The Secondary School Classroom: An Architectural Object to Rethink for Better Support of Educational Success in Quebec. A Literature Review

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ABSTRACT: This literature review explores the impact of classroom architecture on the educational success of secondary school students. It forms part of the work of the Schola research consortium, which aims to guide the renovation of Quebec's public primary and secondary schools. A key premise of this review is that the insights gained can inform the renovation strategies for Quebec's public schools, as outlined in the Quebec Ministry of Education's recent Educational Success Policy, which focuses on supporting students' health, well-being, and academic perseverance. With the majority of Quebec's public schools having reached the end of their first architectural life cycle, renovations are now underway. The method used for this review is based on extensive documentary research conducted across six distinct databases. This approach led to the identification of 16 relevant articles, including six literature reviews and ten field studies, employing both quantitative and qualitative methods. The findings reveal that factors such as the physical environment of the classroom, its layout, and the available furniture and equipment, have a significant impact on academic success, student perseverance, motivation, and well-being. The analysis of these elements highlights the specific requirements for the reconfiguration of classroom spaces, the renewal of furniture, and the modernization of equipment, all of which are crucial for enriching students' learning experiences.

KEYWORDS: Physical environment, secondary school, classroom, adolescent, well-being, educational success

INTRODUCTION

This literature review explores the impact of the physical dimensions of the classroom on the educational success of secondary school students, focusing on their academic performance, health and well-being, as well as their motivation and engagement in learning (MEES 2018). It is part of the work of the Schola research consortium, whose mission includes the launch of an expertise platform in 2024 to guide the renovation of Quebec's public primary and secondary schools. As most public schools in Quebec approach the end of their first architectural life cycle, renovations are currently underway. One of the main challenges is transforming the learning spaces in these schools to better meet the evolving needs of the educational environment and the expectations of new generations of students. Specifically, this review aims to identify the mediating effect of the classroom's physical dimensions on various student behaviors that, in turn, contribute to their educational success. It examines the learning environment from physical, pedagogical, and social perspectives to better understand the complexity of its impact. Additionally, it identifies factors that can inform the requalification of these spaces, the rejuvenation of furniture, and the modernization of equipment to better support learning, new pedagogical approaches, digital technologies, and, ultimately, academic success, perseverance, motivation, and student well-being.

1.0 METHODOLOGY OF THE DOCUMENTARY RESEARCH

For the purposes of this literature review, the physical environment of the classroom is defined as an indoor learning space with or without windows, used for regular teaching, excluding laboratories. This definition includes technological and digital equipment, as well as a variety of semi-fixed or mobile furniture.

The concept plan developed for the literature search included keywords such as "classroom," "secondary school," "adolescent," "engagement," and "well-being," which were further broken down into synonyms and related terms. Initially, 375 titles were identified (Figure 1). Keyword combinations were applied across five databases: two focused on education, Education Source EBSCO (42) and ERIC (152); one in psychology, PsychINFO (23); and two more generalist databases in architecture, Academic Search Premier (46) and Web of Science (40). Additionally, the OECD iLibrary site (20), titles from the bibliography of selected articles, and the document bank of the Schola research group (52) were included. The selected publications consisted of scientific articles published in peer-reviewed journals, written in either French or English. After reviewing the titles and keywords, the list was narrowed down from 375 to 68. A further review of the abstracts reduced the number to 38, and after full-text reading, 16 titles were deemed relevant. These included 10 original studies and six literature reviews. The 10 studies surveyed: (1) were conducted in a secondary school or its equivalent in other countries (such as college or lyceum), (2) focused on students aged 12 to 15 years in good health, (3) considered the physical environment of the classroom, and (4) reported on student behaviors influenced by the dimensions of this environment. Studies that focused solely on common areas of schools were excluded, as were those involving populations of young people with

overweight/obesity, disabilities, or learning difficulties. Both quantitative, qualitative, and mixed methodologies were considered.

