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Author/s:

Vaz-Serra, P;Dangol, N;Dharmapuri Tirumala, R;Tiwari, P

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Physical environment as a factor in schools' performance and efficiency: A review of previous research

Paulo Vaz-Serra¹, Neeraj Dangol², Raghu Dharmapuri Tirumala³ and Piyush Tiwari⁴

^{1, 2, 3, 4} Faculty of Architecture Building and Planning, University of Melbourne, Australia
{p.vazserra¹, neeraj.dangol², dtvragh³, piyush.tiwari⁴}@unimelb.edu.au
ORCID-0000-0001-5286-0801¹, ORCID-0000-0003-4179-3716², ORCID-0000-0002-6614-0167³,
ORCID- 0000-0002-3195-2843⁴

Abstract: The physical environment can considerably influence the efficiency and functionalities of facilities and spaces. Some recent studies examining schools' efficiency consider several factors such as human capital, parents' socioeconomic background, perceptions of teachers and parents towards schools, and financial status. However, very few studies have investigated the influences of schools' physical environment and facilities on their efficiency and students' academic performance. This research aims to review the recent studies on factors influencing schools' efficiency and student academic performance, and the importance accorded to physical environment. The research database, Scopus, is searched using combinations of relevant keywords and various studies that identify the influencing factors. A preliminary analysis of most of these studies indicates that the physical environment's influence on school performance appears peripheral. However, it was identified that physical environment, facilities, and services influence students' academic performance directly and indirectly. One of the limitations highlighted was that many of the studies, which include the physical environment factors in examining schools' efficiency, were based on a single country. The studies were mainly focused on the USA, and only a handful was based on Australia and the rest of the world. This paper identifies the need for more such studies that can contribute to bridging the knowledge on the efficiency drivers of the schools. A better understanding of the drivers for better school performance is needed to lead to an efficient allocation of funding, particularly for public schools in Australia.

Keywords: Efficiency, Literature Review, Performance, Schools, Students.

1. Introduction

The physical environment of the schools is one of the key factors influencing their performance and efficiency (Berman *et al.*, 2018; Uline and Tschannen-Moran, 2008; Schlafler and Burge, 2020). The performance of schools is considered a combination of educational outcomes, satisfaction outcomes and other general outcomes (Prasetyo and Zuhdi, 2013; Erdogdu and Erdogdu, 2015, Tirumala et al., 2021).

The efficiency of schools is measured as a ratio of the outputs to inputs (Raisebeck et al. 2010). To understand the influence of the physical environment and facilities on schools' performance and efficiency, this research explores and reviews the literature on studies looking at various influencing factors. It uses a systematic literature review to identify relevant empirical research with minimum bias. The section on methodology and data elaborates on the process adopted and the search strings used. The subsequent section discusses the findings and results presented in the table of relevant literature and inferences.

2. Methodology and data

This paper uses a systematic literature review to explore recent studies on influencing factors, including physical environment and facilities, on schools' efficiency and performance. A systematic literature review is a research method and process to identify and critically assess relevant previous studies and collect and analyse data from the same (Liberati *et al.*, 2009). This methodology is appropriate for locating empirical research that fits the inclusion criteria specified according to the aim of the study. Bias can be reduced by applying systematic methods. The process adopted in this study was based on Snyder (2019) with six steps: Choosing a database, identification of keywords, setting up inclusion criteria, extracting data, processing data, and conduct content analysis, and identifying and retrieving relevant data. Scopus was selected as an appropriate database because it is "the largest abstract and citation database of peer-reviewed literature: scientific journals, books, and conference proceedings" (<https://www.elsevier.com/en-au/solutions/scopus>), and it identifies emerging trends and covers a broader breadth of interdisciplinary literature. Moreover, its search tools allow criteria based on subject areas, countries, access, document type, keywords, published years, and other factors to find relevant previous research.

