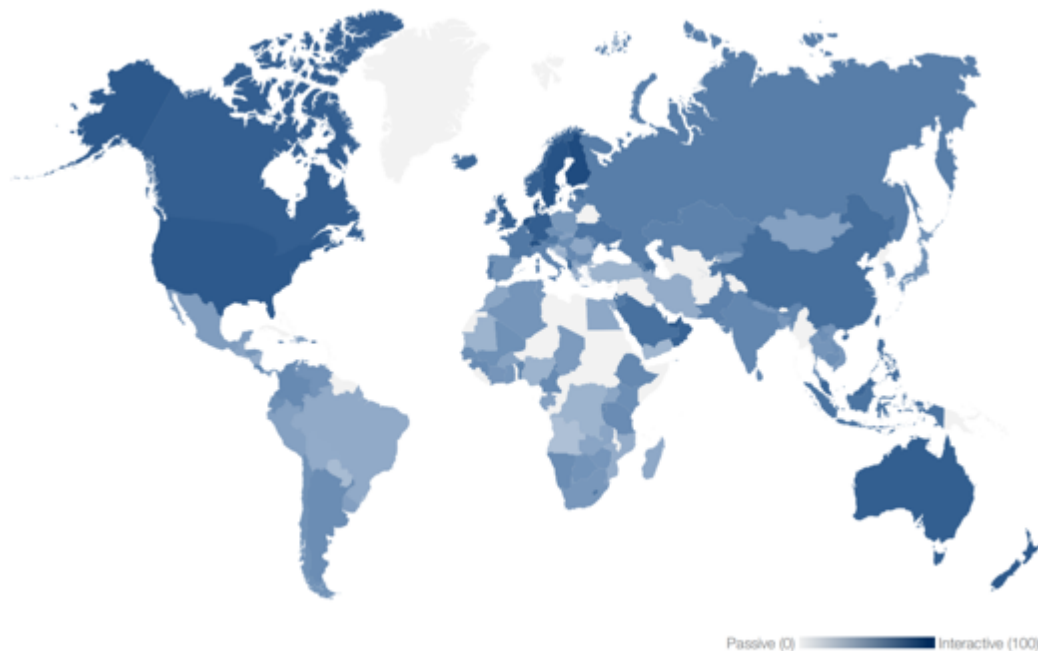


Figure 1.1 The global teaching styles

Source: (World Economic Forum, 2020)

There is economic development in every country during the 21st century. The advancement of technology often accompanies it as every business tries to cope with this pace. This prominent growth makes all businesses suffer countless challenges as they must adapt to this new trend. Thus, the demand for new skills among the workers is enlarged and keeps changing. The rising demand for new skills in the job market has pressured educational institutions to produce future workers and talents so that they can meet the demand (Scott, 2017; World Economic Forum, 2020). The four C's skills which are critical thinking, creativity, communication, and collaboration were highlighted by the Organization for Economic Cooperation and Development (OECD), Assessment and Teaching of 21st Century Skills (ATCS), and Partnership for Twenty-

first Century Skills (P21) (Chiruguru & Chiruguru, 2020). These skills are shown in Figure 1.2.

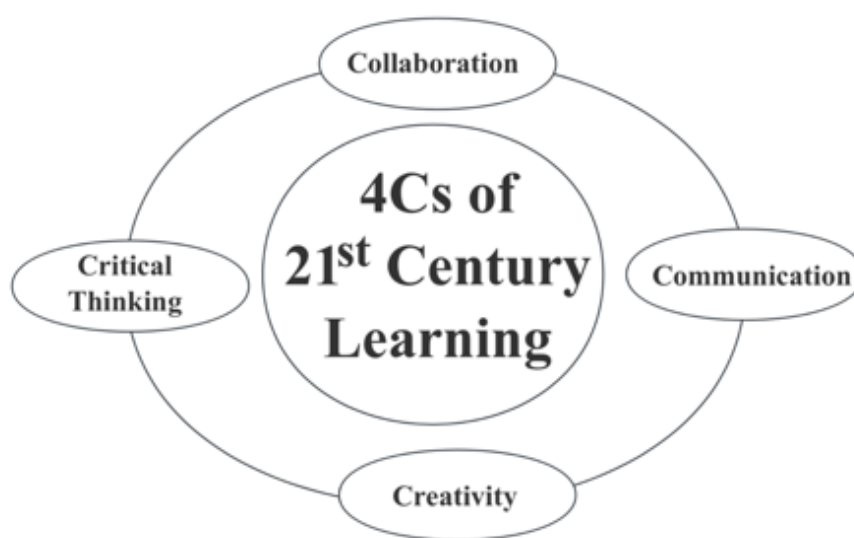


Figure 1.2 Four C's 21st century skills

Source: (Chiruguru & Chiruguru, 2020)

The rising demand for new skills in the job market has pressured educational institutions to produce future workers and global citizens to meet the demand (World Economic Forum, 2020). A new education model known as Education 4.0 was proposed in line with the goals of the Fourth Industrial Revolution. This model aims to transform education and cultivate every student so that they are prepared and readied for the future (de Souza & Debs, 2024; World Economic Forum, 2020). A new paradigm places more emphasis on active learning instead of passive learning. Consequently, there has been a significant change in the global teaching paradigm and learning model over the past 20 years (Cheng & Carolyn Yang, 2023; Nair, 2019), as shown in Figure 1.3. World Economic Forum (2020) highlighted the innovation and creativity skills and learning methods, which are student-driven, problem-based, collaborative, and self-paced learning. These skills and methods are consistent with student-centred learning.