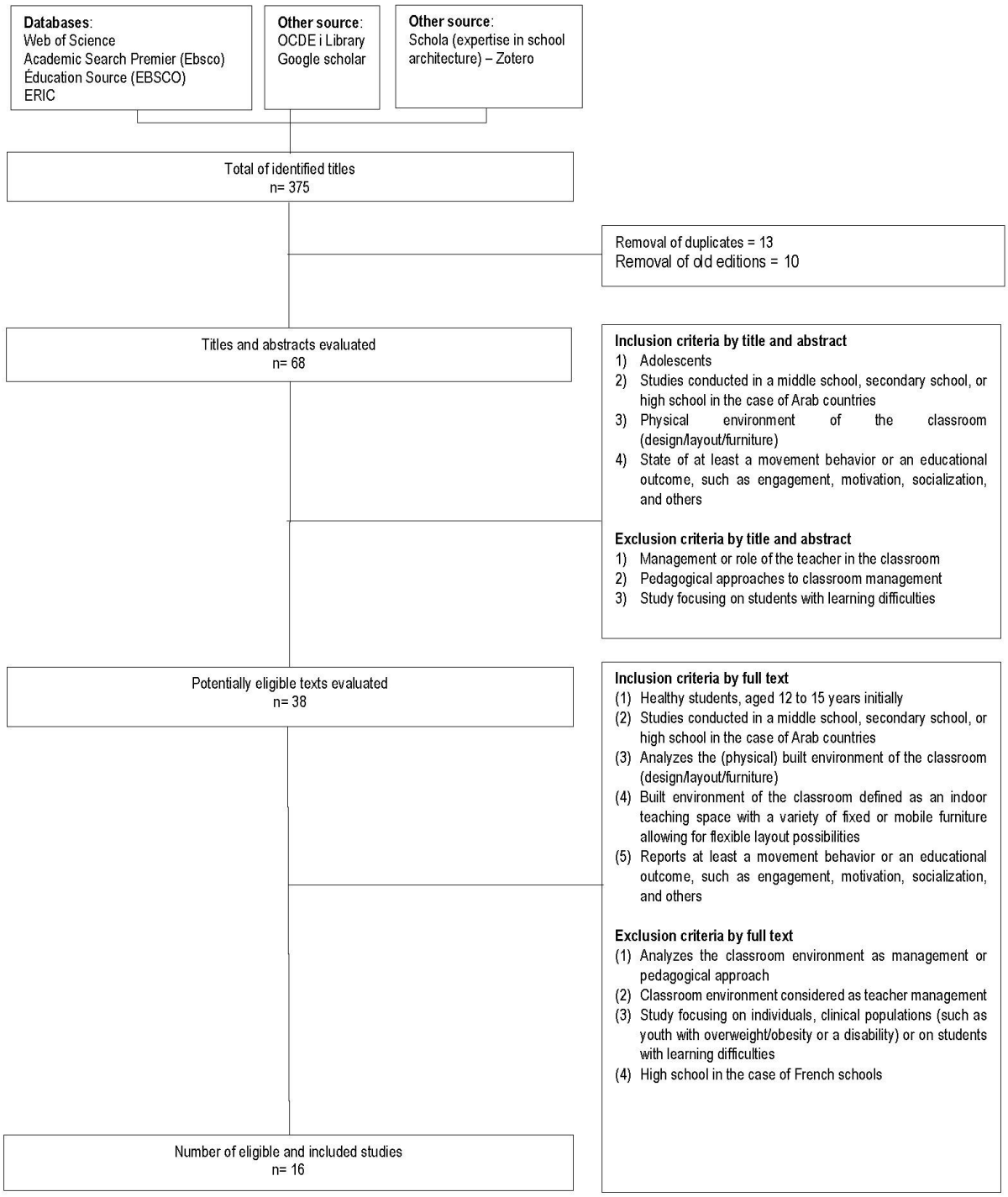

Figure 1: Research protocol and resulting corpus. Source: (Ballita 2023)

2.0 PRESENTATION OF THE CORPUS OF REVIEWED TEXTS

A comparative matrix was used for the systematic analysis of the six literature reviews and 10 empirical studies identified. The analysis was based on the following criteria: (1) the author(s) and their field(s) of research, (2) the year of the study, (3) the location of the study, (4) the methodology, (5) the type of analysis, (6) the sample size and participant profile, (7) the physical characteristics of the classrooms studied, and (8) the main findings.