The next step was identifying keywords to search for relevant literature. According to the purpose of this study, the literature related to influencing factors on schools' performance and efficiency was searched, looking at different studies with ways to measure it. Keywords used in these studies were used to search for further studies. Adopting this process iteratively, the following terms were used as keywords to find relevant studies: 'school efficiency', 'school outcomes', 'school facilities', 'infrastructure', 'physical', 'environment', 'resources', and 'measuring efficiency'. To find specific studies on 'Australian' and 'public schools', these two terms were added to two combinations.

Regarding inclusion/exclusion criteria, all types of documents, namely journal articles, book chapters, and conference papers, were included between 1985 and 2021. Non-English literature was excluded from this research. Based on the identified keywords and inclusion criteria, this study collected 513 results and retrieved them to Endnote X9 Library, where duplicates are identified and deleted. Then the remaining data were filtered based on their relevance to the performance of the schools. Filtering was done by reading their titles, abstracts, and keywords. Among retrieved data, 67 were found relevant in varying degrees to the performance and efficiency of different types of schools. Their content was analysed and categorised, and the findings are discussed in the following section.

3. Findings and discussion

The relevant literature content was analysed, and studies were identified and grouped based on factors influencing school performance and efficiency. The main factors are socio-economic conditions (mentioned by 24 studies) and human capital (by 21) in investigating how these factors influence the

performance of the schools. Studies related to physical environment, class and school size, and funding and finance are similar in number (between 11 and 12 studies). The relationship between perceptions of teachers, students and parents and schools' outcomes is the least studied (7). Most of the studies (82%) addressed only one of the factors, and some of the studies showed other sub-factors under the physical environment factor. Facilities and services influence schools' performance and students' achievements and indicate these factors are associated. The number of studies addressing these factors is identified and presented in Table 1.

Table 1: Number of studies by factors addressed.

Factors addressed	Number of Previous studies	Number of Studies
Socio-economic conditions	24	Agasisti, 2013; Berman et al., 2018; Blackburn et al., 2014; Braddock and Elite, 2004; Bryant and Norris, 2002; Coleman, 1988; Dancer and Blackburn, 2017; Dfaz and Barrios, 2002; Duran, 2008; Fombuena, 2016; Gillborn, 2003; Gorard and Smith, 2010; Handa et al., 2004; Hoxby, 2001; Jehangir, Glas, and Berg, 2015; Kirjavainen and Loikkanen 1998; Lee et al., 2019; Liouaeddine et al., 2018; Memon et al., 2016; Miningou and Vierstraete, 2013; OECD, 2012; Queiroz et al., 2020; Ward Schofield and Hausmann, 2004; Tajalli and Opheim, 2005
Human capital	21	Alexander et al., 2010; Buddin and Zamarro, 2009; D'Aiglepieire, 2011; Darling-Hammond, Berry, and Thoreson, 2001; Duran, 2008; Fetler, 2001; Goldhaber and Brewer, 1996; Handa et al., 2004; Hanushek and Rivkin, 2006; Hanushek and Woessmann, 2017; Hoernemann, 1998; Javier et al., 2016; Kantabutra, 2005; Kantabutra, 2012; Lee et al., 2019; Melvin and Sharma, 2007; Meunier, 2008; Monk, 1994; Philbin, 1997; Treputtharat and Tayiam, 2014; Wolszczak-Derlacz and Parteka, 2011
School and class size	12	Barrett and Toma, 2013; Conroy and Arguea, 2008; Duran, 2008; Finn and Achilles, 1990; Kantabutra, 2005; Kantabutra, 2012; Lee <i>et al.</i> , 2019; McGiverin, Gilman, and Tillitski, 1989; Nyhan and Alkadry, 1999; Okpala <i>et al.</i> , 2000; Sanders, Wright, and Horn, 1997; Wößmann and West, 2006
Physical environment	12	Berman <i>et al.</i> , 2018; Duran, 2008; Javier <i>et al.</i> , 2016; Leung and Fung, 2005; Queiroz <i>et al.</i> , 2020; Roberts, 2009; Schlaffer and Burge, 2020; Stafford, 2015; Tanner and Lackney, 2006; Tanner, 2000; Tanner, 2009; Uline and Tschannen-Moran, 2008; Uline <i>et al.</i> , 2009
Funding and finance	11	Alexander et al., 2010; Chakraborty and Blackburn, 2013; Dancer and Blackburn, 2017; Dolan and Schmidt, 1987; Erdogdu and Erdogdu, 2015; Lee et al., 2019; Mante and O'Brien, 2002; Prasetyo and Zuhdi, 2013; Pugh et al., 2015; Taylor, 2010; Wolszczak-Derlacz and Parteka, 2011
Perceptions of teachers, students, and parents	7	Alexander <i>et al.</i> , 2010; Elliot and Shin, 2002; Kantabutra, 2005; Kantabutra, 2012; Lee <i>et al.</i> , 2019; Liouaeddine <i>et al.</i> , 2018; Mullick <i>et al.</i> , 2013