Figure 1.3 Teacher-centred model converts to a student-centred model

Source: (Nair, 2019)

It is undeniable that traditional learning theories, such as behaviourism, cognitivism, and constructivism, have been extensively used in educational systems at all educational levels. Currently, the cultivation of the four C's skills and 21st century learning methods are mainly affected by constructivist learning theory, which encourages students to construct knowledge through exploration, collaboration, and communication (Goodwin, 2024; Rubino, 2021). This theory proposes that learning space acts as a place to promote students' willingness to learn. However, the transformation from teacher-centred to student-centred learning method is too slow.

1.1.2 Education development in China

China's education system has significantly improved quality and popularised since the Chinese Economic Reform and Opening Up in 1978. The government promotes curriculum reform, emphasizing quality education, and cultivating students' innovative and practical abilities (Guorui Fan, 2025). With the development of modern information technology, smart classrooms and future schools are explored, while traditional classrooms are still the mainstream in the education system (Long, 2024). It is necessary to explore how to adapt the traditional school to future development and transform it into a smart classroom.

In 1999, the MOE of China issued a decision from the CPC Central Committee and the State Council on Deepening Education and Comprehensively Promoting Quality-oriented Education. This policy was officially defined as "quality-oriented

education", which required cultivating students' innovative skills and practical abilities. Quality-oriented education emphasizes the holistic development of students rather than focusing solely on academic performance and test results. It aims to cultivate well-rounded individuals by nurturing five key areas: moral character, intellectual ability, physical health, aesthetic appreciation, and practical skills (MOE, 1999). This student-centered philosophy promotes creativity, critical thinking, emotional intelligence, and social responsibility. In practice, it encourages diverse learning experiences such as project-based learning, arts and sports activities, life skills education, and community engagement. In China, quality-oriented education has become a major reform direction since the 1990s, serving as a response to the limitations of exam-oriented education. Recent policies, like the "Double Reduction" initiative, reflect this shift by reducing academic pressure and fostering more balanced, engaging, and meaningful learning environments (MOE, 2021).

Consequently, the advancement of quality-oriented education is progressing rapidly. Nonetheless, primary schools are experiencing a growing scarcity of educational resources. In alignment with national policy directives and the swift development of the architectural sector, scholars have undertaken comprehensive investigations into the design of learning spaces in primary schools within the framework of quality-oriented education. A summary of relevant school design guidelines is presented in Table 1.1.

Table 1.1 A brief of school design guideline

Year	Title	Summary
1986	Code for design of school GBJ99-86	New China's first national design code for primary and secondary schools' construction. School building design principles and methods are compiled, including site selection and layout, architectural design, and indoor and outdoor environments.

2011	Code for design of school GB50099-2011	The code is applicable to the planning and engineering design of new construction, reconstruction and expansion projects of urban and rural primary and secondary schools. The contents include general basic regulations, sites and general plans, main teaching rooms and teaching auxiliary rooms area index and net height, safe passage and evacuation, indoor environment, construction equipment, etc.
2003	Code for design of special education school JGJ76-2003	It is applicable for schools for the blind, deaf and intellectual training, with emphasis on barrier-free facilities and rehabilitation training space.
2016	Code for design of nursery and kindergarten buildings JGJ 39-2016	The design of nursery institutions for 0–6-year-old children emphasizes safety protection, activity venues, living rooms, etc.
2002	Building standards for ordinary primary and secondary schools in cities (2002)	It specified the school construction scale and the composition of school buildings, network layout, site selection, planning and design, and building area index of school buildings. The school buildings of ordinary urban primary and secondary schools are composed of three parts: teaching and teaching auxiliary rooms, office rooms and living service rooms.
2008	Standard for construction of ordinary primary and secondary schools in rural areas (2008)	It is applicable to township (town) and the following rural ordinary primary and secondary school construction, reconstruction, and expansion projects.
2018	Building area index of ordinary colleges and universities (2018)	It regulates the construction scale and project composition of ordinary institutions of colleges and universities and provides specific standards and basis for the construction of ordinary institutions of colleges and universities.

In 2017, the 13th Five-Year Plan for the Development of National Education pointed out that Chinese education development was unbalanced and uncoordinated. Every school would strengthen its students' practicality, cooperation, and innovation ability, clarify the core quality requirements of students' development, and establish innovative talent training methods. In order to foster students' inventive

spirit and practical competence, educators should employ various teaching strategies, including heuristic, exploratory, cooperative, and interactive approaches (CPC Central Committee, 2019; Zhang, 2019b).

It is worth noting that the "Future School Plan" was launched by the China National Institute of Education Sciences to explore China's future school construction in 2013. In 2016, the Chinese National Institute of Education Sciences and Future School Lab published a 'White Paper on Future Schools in China' which indicated that the education function should adopt a new characteristic, the school curriculum, learning methods, architecture and school space, and the role of the teacher. It shows the characteristics of new school buildings and learning spaces. Learning space design need to change as an essential carrier of school education (Wang et al., 2016).

