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THE ROLE OF ERGONOMIC RESEARCH IN ENHANCING THE PERFORMANCE OF EDUCATIONAL STAFF THROUGH PREVIOUS STUDIES

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ABSTRACT

This paper focuses on the application of ergonomics in the educational field by emphasizing the role of ergonomic design in enhancing the educational performance of all participants in the educational process as an integrated system. The focus is placed on several areas, such as the design of educational programs and curricula, instructional design, and the evaluation of educational performance, among others. The study also highlights the role of educational and school ergonomics based on the general system, which revolves around the design of school buildings and the physical environment in which they are located, due to its impact on the performance of the participants in the educational process. Particular attention is given to teacher performance, such as classroom design and equipment, as well as student behavior in daily activities, especially their interaction with school bags, including their weight and its impact on overall health, particularly back pain and musculoskeletal disorders.

KEYWORDS

Educational Ergonomics, School Building Design, School Bag

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Introduction:

Education is one of the fields that has undergone numerous changes, which have been directly reflected in all educational requirements (curricula, teachers, administration, instructional materials, and school buildings). Given the direct impact of the educational environment on the future of upcoming generations, whose lives begin at school, the topic of this paper has been chosen to focus on the following:

- **School buildings:** Many studies focus on the differences between old and modern school buildings in terms of compliance with quality standards that enable better performance and improved outcomes across all dimensions and requirements.

- **Studies related to school bags and the impact of their weight on students:** This is due to the back, shoulder, and neck pain they may cause when ergonomic standards are not respected in their design and in the weight they carry relative to the student's body weight.

Hence, the importance of this research lies in the assumption that the optimal preparation of successive generations within the Algerian school system at all levels requires the provision of an appropriate educational environment that includes educational requirements responsive to modern developments. This is particularly relevant in the context of discussions about the "school of the future," which is expected to possess the capacities necessary to accommodate modern technological developments based on digital intelligence in all its components.

The Research Problem

Research on the educational process, which is essentially based on the interaction between the teacher and the learner, is a demanding endeavor. This is because it is often fragmented from its general framework into numerous partial and isolated components, which ultimately leads researchers to reach results that are difficult to generalize, at least to some extent. This is due to the considerable complexity surrounding research in such topics. Contemporary studies attempt to adopt a more comprehensive approach that addresses the various dimensions of this issue.

To clarify any ambiguity in this pedagogical debate, specialists in ergonomics emphasize that their approach does not aim to merge disciplines into a single field, but rather to develop educational methodologies so that specialists in any given field can gain a broad understanding of other branches of knowledge. In other words, the ergonomic approach seeks to overcome the “illiteracy” of specialists in one field regarding other areas of knowledge. Ultimately, the ergonomic perspective aims to establish a common ground among sciences and disciplines with the human being at its center (Bouhafis & Mebraki, 2004, p. 5), as humans constitute the basis of all objectives, and without them none of the other goals can be achieved.

The objective of this paper is to evaluate the design process by examining the extent to which it respects the requirements and needs of the system groups involved in the educational process, based on principles of design ergonomics. This is achieved through the use of studies, data, and statistics from various sources, which help provide a broad view of the degree to which quality standards are applied in the design of educational facilities. This subsequently allows us to question the extent to which existing school buildings are capable of adaptation, harmony, flexibility, and accommodation of modern developments in order to create an educational environment that prepares Algerian students for the demands of the future, in light of the internal and external pressures imposed by a digitally open world.

School ergonomics is, to some extent, a relatively new concept in developing countries in terms of both emergence and application. Porcher (1982) suggests that it appeared in the educational field in the early 1970s and is mainly associated with workplace physiology and with providing healthy and comfortable conditions for school life. It includes both human and material inputs: human inputs consist of students, teachers, and school administrative staff, while material inputs include school and classroom design with their various facilities and equipment.

Lancry-Hoestland defines educational and school ergonomics as a working approach that seeks to improve the organization of all educational processes based on human biology and psychology from an anthropological perspective. It encompasses all factors related to educational processes and aims to improve the relationships between student and teacher activities, equipment and tools used, physical space, as well as temporal and academic conditions under which educational projects are implemented (Ouens Yasmine, 2018, p. 47).

Algeria is one of the countries that continue to make significant efforts to reform the educational system and to develop human resources by adapting its educational policies to development plans, civilizational conditions, and socio-economic realities. These efforts aim to reduce pressures and overcome difficulties and obstacles facing this vital sector, foremost among which are academic and behavioral problems. Some attribute these problems to the learner, while others relate them to the educational system itself (Talbi Naima, 2014, p. 80).