Figure 1 shows the time distribution of these studies. The number of publications are grouped into different blocks (i) the first block between 1985-1999 and then (ii) five year blocks from 2000 till 2021. The publication trends is similar in all the blocks. While there has been substantial growth in the number of educational institutions, the research outputs on the topic are stagnant, indicating a need for increased research and findings that can provide input to policymakers.

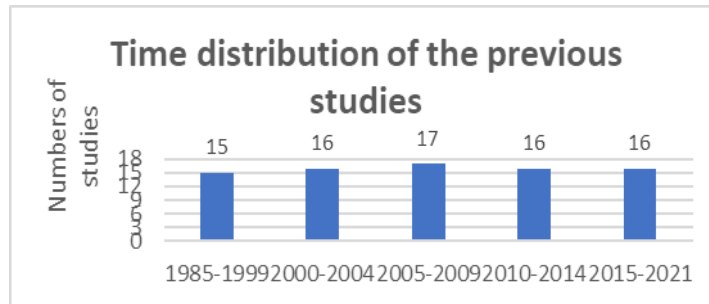


Figure 1: Time distribution of the previous studies

3.1. Physical environment

Only 14% of the studies (12) have discussed about the role of the physical environment in the schools' performance and efficiency. The studies mentioning the physical environment appeared the highest between 2015 and 2021, indicating an increasing interest in construction practices of schools.

School's physical environment and facilities are considered important factors influencing students' performance (Berman *et al.*, 2018; Schlaffer and Burge, 2020; Uline and Tschannen-Moran, 2008). The physical characteristics of a school building and complex are tangible settings where teaching and learning activities occur. How a school building is constructed and maintained affects how its occupants—students and teachers—perceive and utilise the space (Uline and Tschannen-Moran, 2008). Teacher attitudes and behaviours are affected by the quality of the buildings they teach in. Teachers are less likely to be enthusiastic and encourage their students' learning when teaching in low-quality facilities (Uline and Tschannen-Moran, 2008). Students are more likely to participate actively in their own and each other's learning when they feel free to move within and outside their respective classrooms. The distinctive character of several areas within a school may generate a sense of community and a shared commitment to learning objectives.

Adults and students are more prone to violate personal space and agitate one another when physical environments cause them inside a school to move close to one another in crowded areas. However, well-planned passageways make it pleasantly possible for passers-by to move ahead to shared locations. These are the findings of a study by Tanner and Lackney (2006) based on 71 schools in the USA. Numerous design elements and categories have been linked to increased student accomplishment, such as adaptable classroom layouts, well-defined paths, pleasant outdoor areas, large-group meeting spaces, instructional neighbourhoods, and sufficient egress (Tanner and Lackney, 2006). Also, Tanner's (2009) study shows that the school building design, particularly movement and circulation patterns, natural light, and classrooms with views, influence student performance. Movement and circulation patterns include outside walkways, pathways, public areas, and outdoor spaces.