In 2017, the National Centre for Schooling Development Programme launched the "Future School Research and Experiment Program". Building a future campus that is oriented toward future talent training and student-centred is imperative. In 2018, the Chinese National Institute of Education Sciences and Future School Lab published 'Chinese Future School 2.0: Conceptual Framework', which indicated the interior space of the classroom characteristics: Students can move freely in the learning space and access the materials and tools easily and quickly. Students can choose their seats freely instead of being assigned by their teacher. The tables, chairs and equipment in different classrooms should be diverse. Future schools aim to create comfortable and suitable learning spaces for teachers and students. Moreover, China Future School Innovation Plan 2.0 was released in 2020, and China Future School Innovation Plan 3.0 which promotes the development of China's future schools from the perspective of smart education and proposes to deepen the theoretical research and practical exploration of future schools under the background of digital transformation was

released in 2022. These documents put forward a lot of forward-looking ideas, but there are not detail requirements for the practice. Due to the constraints of traditional education concepts, education systems and other factors, future schools are difficult to completely get rid of the influence of traditional education models in some respects (Zhang Ruqing, 2025). There still be a dependence on the path of traditional exam-oriented education, and it is difficult to truly realize the comprehensive development of student-centered education (Yang Danni, 2022).

In China, there are some reports about the ideas and concepts of the future school. These reports are designed to address the challenges in the context of digital transformation and to integrate education's response to social development needs into the exploration of the future school. However, it ignores the existing space and has no detailed requirements for the renovation of the interior space, thus renovation effort would be futile in the sense of achieving ‘ideal future school’.

1.1.3 Primary schools in Shandong Province

Shandong is a big province of education, with a large number of schools and students. Vigorously promote the development of pilot areas for the revitalization of rural education, 90.3% of primary schools in the province to achieve group education and improve the conditions of rural schools(Li ming, 2025). However, due to the relatively large regional differences, the contradiction of unbalanced education development is still prominent between eastern and western Shandong, urban and rural areas (Shandong education, 2024). The supply of high-quality basic education resources is insufficient, and the distribution is unbalanced. There are insufficient high-quality digital education resources, limited carrying capacity of infrastructure such as network environment and computing resources, and insufficient application of new technologies. Although the quality education is advancing continuously, the

exam-oriented education is still obvious, and the cultivation of students' innovative ability, practical ability and comprehensive quality is not enough (Shandong Department of Education, 2020).

The National Bureau of Statistics of China calculated the total number of schools, external teaching sites and classes in primary schools in 2022. The number of primary schools and students in Shandong province ranked fifth and third among the 21 provinces and cities, as shown in Figure 1.4 and Figure 1.5.

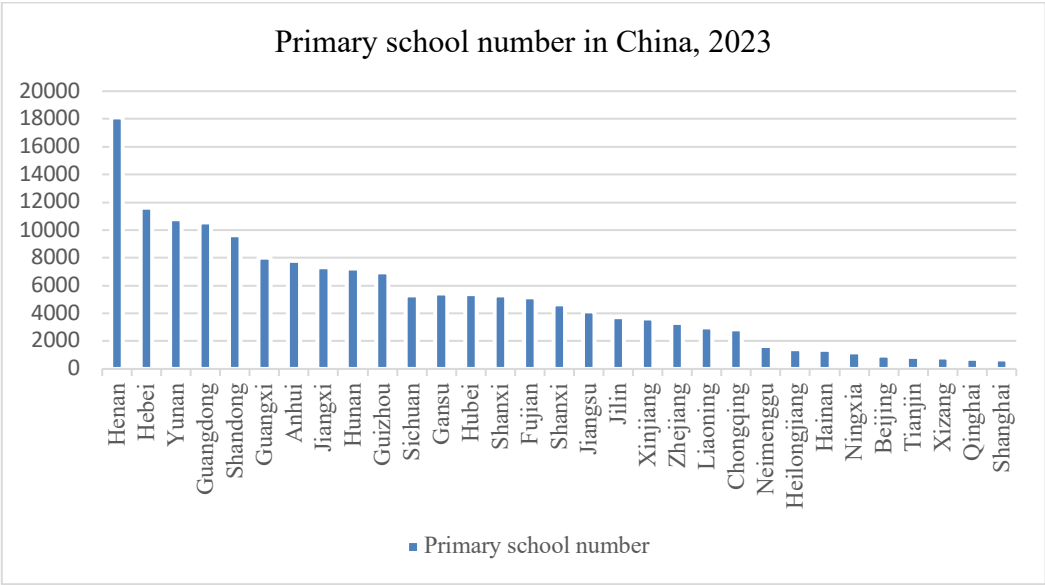


Figure 1.4 Primary school number of each province, 2023

Source: (National Statistics Bureau, 2024).

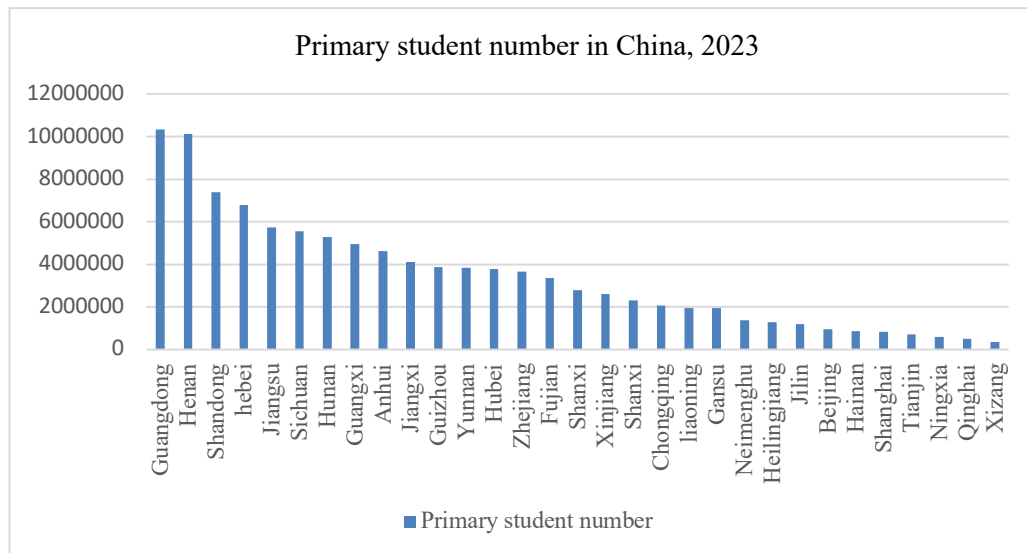


Figure 1.5 Primary student number of each province, 2023

Source: (National Statistics Bureau, 2024).