Although no specific publication date limit was set, all 16 articles were published after the year 2000, with 14 published between 2010 and 2021. Psychology and educational sciences dominate these studies, with the majority authored by researchers in these fields (11/16), including three solely from psychology and three from education. Two publications were authored solely by researchers in architecture, while only three articles combined expertise in architecture, education, and health. Four of the six literature reviews cover both primary and secondary schools,

encompassing 88 articles published between 1978 and 2013. The remaining two reviews focus exclusively on secondary schools, identifying 27 studies published between 1960 and 2019. The 10 empirical studies were conducted across several continents: four in Australia, three in the United States, and two in Europe (one each in Scotland and England). One study was conducted in multiple countries, including the Netherlands, Norway, Japan, Singapore, China, and India. All the countries involved have aging school infrastructure, with some studies focusing on recent renovations or newly constructed schools. Four of the empirical studies employed qualitative methods: two based on direct observations, one using participatory activities and conceptual mappings, and the last involving interviews with teachers and focus groups with adolescents. Two quantitative studies examined various school buildings, classroom layouts, and furniture arrangements: one focused on the buildings of nine secondary schools, and the other on three types of classrooms within the same secondary school. Lastly, four studies utilized a mixed-methods approach, combining focus groups, interviews, observations, and plan analysis. One of these studies analyzed the plans of 59 secondary schools across multiple countries.

Table 1: Comparative matrix of the 16 reviewed texts. Source: (Ballita 2023)

Author	Authors' field	Year	Type of research	Method adopted	Country	Sample	**School level**
Bluyssen		2017	Literature Review	Documentary research	N/A	N/A	Primary and secondary
Byers et al.	Education, psychology	2018	Qualitative study (quasi-experimental)	Comparative analysis of 22 classrooms + Survey on student attitudes	Australia	3 buildings built between the 1940s and 1960s, 22 classrooms	Secondary
Byers et al.	Education, psychology	2018	Literature Review	Documentary research in 12 databases	N/A	21 articles in this journal, ranging from 1960 to 2016 (comparative or quasi-experimental studies)	Secondary
Cheryan et al.	Psychology	2014	Review of the literature	Documentary research	N/A	48 scientific articles, from 1978 to 2014	Primary and secondary
Dovey et al.	Architecture	2014	Qualitative and quantitative study	Plan analysis"	Japan, Singapore, the Netherlands, China, India, and Norway	An international sample of 59 schools focusing on the English-speaking world	Primary and secondary
Edgerton et al.	Psychology	2011	Qualitative and quantitative study	6 focus groups + 1 questionnaire Survey + 3 groups of students	Scotland – United Kingdom	7 to 11 participants per group, total sample of 51 students from levels S1, S3, and S5	Secondary
Fouad	Architecture	2017	Quantitative study	Comparative case study	England – United Kingdom	9 secondary schools	Secondaire
Fredricks et al.	Psychology	2004	Literature Review	Documentary research	N/A	N/A	Primary and secondary
Gislason	Education	2010	Qualitative and quantitative study	Behavioral observation and semi-structured interview	Minnesota – United States	3 secondary schools, 11 teachers, and 15 students	Secondary
Guardino et al.	Education	2010	Qualitative study (quasi-experimental)	Concept map	N/A	Concept map with students aged 12-15 years	Primary and secondary
Hidding et al.	Public health	2018	Qualitative study	Focus group + observation	N/A	Students aged 12, 14, and 16 years	Secondary
Imms et al.	Education	2017	Quantitative study	Comparative quasi-experimental case study	Australia	3 classroom modes, occupied by 3, 7th-grade classes, receiving a similar curriculum while retaining the same teacher throughout each intervention	Secondary
Kariippanon et al.	Education, psychology	2017	Quantitative study	Qualitative case study approach	Australia	Teachers (interview with 35 participants), students (6 focus groups consisting of 5 to 6 students)	Primary and secondary
Kariippanon et al.	Education, psychology	2021	Literature Review	Documentary research	N/A	5 quantitative articles and one qualitative article were selected, ranging from 2014 to 2019	Secondary
Ryan	Education psychology	2001	Qualitative study	Qualitative case study approach	N/A	Targeted students: 11-16 years old	Secondary
Ucci et al.	Architecture, éducation	2015	Literature Review	Documentary research	Australia	20 were included in this review, ranging from 2008 to 2013	Primary and secondary