Given that ergonomic intervention aimed at improving educational factors greatly benefits and supports the educational process, educational ergonomics is concerned with studying the interaction between educational performance and the design of educational factors. It seeks to verify the adequacy of academic programs and curricula and to ensure that their design is based on learners’ needs, interests, tendencies, values, and culture, in a manner that keeps pace with the times and facilitates the acquisition of appropriate cognitive, affective, and psychomotor skills (Khaled Miqdad, 2010).

Within this context, the practice of ergonomics in the educational field aims to analyze the interaction between educational performance and the design of educational factors, as well as to study the factors influencing performance through the application of learning ergonomics. This includes the study of learning styles, optimal assessment methods, learners’ behavior during the educational process, and issues related to the design of instruction, textbooks, lessons, educational publications, documents, and educational technologies.

In addition to the ergonomics of educational services (libraries, laboratories, educational administration, and school furniture) and the ergonomics of educational equipment and tools, environmental ergonomics focuses on designing the physical educational environment, including lighting, ventilation, temperature, and

humidity levels within classrooms, as well as the school environment, social and cultural context, and administrative setting. Ensuring that training materials, environments, and delivery methods are ergonomically designed before initiating training is considered a fundamental requirement for the success of the educational process (Khaled Miqdad, 2010).

We will attempt in this paper to address the contribution of educational ergonomics to enhancing the performance of the educational process through two main components:

1. The design of school buildings and equipment.
2. The design of the school bag (backpack).

This will be achieved through the presentation and discussion of several studies conducted in the Algerian context.

The growing interest of many countries around the world in conducting research in this field, in contrast to the limited attention it has received in Algeria, encourages us to examine the few studies carried out in our country, despite the fact that this field is rich and fertile for research. Educational policy in Algeria has not given sufficient importance to school ergonomics and its educational applications. Following independence, national educational policy focused primarily on building a large number of educational institutions at all levels in response to the urgent need for schooling and to keep pace with rapid demographic growth. As a result, the state prioritized the construction of schools in cities, villages, and remote areas, while neglecting the importance of the architectural design and internal equipment of these public buildings. The same school architectural models inherited from the French colonial period continued to be reproduced, without sufficient consideration of developments in global school architecture and educational equipment, particularly during the 1970s and 1980s (Slimani Sabrina, 2012).

Consequently, Algerian school architecture has remained confined to old, traditional, and standardized patterns that do not contribute effectively to the educational process, as they do not allow students to fully mobilize their capacities during interaction and socialization processes inside and outside the classroom. Moreover, discomfort resulting from poor design and unsuitable physical conditions further limits their effectiveness. Malaguzzi considers school architecture to be the “third teacher” after parents and teachers. However, the Algerian student, like children elsewhere, experiences rapid cognitive and physical development and is required to accomplish far more complex academic tasks than children in the past, while still learning in physical spaces that have changed very little compared to those of previous generations. These spaces are often equipped with outdated furniture and materials that no longer meet modern pedagogical requirements and contemporary teaching methods. Such equipment affects students’ academic performance, comfort, and motivation, and does not facilitate social interaction within the educational environment. It is also poorly adapted to students’ anthropometric dimensions.

Bendak (2012) notes that anthropometric measurements are rarely available in developing countries, which often rely on data from developed countries or on arbitrary standards when designing school furniture. Bendix (1987) argues that any mismatch between the dimensions of school furniture and students’ anthropometric measurements leads to excessive physiological strain on muscles, ligaments, joints, and intervertebral discs. Similarly, Hira (1980) suggests that learning can be negatively affected by uncomfortable and constrained postures, even when the lessons themselves are interesting and motivating. Yeats (1997) emphasizes that encouraging correct sitting posture through appropriate furniture is essential for children as well as adults, since sitting habits formed at an early age are difficult to change later. Troussier et al. (1999) observe an increase in neck, shoulder, and back pain among students in recent years, attributing this to poor-quality furniture and inadequate design, which affect sitting posture in relation to classroom activities, anthropometric characteristics, and furniture design (Ouens Yasmine, 2018).

Regarding school bags and the impact of their weight, a study by Tehani Al-Ahmad in Saudi Arabia recommended that the weight of the school bag should not exceed 15% of the student’s body weight. Using modern instruments to assess cervical posture among female students, the study found deviations in neck alignment associated with carrying heavy backpacks. The results showed that maintaining the bag weight below 15% of body weight helps prevent postural deviations, particularly among children under the age of 12. In order to reduce such problems, several international health organizations have also recommended limits on backpack weight. The Professional Association of Occupational Therapy (2004), for example, set the recommended maximum at 15% of body weight, a standard also adopted by the American Physical Therapy Association and the American Academy of Orthopaedic Surgeons.