The Centre for Chinese Studies in Washington, D.C. and the Ivy League +2 Alumni Association identified the 500 best primary schools in China (China Education Online, 2014). They work closely with Ministry of Education of the People's Republic of China (MOE), and this ranking is supported by data from education departments in more than 50 provinces and municipalities across China. The ranking is based on the quality of teachers, environment, facilities, junior high school enrollment rate, college enrollment rate, overseas study rate, student expenditure and alumni donation. It compares each province or city's best primary schools and student numbers (see Figure 1.6). The top three provinces in student numbers are Guangdong, Henan, and Shandong. Henan and Shandong provinces have the most significant numbers of students but few best schools. On the contrary, Beijing and Tianjin are the cities with the best schools and fewer students. This means that students who stay in the province with many students and few high-quality schools have fewer opportunities to enjoy high-quality education.

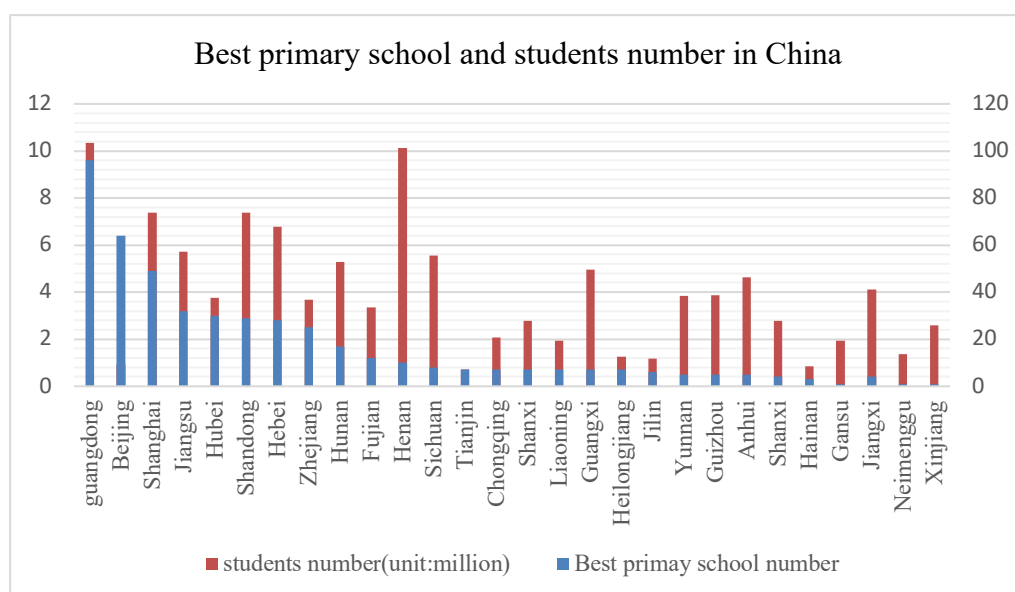


Figure 1.6 Best primary school and student number in China

Source: (China Education Online, 2014)

1.1.4 Learning space and learning effectiveness

The learning space and spatial alignment must satisfy the pedagogical transition and 21st century skills cultivation (Semerci & Batdi, 2015). Many countries are eager to improve current learning spaces beyond the status quo to cultivate skills and talents in the 21st century among students to support student-centred learning methods (World Economic Forum, 2020).

In the early 21st century, the idea of building a flexible learning space in school had resurged. Several educational programmes around the world, such as the Building Schools for the Future programme in England and Wales (4ps & Partnerships for Schools, 2008), the Building the Education Revolution government programme in Australia (Australian National Audit Office, 2010), and the Innovative Learning Environments project (ILEs) in Canada, Peru, and New Zealand (OECD, 2017), argued that education was needed to change and advocate for creative learning spaces that support ‘21st century learning’. The Nordic countries emphasise flexibility and open designs compared to others (Grannäs & Stavem, 2021; Sigurdardottir &

Hjartarson, 2016). The notions of "mobile," "agile," and "flexible" learning spaces, together with deliberate pedagogical adjustments, are the driving forces behind these new open-plan school designs (Dovey & Fisher, 2014). Although flexible learning space has been popularised in recent years, many countries are still using traditional learning space as the mainstream in their education system (Duthilleul et al., 2019).

Learning space is not only an environment in which learning activities occur, but it also influences cognition, emotions, attention, and teaching activities (Cleveland & Soccio, 2015; Wallace et al., 2022). Other factors such as size, arrangement, fresh air, temperature, light, acoustics, furniture, writing and display surfaces (blackboards, tack surfaces, and markerboards) and aesthetics style can directly impact on the learning method and learning performance (Phillips, 2014). A well-designed learning space can improve students' cognitive processes by offering the best resources and stimuli (Barrett et al., 2015; Oogarah-Pratap et al., 2025). Learning space with comfortable seating and natural lighting can provide an environment that is favourable to learning (Bluteau et al., 2022). Additionally, an organised learning space might maintain their attention, and dynamic learning space can support a variety of teaching strategies, including group projects and individual study (Han, 2021). By taking care of these components, teachers may design a learning space that promotes students' overall growth in addition to their academic success. Barrett et al. (2015) found that a learning space that fulfilled the above requirements can increase students' academic performance by 16%. A poorly designed learning space is detrimental to students' learning effectiveness. Classrooms with inadequate lighting, uncomfortable furniture, and poor acoustics can create distractions and discomfort. It can decrease students' academic performance and lower their overall satisfaction towards the learning experience (Y. (Felicia) Huang & Chui, 2024; Y. Li & Ho, 2024).