3.0 RESULTS

The results of three studies show that the learning capacity and academic performance of young people are most often associated with the physical environment in which their learning takes place (Bluyssen 2017; Byers et al. 2018; Cheryan et al. 2014; de Dear et al. 2015). One literature review also reports that the design of learning spaces can impact student motivation (Ucci et al. 2015).

Several authors agree that, given the number of years students spend in school, the physical environment of the classroom significantly influences their life experiences, behaviors, and social relationships (Bluyssen 2017; Cheryan et al. 2014; Eccles & Roeser 2011; Germanos 2009; Jodelet 2015; Mazalto & Paltrinieri 2013). According to some studies, classroom design can foster aggressive behaviors (Bluyssen 2017; Gislason 2010; Kritchevsky et al. 1969), reduce student participation, and disengage students from their learning (Byers et al. 2018; Gislason 2010; Mahat et al. 2016; Dornfeld 2016; Ucci et al. 2015). Conversely, a classroom environment adapted to students' needs encourages participation and reduces aggressive and distracting behaviors. Architectural characteristics and symbolic features of classrooms can either hinder or facilitate student performance and academic perseverance in secondary schools (Bluyssen 2017; Cheryan et al. 2014; Edgerton et al. 2011; Gislason 2010; Ucci et al. 2015; Winterbottom & Wilkins 2009). Providing students with a classroom where they feel at home and comfortable, whether alone or in groups, allows them to establish a sense of recognition and identification, which in turn positively influences their well-being (Bluyssen 2017; Fredricks et al. 2004), sense of control (Edgerton et al. 2011; Laquerre 2018), and social relationships (Bluyssen 2017; Edgerton et al., 2011).The following sections specifically address the dimensions of the physical environment of classrooms that impact aspects of educational success. The identified evidence is classified into four physical dimensions of the classroom: 1) size and configuration of the space, 2) physical ambiance, 3) furniture and displays, and 4) technology. These categories are cross-referenced with three dimensions of educational success: 1) perseverance and academic success, 2) health and well-being of students, and 3) behaviors likely to contribute to these (Table 2). The next section reviews these categories one by one to present the identified evidence (Table 3).

Table 2: Table showing the relationship between the three categories of classroom architecture and adolescent behaviors. Source: (Ballita 2023)

	Architecture (Classroom scale)																	
	Physical Ambiances								**Size, configuration**					**Furniture**				**Digital**
Behavior / perception (adolescent)	Lighting	Air quality	Thermal	Acoustics	olfactory	Visual appearance	Physical quality	Color	Size	Spatial typology	Shape	Spatial density	Accessibility	Furniture arrangement	Variety of furniture	Object	Display	Equipment/ technology
Academic success	●	●	●	●	●	●	●				●	●		●	●			
Attendance		●					●											
Long-term success	●		●						●	●		●					●	
Learning ability	●		●	●	●	●	●				●		●	●	●	●		●
Creativity	●		●	●		●											●	
Physical health	●		●	●		●	●							●				●
Psychological health	●			●	●	●							●		●	●	●	●
Well-being	●	●	●	●		●	●		●		●		●	●	●			●
Physical comfort	●	●	●	●		●	●		●	●	●	●		●	●	●	●	
Visual comfort	●					●	●	●									●	
Stress	●		●	●	●	●	●					●	●		●	●		
Interaction	●		●	●			●	●						●			●	
Socialization					●						●		●					
Autonomy							●	●	●	●		●						●
Engagement	●		●	●	●	●	●	●	●				●	●	●	●	●	●
Concentration				●	●			●			●		●					●
Motivation	●		●		●	●	●				●			●		●	●	●
Sense of belonging					●	●	●						●				●	●
Sense of pride						●	●										●	
Sense of security	●			●	●		●		●	●	●				●	●		
Attitudes	●		●	●	●	●			●		●	●		●				
Joy of learning		●				●												
Self-regulation	●		●	●	●					●								