Various aspects of buildings linked to human comfort are found to be associated with student attainment. Such aspects include building age, climate control, indoor air quality, lighting, and acoustic (Uline and Tschannen-Moran, 2008). Stafford's (2015) study, based on schools in Texas, USA, indicates that students' performance on standardised tests improves when the school's indoor air quality is improved. Asthma, respiratory infections, skin rashes, and fever are more serious health impacts that are likely to cause school absences. More minor physical issues, such as itchy eyes and noses, nausea, exhaustion, and dizziness, as well as cognitive issues, like trouble concentrating, memory loss, and delayed

mental processing, are less likely to cause students to miss class. Still, they may have a direct impact on how well they learn. A study by Leung and Fung (2005) based in Hong Kong found that most of the changes in facility management components were significantly related to the changes in students' learning behaviours. The study revealed that the environment in newer school buildings significantly improved over that of old school buildings. In the newer schools, each classroom had additional amenities like a bulletin board, library nook, indoor plant, etc., and the chairs were placed in circles. This promotes group focus, communication, and coordination.

According to Duran's (2008) research, pupils who attended schools with poor facilities spent, on average fewer days in class and performed worse on English and math standardised tests. The study is based on 95 elementary schools in New York City. According to the study, the state of academic facilities can influence students' performance on three levels. First, the physical characteristics of a school facility, such as poor temperature control or filthy flooring, urinals, and restrooms, directly interfere with kids' ability to learn there. A second level is a social interaction, including daily interactions between students and teachers, which are affected by the school building conditions. A third level is an environmental level which is created by physical conditions.

Furthermore, the study findings relate the condition of school buildings to social justice because it observes that poor and minority children are more susceptible to attending schools in poor conditions in the USA. Berman *et al.* (2018) also found in their study that school environment conditions are linked to students' academic achievement in the case of public schools in Baltimore, USA. They observed that school building conditions significantly impacted student absenteeism. They discovered 77 per cent of Baltimore's school amenities to be in bad shape, and none of the structures in these schools was deemed acceptable for educational purposes.

Below is a brief discussion on the other parameters that influence the schools' performance and efficiency.

3.2. Human capital

Several studies showed that human capital is important for the performance of schools (Wolszczak-Derlacz and Parteka, 2011; Kantabutra, 2012; Alexander *et al.*, 2010; Hanushek and Rivkin, 2006; Javier *et al.*, 2016). From these studies, it can be inferred that there are three types of school employees: administrators, teachers, and non-teaching staff. Depending on their positions, backgrounds, and experiences, school staff members' human capital may influence students' performance in many ways. Since instructors are directly involved in delivering lessons and interacting with students, their influence on students' performance is thought to be larger than that of administration and non-teaching employees. Numerous studies demonstrate how teachers aid in students' intellectual growth and advise additional research into what makes a successful teacher (Hanushek and Rivkin, 2006). Various findings have been found in several studies that have looked at a teacher's quality in terms of educational achievement, experience, or qualification. For instance, Cho (2009) does not detect the correlation between teacher experience and students' academic achievement that Melvin and Sharma (2007) do.

Studies have used multiple models to examine human capital and student performance (Hoernemann, 1998; Philbin, 1997). The "instructional leadership model" was the first one that academics used to look at the relationships between school administrators and general academic success. The authors explored the relationships between school officials and student performance using a modified model called the "transformational leader behaviours model" (Hoernemann, 1998; Philbin, 1997). Other empirical studies show that the degree of teachers' knowledge about their subject influences the students' output (Buddin

and Zamarro 2009; Treputtharat and Tayiam 2014; Ferguson and Brown 2000; Darling-Hammond *et al.*, 2001; Fetler 2001; Monk 1994; Brewer and Goldhaber 1996). Lee *et al.* (2019) found that teachers positively influence students' performance, improving school efficiency. They found a substantial impact on student learning through teachers' ability to explain lessons and tasks. In the same way, if teachers do not participate sufficiently in student learning, it can influence student performance negatively. This finding is based on data from 430 primary schools in Queensland, and the data were analysed using data envelopment analysis. Wolszczak-Derlacz and Parteka (2011) found that having more women in academic positions improves European countries' public higher education institutions. They based their study on a sample of 259 public higher education institutions from seven European countries, where data were collected between 2001 and 2005. According to Hanushek and Woessmann's (2017) study, among other factors that affect school performance, teachers' quality impacts student success in exams. Several contributions agree with the findings regarding the influence of teachers' education and experience on the performance of students and schools.