1.2 Problem Statement

Ministry of Education (MOE) of China released the “Modernisation of Chinese Education 2035” in 2019, which aims to effectively utilise the learning resources to strengthen students’ practical, cooperation, and innovation skills and clarify core quality requirements for student development (Zhang, 2019a). However, MOE of China found that the students’ learning effectiveness, cooperation skill and innovation skills are very low based on the PISA result (Cao, 2019). Some research found the space layout affect students learning effectiveness. For example, rigid learning space layout hinders educators to use more expansive pedagogies that are more likely to support student-centred, technologically enhanced learning. Working in individual don’t encourages collaboration and develop effective communication skills as students can’t share ideas and solve problems together as the rigid layout always feature fixed desks and seating (Kariippanon et al., 2021). Inflexible learning spaces are common whether in developed countries or developing countries (Halidane et al., 2023; Nja et al., 2023). It was developed during the modernist architectural era that followed World War II and always enables the instructor to teacher-led direct instruction (Byers et al., 2018; Dovey & Fisher, 2014). Most schools are still using traditional learning spaces model in China, which might not be able to reach the target of the new plan (Cleveland & Soccio, 2015; Niemi et al., 2022; Starkey et al., 2021).

Moreover, inappropriate learning space aspects significantly affect student learning effectiveness (Bennell, 2022; Y. Wang et al., 2023). Students are often confined to rigid classroom layouts with uncomfortable indoor environment quality such as poor lighting, air quality (Korsavi et al., 2020b), overcrowded spaces (Bennell, 2022; Blatchford et al., 2011; King-Agboto & Ugorji, 2023), mismatched furniture (Adeyemi et al., 2020), declining space quality (Barrett et al., 2015), colour and

decoration (Jiang et al., 2025), which collectively limit engagement and learning flexibility. These problems are more prominent in China, especially the impact of large class sizes on students' learning (Meng et al., 2023, 2025; G. Zhang et al., 2007; Z. Zhang, 2019). Therefore, current learning spaces still has many issues hinder students learning effectiveness and not conducive to developing 21st century skills such as creativity, collaboration, cooperation, and critical thinking.

Uncomfortable and poorly designed classrooms often lead to disciplinary issues (Korsavi et al., 2020b; Korsavi & Montazami, 2020), while small, monotonous spaces reduce students' motivation to learn (Li & He, 2023). Baloch et al. (2021) found that direct sunlight is negatively associated with test scores if glare becomes a problem. Ding et al. (2023) found that classrooms struggle with low temperatures during winter in colder climates in the Netherlands. Bakó-Biró et al. (2012), who demonstrated the adverse effects of poor ventilation on students' concentration and performance. Szpytma and Szpytma (2022) argued that the traditional layout is too simplistic and inflexible, not conducive to student-centred pedagogy emphasising diversity and diversity. Moreover, there is a high mismatch rate of desk heights in primary schools, ranging from 89.7% to 94.6%, as students' body shapes vary significantly during this developmental stage (Chung & Wong, 2007; Gouvali & Boudolos, 2006). Starkey et al. (2021) further demonstrated that mismatched furniture can adversely affect students' posture, comfort, and learning outcomes. It is worth noting the findings of Burke & Grosvenor (2003), Maxwell (2003) and Meng et al. (2023), who reported that mismatched or overly bright colours can negatively affect students' perceptions of the learning environment. The researchers have different opinion for the colour element. Duyan and Ünver (2022) and Kwallek et al. (1996) discovered that blue wall dramatically decreased students' attention span. Although existing research explores

individual factors of learning environments affecting students' learning, there is a lack of holistic, user-informed studies focusing on design aspects that influence learning in Chinese primary schools.

The learning space was designed based on Code for the Design of School GB 5099-2011 (GB 5099-2011 code) in China, which offers guidelines and specifications for building a traditional learning space. However, the current GB 5099-2011 code does not provide any useful recommendations for space reallocation or multipurpose usage of space (Hui, 2019). Users' needs are frequently overlooked in the design of learning spaces, which undermines the effectiveness of teaching and learning. Few studies explore how instructors are supported in using educational spaces, leaving teachers with limited guidance on how to manage and adapt their classrooms effectively (Dovey & Fisher, 2014). Rönnlund et al. (2021) note that the process of creating and constructing learning environments is often challenging due to a lack of clear design guidelines. Some stakeholders even perceive user participation in the design process as inefficient or unnecessary (James, 2011), and there remains a disconnect between the rhetoric of inclusive design and its actual implementation (Parnell & Patsarika, 2016). Although user participation is widely recognized as essential in design practice, the perspectives and experiences of users—particularly teachers and students—are often under-represented in classroom design decisions. This lack of input results in learning environments that fail to meet the practical needs of their users and, consequently, limit learning effectiveness. Furthermore, there is a scarcity of research that provides school administrators and designers with concrete guidance on improving primary school learning environments. In contrast, several Western countries—including the United States, United Kingdom, Australia, New Zealand, and Finland—are actively reforming educational spaces to support student-

centered learning. For example, the UK's Education Funding Agency (EFA) has developed a standardized set of school design guidelines. As Vijapur et al. (2021) emphasize, the development of such design frameworks is increasingly urgent, as many governments are committing significant resources to building new learning environments that foster student-centered pedagogies. In comparison, China currently also lacks sufficient design guidelines that integrate user needs to support student-centered learning and the development of 21st century skills.