Table 3: Table showing the relationship between the three categories of classroom architecture and adolescent behaviors. Source: (Ballita 2023)

		Classroom scale																					Behavior/perception (adolescents)																								
		Physical Ambiances								Size, configuration, and type of space							Furniture and technology						Réussite						Santé - bien-être							Comportement - Médiateur de réussite et de bien-être											
Author	**Year**	Lighting	Air quality	Temperature	Acoustics	Location	Visual appearance	Physical quality	Color	Size	Spatial typology	Shape	Spatial density	Accessibility	Furniture arrangement	Variety of furniture	Object	Display	Equipment/technology	Lighting	Air quality	**School scale**	Performance	Academic success	Attendance	Long-term success	Learning ability	Creativity	Physical health	Healthy lifestyle	Psychological health	Anxiety- Well-being	Physical comfort	Visual comfort	Stress	Interaction	Socialization	Autonomy	Engagement	Concentration	Motivation	Sense of belonging	Sense of pride	Sense of security	Attitudes	Joy of learning	Self-regulation
Bluyssen	2017	•	•	•	•			•	•														•	•		•	•	•	•		•	•	•	•	•						•						
Cheryan et al.	2014	•		•	•		•	•									•		•	•	•			•	•									•		•						•	•	•			
Edgerton	2011					•	•	•								•						•									•					•			•				•			•	
Byers et al.	2018	•		•	•								•	•	•								•	•									•			•			•		•				•		
Byers et al.	2018	•		•	•			•					•	•										•															•		•			•			
Kariippanon et a	2017	•	•					•			•		•	•				•												•		•	•				•	•	•		•			•			•
Dovey et al.	2014							•		•	•	•	•	•		•											•						•			•	•	•	•		•	•		•	•	•	
Kariippanon et al.	2021												•	•										•			•					•	•			•	•	•	•					•	•	•	
Gislason	2010	•	•	•	•						•					•						•		•			•						•				•		•	•	•	•				•	
Fouad	2017					•	•	•		•		•	•	•		•	•					•		•			•						•			•	•			•	•				•		
Ucci et al.	2015	•	•	•	•	•		•		•	•		•	•			•					•	•					•	•		•	•	•		•					•					•		
Imms	2017							•			•		•	•			•				•		•	•			•										•		•		•					•	
Ryan	2001							•														•		•													•		•		•						
Fredricks	2004							•														•		•															•		•						

3.1. The size and configuration of classroom

According to some studies, the size of the classroom and the distance between classrooms are associated with pedagogy and academic performance (Byers et al. 2018; Imms & Byers 2017). Gislason (2010) suggests that the layout and configuration of the classroom play a crucial role in students' behavior, contributing to three key factors in school learning: the flexibility of spaces, flexible schedules, and independent learning. Other studies indicate that the configuration of the learning space influences secondary students' academic performance and engagement (Imms & Byers 2017).

Several studies have found that the type of classroom and its organization promote autonomy and self-regulation, which in turn, facilitate learning (Cheryan et al. 2014; Dovey & Fisher 2014; Kariippanon et al. 2017). Two studies show that flexible learning spaces foster better interaction with peers and teachers compared to more rigid or traditional layouts (Byers et al. 2018; Imms & Byers 2017). In flexible designs, students were more engaged, more attentive to tasks, and collaborated and interacted more (Byers et al. 2018; Imms & Byers 2017; Kariippanon et al. 2021; Ucci et al. 2015). However, Cotterell (1984, cited in Ucci et al. 2015) suggests that the layout of secondary classrooms in open spaces increases anxiety among students, and teachers are less motivated, spending more time on transitions and managing behavior.