3.3. Socio-economic conditions

Socio-economic composition is another determinant found to be influential in student performance by several studies (Dancer and Blackburn, 2017; Liouaeddine *et al.*, 2018; Fombuena, 2016; Berman *et al.*, 2018). Research in the USA finds that schools with more white than black students lead to better educational achievement for African American students (Ward Schofield and Hausmann, 2004; Braddock and Elite, 2004). Hoxby (2001) and Ching (2000) support the findings of their studies that students' socioeconomic characteristics substantially affect cognitive and academic capacities, resulting in improved school performance. Social capital is a measure used to assess how interconnected community members are. (Coleman, 1988). The source of social capital is a link between people and social networks, as opposed to the location impact, which is essentially geographic. According to Coleman (1988), social capital is as crucial to one's personal development as human and financial capital. Student educational attainment can be explained in large part by social capital. Communities build social capital by connecting their residents through clubs and social organisations. The networking theory explains how social capital may affect personal growth in various ways (Bryant and Norris, 2002). According to this theory, social capital has three functions: linking, bridging, and bonding. (Bryant and Norris, 2002).

After the well-known Coleman Report (Coleman, 1988), family and environmental factors play a key role in students' success, and failure has been widely accepted. Studies demonstrated that schools are likelier to have lower learning outcomes when more students are from socioeconomically disadvantaged backgrounds (Tajalli and Opheim, 2005; Agasisti, 2013; Jehangir *et al.*, 2015). Students' academic achievement was positively related to parents' education level (Kirjavainen and Loikkanen 1998). Substantially impacted and Vierstraete (2013) did a comparable study in Burkina Faso's schools with a focus on the living conditions of households. Memon *et al.* (2016) discovered that parental education substantially impacted children's success rates in pre-medical entrance exams.

3.4. Perceptions of teachers, students, and parents

According to recent studies, attitudes towards teachers, students, and parents impact how well schools perform (Lee *et al.*, 2019; Kantabutra, 2012; Liouaeddine *et al.*, 2018). This is similar to how customers' and employees' satisfaction is essential in measuring a company's performance.

A teacher's level of job satisfaction is determined by several factors, including pay, benefits, task demands, teacher policies, job profile, leadership, colleagues, interaction, recognition, and career advancement (Slavitt *et al.*, 1986). Other elements influencing student satisfaction include the return on investment, advisor accessibility, a safe campus, clear and appropriate major prerequisites, advisor availability, enough computer labs, unbiased and fair faculty, and information access (Elliot and Shin, 2002). According to Lee *et al.* (2019), students perform better and earn higher grades when they perceive that their school values their input. This implies that teachers should consider and discuss students' opinions in class. This shows that a school is open to student input, which will help students' opinions of teachers and their work.

3.5. Class and school size

Class size, school size, and the teacher-to-student ratio can impact a school's performance (Kantabutra, 2012; Lee *et al.*, 2019; Duran, 2008). When Kirjavainen and Loikkanen (1998) examined variations among Finnish senior secondary schools, they discovered higher learning efficiency levels in institutions with smaller classrooms. Additionally, they observed that schools with more diverse student groups exhibit higher levels of inefficiency. Similarly, studies by Wößmann and West (2006), Barrett and Toma (2013) and Conroy and cost-effectiveness (2008) and found that small class sizes contribute to higher efficiency in academic outcomes. Okpala *et al.* (2000) state that class size measures teachers' ability to interact with students.