In summary, the current school space design in China remains poorly aligned with modern educational goals, limiting opportunities for experiential learning, creativity, and skill development. The existing design code, GB 5099-2011 code, is outdated and does not support contemporary, student-centered pedagogies. It also fails to address key aspects of effective learning environments, such as spatial flexibility, furniture ergonomics, lighting quality, and user participation. Some design criteria in the Code for the Design of School GB 5099-2011 (GB 5099-2011) in China need to be improved. Therefore, this study aims to bridge the gap by developing context-specific design criteria rooted in user needs and focused on enhancing spatial effectiveness.

1.3 Research Questions

In developing the design guidelines for 21st Century learning spaces, it is imperative to investigate how the learning spaces can enhance learning effectiveness in the 21st Century. With such curiosity, in particular for China's primary school context, three research questions emerged as below:

RQ1: What are the empirical issues and problem of current learning spaces affecting learning effectiveness?

RQ2: How do design aspects of learning spaces affect learning effectiveness?

RQ3: What physical design criteria should be in place to improve learning effectiveness in relation to the guidelines?

1.4 Aim and Objectives

This study aims to improve the design of interior space of education building with the intention to boost learning effectiveness in the 21st century. With special emphasis on the primary schools in China, three research objectives are identified as below:

RO1: To identify empirical issues and problem of current learning spaces affecting learning effectiveness.

RO2: To analyse design aspects of learning spaces that can boost learning effectiveness.

RO3: To propose physical design criteria in the form of an enhanced guideline (Learning Space Design Guidelines) to improve learning effectiveness.

1.5 Research Constructs

The following Figure 1.7 presents the research constructs:

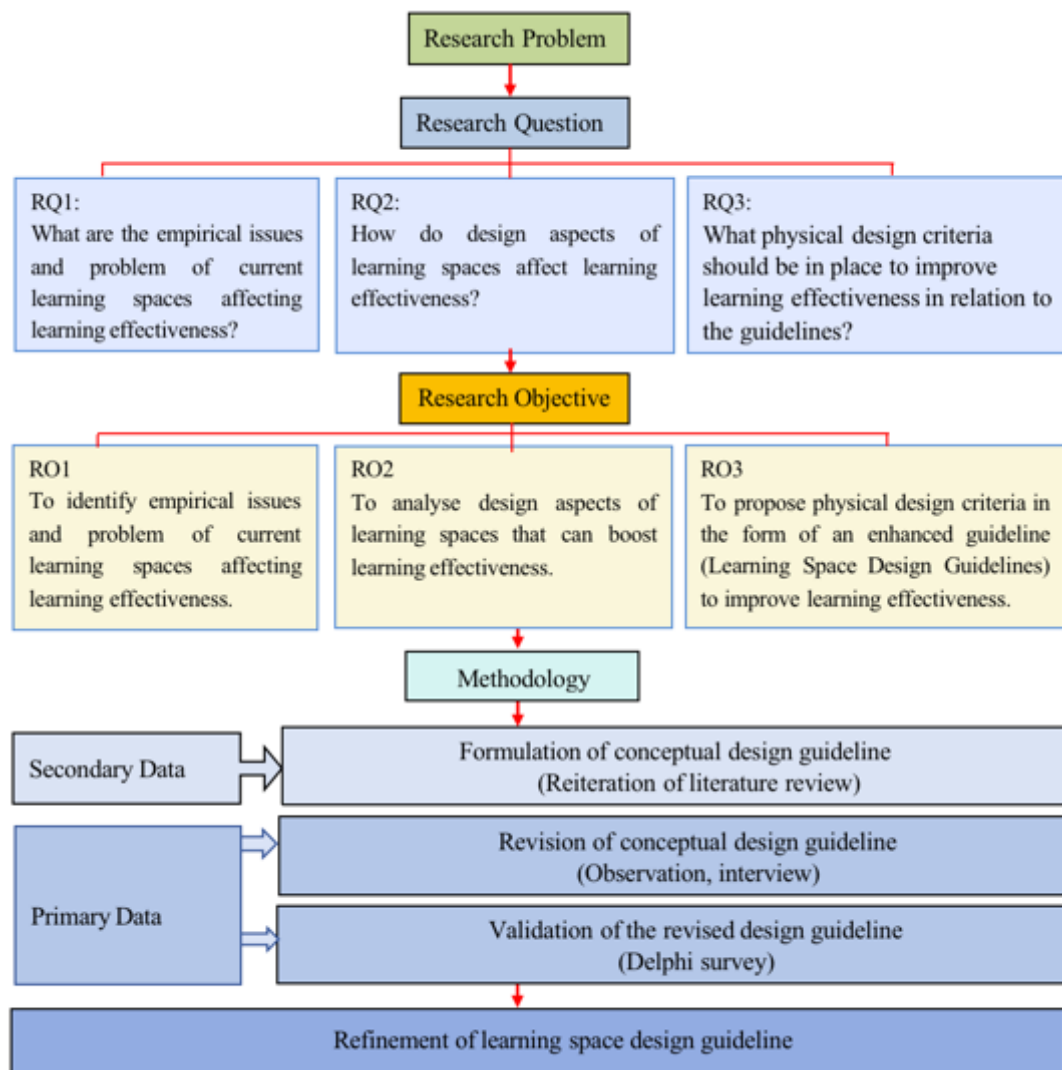


Figure 1.7 The research constructs

1.6 Scope of Research

This study mainly focuses on public primary school and interior learning space design. Each research scope is explained as below:

1.6.1 Public primary school

The Chinese education system is a comprehensive and multi - level system that includes several stages and types of education, as shown in Table 1.2.