The impact of classroom size on the well-being and comfort of students has been the subject of several studies. In terms of psychological well-being, whether small, medium, or large, classrooms that mimic home-like environments reinforce a sense of well-being (Edgerton et al. 2011) and psychological comfort for students (Bluyssen 2017; Ucci et al. 2015). Regarding physical well-being, flexible learning spaces are designed with student comfort in mind (Hidding et al. 2018; Imms & Byers 2017). These flexible spaces, combined with student-centered pedagogy, positively impact the well-being and physical health of adolescents (Imms & Byers 2017; Kariippanon et al. 2017). Students feel more comfortable in smaller spaces, which enhances their sense of comfort (Dovey & Fisher 2014; Imms & Byers 2017), well-being (Imms & Byers 2017; Kariippanon et al. 2017), and belonging (Edgerton et al. 2011; Gislason 2010). Other studies indicate that large open-space learning environments with traditional classrooms negatively affect students' academic outcomes (Byers et al. 2018; Mahat et al. 2018; OECD 2013; Ucci et al. 2015). The studies by Cicek and Taspinar (2016, cited by Byers et al. 2018; Mahat et al. 2018), and Kazu and Demirkol (2012, cited by Dovey & Fisher 2014), show that students in a mixed learning environment achieve better results than their peers in more traditional and larger environments. Reiss and Dyhdalo (1975, cited by Ucci et al. 2015) found that students in large open spaces were more perseverant in their learning but performed worse on the CAT instrument compared to students in smaller, traditional classrooms.

3.2. The physical ambiances

Physical ambiances refer to environmental factors that influence the senses and result from the interaction between the material properties of architecture and natural elements like air and light, in connection with human occupation. These include light, thermal, acoustic, and olfactory ambiances (Adolphe 1998).

Two literature reviews suggest that unsatisfactory ambient conditions can have both short- and long-term effects on health, potentially impacting student productivity (Bluyssen 2017; Ucci et al. 2015). The reviews by Byers, Imms et al. (2018), covering 21 articles (1960-2016), and Cheryan et al. (2014), analyzing 48 articles (1978-2014), indicate that the physical ambiances of the classroom are directly linked to academic results and students' learning capacity. Favorable environmental conditions, which include optimal air quality, light, noise, temperature, and ventilation, alongside suitable spatial density, are shown to enhance teaching and learning (Byers et al., 2018; Cheryan et al., 2014; Imms & Byers 2017; Ucci et al. 2015). Byers et al. (2018) report that ambient factors account for 16% of the variation in students' academic progress. However, other studies suggest a more modest influence, contributing to about 1.5% of the improvement in academic results (Byers et al. 2018; Mahat et al. 2018).

Light, or light ambiances, are strongly associated with students' learning capacity and well-being (Bluyssen 2017; Imms & Byers, 2017), engagement in class (Kariippanon et al. 2021; Ucci et al. 2015), academic success (Bluyssen 2017; Byers et al. 2018; Cheryan et al. 2014; Imms & Byers 2017), and academic perseverance (Kariippanon et al., 2017; Winterbottom & Wilkins, 2009). Studies show that students exposed to more natural light in their

classrooms perform better than those with less natural light exposure (Bluyssen 2017; Imms & Byers 2017; Kariippanon et al. 2017; Ucci et al. 2015). Bluyssen's (2017) literature review, although considering both primary and secondary school students, highlights the influence of acoustics on communication abilities, attention, and memory, which can negatively impact motivation and achievement levels. According to Cheryan et al. (2014), acoustic vibrations from both internal and external sources in classrooms contribute to discomfort and stress. Several studies show that poor acoustic quality in classrooms, caused by noise from heating and ventilation units (U.S. Architectural Transportation Barriers Compliance Board 2002, cited in Cheryan et al. 2014), airplane flight paths (Evans & Maxwell 1997, cited in Cheryan et al. 2014), and road traffic (Bluyssen 2017), is linked to students' well-being and comfort (Bluyssen 2017; Gislason 2010; Ucci et al. 2015). Research by Lupien (2009, cited by Guardino & Fullerton 2010) suggests that students' perceived loss of control over noise nuisances is a psychological determinant of stress, with significant implications for individual well-being and mental health.