The teacher-student ratio can be a proxy for the typical class size. A trade-off between cost-effectiveness and student accomplishment has been discovered in studies on the teacher-student ratio (Wößmann and West, 2006; Barrett and Toma, 2013; Conroy and Arguea, 2008). There has been some discrepancy in previous research on the connection between class size and student achievement. Several researchers say kids learn best in smaller classes (Finn and Achilles, 1990; McGiverin *et al.*, 1989). Other scholars have demonstrated otherwise, indicating that larger class size had better student achievement in several schools, including Sanders *et al.* (1997) and Nyhan and Alkadry (1999). Despite the lack of agreement, research on the connection between class size and student learning performance is ongoing, suggesting that reducing class size is a policy alternative that should be considered (Wößmann and West, 2006; Barrett and Toma, 2013; Conroy and Arguea, 2008).

3.6. Funding and finance

Studies have shown that educational expenditure positively impacts school performance (Prasetyo and Zuhdi, 2013; Erdogdu and Erdogdu, 2015). A positive relationship between financial resources on education and student performance was identified by Dolan and Schmidt (1987) decades ago. These studies explain that higher per-student expenditure and funding give students better access to more qualified teachers who effectively implement pedagogical methods in their classrooms. Consequently, students become capable of achieving higher outcomes.

Dancer and Blackburn (2017) found in the case of Australia how government funding can be influential in improving the efficiency of public schools. They identified that two-thirds of children in Australia go to public schools, and billions of dollars are provided at state and federal levels to operate these schools. They studied the influences of government funding on the efficiency of public schools. Similarly, Chakraborty and Blackburn (2013) examined the cost efficiency of Australian schools based on the operating expenses per student. They used NAPLAN results for Grades 3 and 5 as some of the inputs. They found that using resources has been inefficient in primary schools because students' scores are

unsatisfactory. One of its causes is the social disadvantages identified in these schools. Similarly, Pugh *et al.* (2015) estimated the impacts of school expenses on school performance represented by the Australian Tertiary Admission Rank (ATAR) score. Their results indicated that the influence of school expenses on its performance also depends on the school size. Schools with less than 1,500 students can have better positive impacts on higher ATAR scores because of expenditure. In the case of schools with more than 1,500 students, the impacts decrease. The study found that an increase in spending enhances the estimated median ATAR score; however, the impact is negligible.

5. Conclusion

The literature review identified the frequency of studies that identified various factors that influence the schools' performance and efficiency. The number of studies showing the importance of schools' physical environment and facilities is about 14% in 1985-2021. However, it is increasingly being recognized that all the factors substantially influence the schools' performance and efficiency, and, importantly, each other. It has become increasingly important to have well-designed spaces that can provide a conducive ambience, while affording sufficient protection during the natural calamities and health emergencies, as COVID – 19 , yet have the flexibility to offer a wide range of pedagogical approaches. The physical environment, facilities and services are related to other factors influencing students' performance. That way, schools' buildings and the physical environment are designed and constructed can have direct and indirect impacts on students' achievement. For example, the studies discussed above on ways of funding show how funding received by schools affects students' outcomes. However, it would be more beneficial to identify what funding is generally allocated for developing and maintaining schools' buildings and services, which eventually affects teaching and learning. Similarly, school buildings, facilities and physical environment are more likely to influence teachers' perceptions and attitudes towards schools which can affect their teaching. Schools' physical settings can also affect how parents perceive the schools they send their children to. The schools' physical conditions can also affect students' physiological, psychological, and emotional states and attitudes towards school. Studies on how schools' physical environment influences all these factors and, eventually, students' performance and behaviour are rare, particularly in the case of Australia. Most of the research is based in the USA, indicating a necessity of research on relationships between the physical environment of schools and students' performance in other countries, including Australia. Therefore, this review finds a need for such studies that can contribute to bridging the lack of knowledge. This is particularly important for public schools which operate on government funding, including PPP schools, so that the efficiency of the schools can be enhanced by addressing the inadequacy of the physical environment and facilities.

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