Table 1.2 Education stage in China

Education stage	Age	Goal	Source
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Preschool Education		3 – 6 ages	Preschools focus on activities such as games, art, and music to stimulate children's interests and cognitive abilities.	(MOE, 2018a)
Compulsory Education	Primary Education	6 - 12 ages	Students receive basic education in Chinese, mathematics, science, morality, and other subjects. The curriculum also includes physical education, art, and music to develop students' comprehensive abilities.	(MOE, 2018a)
	Junior High School Education	12-15 ages	This stage introduces more specialized courses such as physics, chemistry, and history to prepare students for further studies.	(MOE, 2018a)
Senior High School Education		15-18 ages	The curriculum covers a wide range of academic subjects, and students need to master in - depth knowledge and skills to meet the requirements of higher education.	(MOE, 2018b)
Higher Education	Undergraduate Education	4-5 years	Students choose a major and study a variety of courses related to their major, as well as general education courses. They need to complete a certain number of credits and pass the graduation thesis defence to obtain a bachelor's degree.	(MOE, 2018b)
	Postgraduate Education	Master's Degree 2-3 years	Students conduct in - depth research in their professional fields under the guidance of tutors, complete thesis,	(MOE, 2018b)

			and pass the defence to obtain a master's degree.	
		Doctoral Degree 3-5years	Students are required to conduct original and in - depth research, make important contributions to the academic field, and complete and defend their thesis to obtain a doctor degree.	

Compulsory education is imposed on every family by the government to ensure that all children can receive education as it is one of their rights. All Chinese children must undergo nine years of compulsory education. Primary education is provided from standard one (6 years old) until standard six (12 years old). The primary education is conducted in a primary school. Based on 2024 national education statistics published by the National Bureau of Statistics of China, primary schools and students are the main compositions of the Chinese education system, as shown in Figure 1.8. Primary schools can be divided into public and private schools based on their operation. Public school is a government school, while private school is a non-government school. Therefore, this study focuses on public primary schools in China.

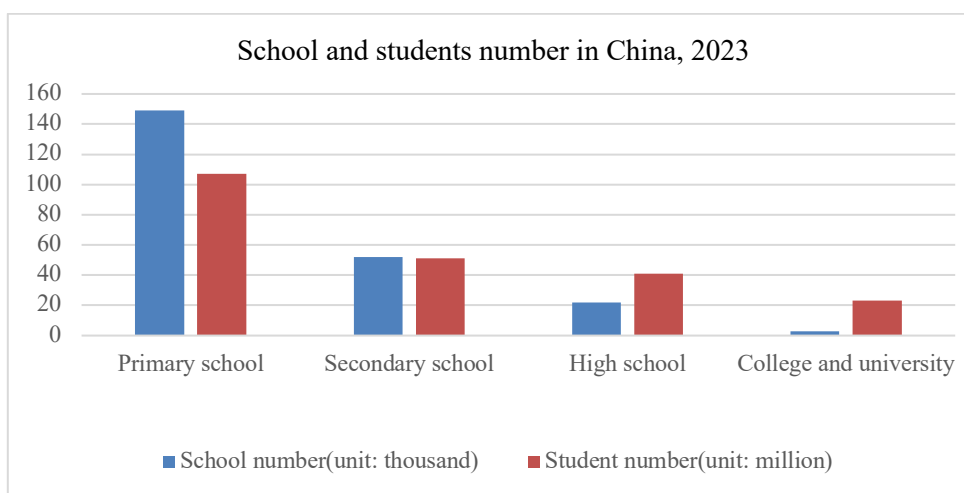


Figure 1.8 Main results of 2023 National Education Statistics

Source: (China Statistical Yearbook, 2024)

1.6.2 Class size

Class size is defined as the total number of students enrolled in a common curriculum, determined by the maximum number of common courses, and eliminating instruction in smaller groups (OECD, 2024).

At the primary level, the mean class size in OECD nations is 21 students. All countries with accessible data report fewer than 25 students per class, except for Chile, Israel, Japan, and the United Kingdom. Among all countries with available data, class sizes vary, with some nations such as Croatia, Estonia, Finland, Latvia, and Luxembourg having fewer than 20 students per class (Figure 1.9). Smaller classes are frequently regarded as advantageous, as they enable teachers to concentrate on the specific needs of individual students and diminish the time required to manage disruptions (Blatchford & Russell, 2020). However, the overall evidence regarding the impact of class size on student performance is inconclusive (OECD, 2024). However, there are more than 45 students in primary school classroom in China (MOHURD, 2012). This study focuses on the influence of large class learning space on students' learning based on Chinese educational context.