Conversely, good air quality has a positive effect on students' health and academic performance (Bluyssen 2017; Chatzidiakou et al. 2012; Gislason 2010; Ucci et al. 2015). Studies by Bluyssen (2017) and Gislason (2010) associate air quality (e.g., CO2 levels, air renewal rate, humidity) with comfort, health, and well-being in students. Research conducted in Australia has demonstrated the influence of the thermal environment in classrooms on student comfort, well-being, and academic performance (Bluyssen 2017). Additionally, three experimental studies suggest that male adolescents are more sensitive to temperature changes compared to their female counterparts (Allen & Fischer, 1978, cited by Cheryan et al. 2014; Burgeson 2017; Carignan 2018, cited by Cheryan et al. 2014; Kariippanon et al. 2017).

3.3. The furniture and displays

Furniture encompasses all furnishings in a classroom, such as desks, chairs, and tables. A display is a generic medium typically associated with educational material (Kariippanon et al. 2017) but can also serve as a tool for personalization; it is considered an integral part of classroom organization. According to Byers et al. (2018), the spatial arrangement of a classroom influences students' attitudes toward their learning experiences and their engagement.

Some studies suggest that offering a variety of furniture and displays can promote student autonomy by enabling them to work individually or in groups (Kariippanon et al. 2017). Providing diverse workspaces and furniture options allows students to make their own choices, reinforcing their sense of control (Cheryan et al. 2014; Kariippanon et al. 2017). Byers et al. (2018), in their study of 22 classrooms across three secondary schools in Australia, and the review by Ucci et al. (2015), found that the arrangement of school spaces and the variety of furniture affect both the level of physical activity and the seating position of students. A diverse range of furniture, when well-organized, contributes to effective class management and high student engagement (Cheryan et al. 2014). The arrangement and variety of furniture also facilitate the teacher's work and promote quiet, individualized student activities (Legout 2018, cited by Kariippanon et al. 2017). However, some studies report that a variety of furniture can lead to agitation and anxiety among secondary school students (Ucci et al. 2015). This variety also impacts students' comfort and their degree of interaction with both peers and teachers (Cheryan et al. 2014; Kariippanon et al. 2017; Ucci et al. 2015).

Several studies and scientific reviews suggest that learning environments with a variety of furniture options, arrangements, and resources are beneficial for teaching, learning, and the social, emotional, and physical well-being of students (Cheryan et al. 2014; Kariippanon et al. 2017; Ucci et al. 2015). However, some studies indicate that incorporating furniture elements such as stools encourages greater mobility and reduces the time spent in a seated position, which may cause discomfort among students (Kariippanon et al. 2017) and negatively impact learning and engagement (Imms & Byers 2017).

3.4. Digital equipment

Digital equipment in the classroom, including computers, projectors, tablets, and interactive whiteboards, contributes to innovative learning environments where teaching is supported by digital tools. Cloutier, Denault, and Drapeau (2019), experts in psychoeducation, secondary education, and youth psychology, suggest that adolescents' motivation in learning spaces is influenced by the digital environments they encounter during their transition from childhood to adulthood. A quasi-experimental study indicates that a more dynamic and flexible space, where technology is actively integrated, improves classroom outcomes (Imms & Byers, 2017). In these environments, students feel more comfortable, reporting a greater sense of well-being (Imms & Byers, 2017).

The availability of diverse choices for engaging with learning materials also supports students' self-regulation (Cheryan et al., 2014; Kariippanon et al., 2017). According to a literature review by Byers, Mahat, et al. (2018, p. 174), learning spaces equipped with digital and visual technologies significantly influence learning, motivation, and student engagement. Digital resources in the classroom promote autonomy, allowing students to work individually or in groups, and enabling them to access both digital and traditional resources at various points during a lesson, depending on the task and their progress pace (Kariippanon et al., 2017). In a study by Byers et al. (2018) across 22 classrooms in Australia, all classes in innovative learning environments rated their motivational expectations and values higher compared to traditional classrooms. Multiple studies suggest that students in these tech-enhanced environments report greater cognitive and emotional engagement than their peers in conventional settings (Byers, Imms, et al., 2018; Imms & Byers, 2017; Kariippanon et al., 2017). Furthermore, Imms et al. (2017), in a study involving 7th graders in three types of classrooms in Australia, found that more dynamic and adaptable spaces, enhanced by technology, significantly improved students' perceptions of their learning experience.