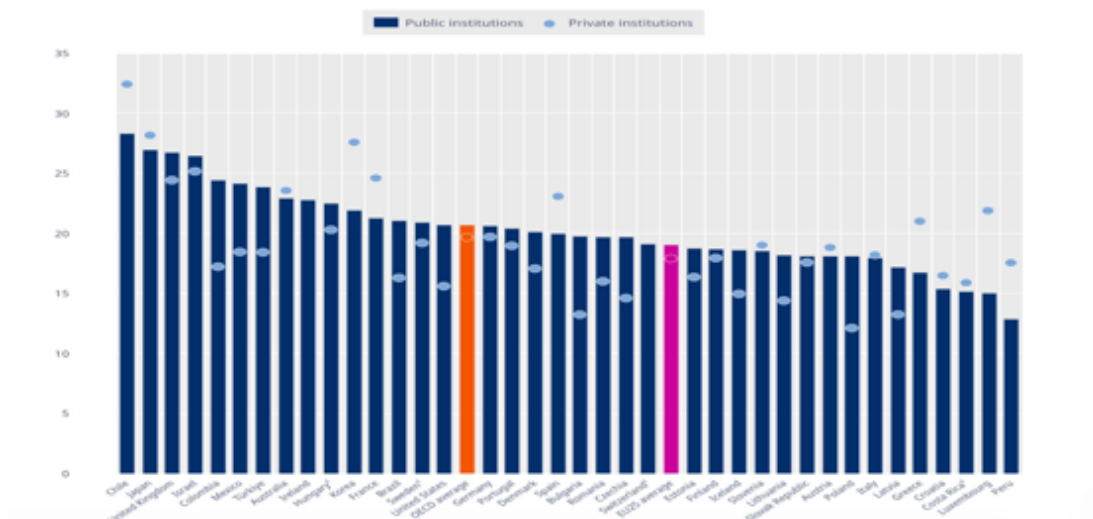


Figure 1.9 Average class size in primary education

Source: (OECD, 2024)

1.6.3 Students-centered teaching methods

The common classroom modes are subject-based and class-based. For subject-based classroom, various topic teachers deliver teaching in the subject-based classroom approach (Huang & Chui, 2024). Students change classes and have new peers depending on the courses they take, while subject teachers remain in the same classroom (Forster et al., 2020). For class-based classroom, most subjects are taught in the same classroom with the same class of students, with the exception of sports, science, and art, which are taught in different places but with the same class of students. China operates a class-based classroom system that spans from primary through secondary education. In this model, students remain in a fixed classroom while subject-specific teachers rotate among classes, as opposed to students transitioning between specialized classrooms. Moreover, it is common for students to remain with the same cohort of peers and often the same instructor for several consecutive years, promoting instructional continuity and fostering stable social and academic relationships (Jia et al., 2009).

MOE (2022a) mentioned creating a student-centered learning environment, highlighting students' dominant position in learning, carrying out differentiated teaching, strengthening individualized guidance, and meeting students' diversified learning needs. The classroom teaching method in the new era is no longer the traditional way of passive acceptance and inculcating memory, but the student-centered concept, and the teaching method of helping students learn to learn, active learning and deep learning through diversified learning methods. Although students begin to try independent learning, cooperative learning and inquiry learning, the teaching method has not changed fundamentally, and the teaching mode is still

teacher-lecture-based in the classroom as the large class size and the lack of resources in some areas(Chen youqing, 2019; Wang zijun, 2024).

1.6.4 Interior learning space

As talent skills and pedagogical approaches are demanding in the 21st century, educators and professional designers have begun to realise the critical role of learning space in education (Attai et al., 2021). Every child and adolescent spend more than 12% of their life at school. Korsavi et al. (2020) concluded that the time they spend inside the school is significantly higher than in their house. Notably, the performance and well-being of students are correlated with the interior design of learning spaces (Bluteau et al., 2022; Kariippanon et al., 2018; Küller et al., 2009; Marshall & Losonczy-Marshall, 2010; Oldham & Kim, 2020). A learning environment's physical attributes influence students' cognitive and emotional domains (Che Ahmad et al., 2014). Moreover, Barrett et al. (2015) found that the physical characteristic of the classroom is proven to have an impact on students' learning progress. However, whole-school factors did not seem as important as the design of the individual classrooms. This research mainly focuses the classroom design. Based on developed countries' learning space design guidelines, an open and flexible classroom can form a better environment for group learning and individual learning to promote the cultivation of students' 21st century skills (DoDEA, 2017).

In July 2021, the Ministry of Education of the People's Republic of China issued a Double Reduction Policy, which aims to reduce the students' homework, and primary schools implement after-school delay services in many provinces and cities. Therefore, students can still stay at school when school time is over. Students spend almost seven hours staying at school every day. Students mainly stay inside the

classroom except for Physical Education (PE). Therefore, this study primarily focuses on interior learning space.

1.6.5 Physical learning space

Learning space includes psychosocial learning space and the physical learning space (Baars et al., 2021). For the psychosocial space, contemporary pedagogies conceptualize learning as a constructive, social, and contextual endeavor rather than an isolated activity by the learner (De Kock et al., 2004). The physical learning space is characterized as the constructed settings within a school designed for educational purposes, encompassing school buildings, learning spaces, and their spatial configuration, furnishings, fixtures, and equipment.

Learning process occurs within a learning environment that encompasses all contextual factors. These factors can be categorized into various dimensions of the learning space. Initially, research on the learning space primarily concentrated on psychosocial dimensions, which encompass all psychological and social elements involved in the learning process (Cleveland & Fisher, 2014). Moos (1980) posits that the perceptions of students and teachers serve as the most reliable data source for assessing the psychosocial learning space, as they reflect enduring characteristics, mitigate incidental occurrences, and provide direct insight into mutual expectations regarding behaviour and productivity. A physical learning space can improve design and draw in users. The constructed surroundings of a school that are meant to serve as learning spaces, such as the interior learning spaces and their spatial arrangement, furniture, and decoration, are referred to as the physical learning spaces (Baars et al., 2021).

The research on the physical learning space demonstrates that while the same components are often found, many studies have varying phrasing and aspect selection.