But what about older schools that lack such technology? How can we stimulate the interest of young people in these environments?

4.0 DISCUSSION

This review primarily aims to understand the influence of classroom architecture on the well-being, engagement, and motivation of high school adolescents. The fact that many countries from which these studies originate have aging school infrastructure, with most schools built following the educational reforms of the 1960s, in addition to the growing need for school renovations, helps explain the emergence of these studies. Most research focuses on schools that are either due for renovation or have already undergone renovations, with fewer studies addressing the design of new schools. The establishment of the Programme for International Student Assessment (PISA) by the OECD (Organisation for Economic Co-operation and Development) in 2000, which includes the countries involved in this study, has undoubtedly had a significant impact on the field. Indeed, many of the selected articles reference this program. Similarly, the countries involved in these studies have also carried out school reforms or established educational success policies in the 21st century, much like Quebec.

The physical environment of classrooms is categorized into three aspects: physical ambiance, size/configuration, and furniture/technology. These categories are highlighted based on the analyzed studies, though it is clear that they have been studied unevenly. While physical ambiance and classroom layout have been extensively explored in relation to educational success and engagement, the arrangement and variety of furniture and displays have received less attention (Table 2). Furthermore, while all three categories - physical ambiance, furniture/displays, and size/configuration - are often linked to students' academic perseverance, fewer studies examine the relationship between these three aspects and mediators of educational success among adolescents, suggesting areas for future research.

Preliminary observations conducted in six schools pointed to external factors that influence the internal functioning of classrooms, such as variations in room allocation for different subjects, student groups, and teachers. These dynamics differ significantly across countries and preceded the current literature review. Notably, the studies examined here do not focus on hallways and informal spaces, which are common in many schools in Quebec. Although several studies acknowledge the role of hallways and informal spaces in influencing the classroom climate and overall environment—often characterized by noise—none offer a detailed description of these areas. While there is an understanding of how the built environment of a classroom impacts adolescents, few studies explore how activities unfold in classrooms during successive class sessions. Concepts such as adolescent happiness, autonomy, self-esteem, and socialization take center stage in the studies, yet factors like a sense of belonging, pride, appreciation, concentration, interaction, self-perception, enjoyment of learning, and long-term success remain largely unexplored. Additionally, the role of relaxation, breaks, and transitions between classes is barely addressed. Issues related to mental and physical health, psychological stress, and anxiety, though present in schools, are not frequently linked to classroom environments. Regarding classroom characteristics, ambient quality, layout, and digital equipment are often studied in connection with academic performance and adolescent comfort but are generally viewed as criteria for satisfaction and motivation that are rarely described in detail. Terms like decoration, displays, aesthetics, and atmosphere remain ill-defined in the studies, while physical ambiance and layout are more explicitly covered (Table 2). The dimensions of joy, happiness, well-being, and adolescents' perceptions are among the least explored classroom characteristics. These dimensions are undoubtedly important to study, as they are key to supporting the well-being, motivation, engagement, and academic perseverance of young people in their educational journey.

CONCLUSION

The analysis of physical environments, diverse arrangements, and furniture from the reviewed studies provides valuable insights into the factors influencing educational success, students' use of classrooms, and the characteristics of learning spaces. These elements reveal students' behaviors and emotions during learning sessions. While most studies emphasize the importance of the physical environment for student well-being and performance, they often overlook aspects such as health, happiness, and motivation, and are less systematic in analyzing classroom environments and school plans.

The next phase of this research, focusing on developing a tool for secondary school classroom design and renovation, is crucial. It will involve data collection in four schools in Quebec through direct observations, furniture inventories, teacher surveys, and interactive activities with students. Built on established criteria, this phase aims to create precise classroom designs based on student perceptions to enhance their well-being and educational success, aligning with the policies of the Quebec Ministry of Education.At the same time, ensuring optimal learning environments requires addressing the minimum structural quality of classrooms, particularly in older schools lacking digital equipment, especially in light of the challenges posed by the surge in online learning during the pandemic.

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