This raises several important questions in the Algerian context: Is this standard applied in Algerian schools? Will the school bag continue to represent a heavy burden for students? And what solutions can be proposed to address this serious problem? (Talbi Naima, 2014).

Review of Previous Studies on the Contribution of Ergonomics to the Educational Process

School ergonomics addresses a wide range of topics through research and analysis that aim to improve learning conditions for all participants in the educational process. As an applied science, it is not the responsibility of psychologists alone, nor solely of specialists in sociology or education, but also involves other disciplines that are directly or indirectly related to the school environment, such as medicine, architecture, biology, and other fields whose combined efforts are necessary to ensure children's well-being at school.

For this reason, many countries have directed their attention toward this field because of the remarkable results achieved by ergonomic interventions implemented in various contexts. The United States is considered a leading country in this area, accounting for nearly half of the studies, research projects, and experiments conducted worldwide on school ergonomics. It is followed by Australia and Brazil with lower proportions, then Canada and New Zealand, followed by England. Other countries involved in this field include Chile, Colombia, Japan, Croatia, Germany, Hong Kong, India, Iran, Ireland, Malaysia, Mexico, Russia, Portugal, Singapore, Slovenia, Sri Lanka, Switzerland, Venezuela, and finally Palestine, which, despite being the smallest among the group, has shown interest in studies related to school ergonomics. In total, 26 countries participate in the Committee on Ergonomics for Children and Educational Environments of the International Ergonomics Association (2008) (Ouens Yasmine, 2018). Despite this global trend, studies conducted in the Algerian context remain very limited, mainly due to the relatively recent emergence of the ergonomic approach in developing countries, including Algeria, where insufficient attention has been given to this field of research.

Below, two Algerian studies relevant to the issues raised in this paper are presented.

Study by Ouens Yasmine (2018): "Teachers' and Pupils' Views on the Algerian School Environment: An Ergonomic Reading of Three Primary Schools in the City of Tizi Ouzou."

The aim of this study was to identify and highlight the importance and role of school ergonomics in the educational sector and its contribution to ensuring comfort and safety for students and staff in educational institutions, as well as to assess the extent to which ergonomic standards related to school architecture and furniture are respected and applied.

The researcher adopted a descriptive-analytical methodology. The study sample consisted of 208 participants divided into two groups: the first included 169 fifth-grade primary school pupils (boys and girls), and the second included 39 primary school teachers. A questionnaire designed by the researcher on school furniture was administered to pupils, while another questionnaire designed by the researcher on school architecture was administered to teachers. The study addressed the following questions:

- What are teachers' views on the school architectural design adopted in Algerian primary schools?
- What are pupils' views on the school furniture used in Algerian primary schools?

The results showed that most of the chi-square (χ^2) values related to the school architecture questionnaire were statistically significant, indicating that the three schools involved in the study did not comply with ergonomic standards that ensure the safety and health of their occupants. Classrooms located on the ground floor adjacent to the external courtyard were deprived of natural lighting, which constituted a primary cause of insufficient daylight. In addition, classroom orientation played a significant role: classrooms whose windows faced north lacked direct sunlight, as observed in the El-Ikhwa Tiyab School and Base 4 School, where some classrooms were oriented only toward the north, while southern windows opened onto internal corridors, preventing access to sunlight even on upper floors. This deprivation was particularly evident during winter and on cloudy days. Moreover, the presence of trees and external walls near classroom windows further reduced natural light, especially in the Ahmed Ouamrane School. This finding is consistent with Minier (2001), who noted that trees growing near classroom windows reduce natural lighting.

These findings indicate that school architecture in Algerian primary schools does not meet ergonomic design standards that ensure students' health and safety.

The results also showed that pupils experienced back pain while sitting in class, mainly due to discomfort caused by inappropriate seating, particularly the unsuitable height of chairs, which did not exceed 38 cm. Mandal recommended the provision of adjustable furniture in different sizes suitable for various age groups and adaptable to children's physical development and learning tasks. Fisks (1984) argued that prolonged sitting on excessively low furniture may predispose children to Scheuermann's disease (kyphosis

of the thoracic and lumbar spine), due to poor adaptation of chairs and desks to children's body dimensions. This confirms that the school furniture used in Algerian primary schools does not comply with ergonomic design standards that ensure students' health and safety.

The results of this study showed that pupils suffer from back pain while sitting in class. This discomfort is mainly due to the inappropriate and uncomfortable design of classroom chairs, particularly their unsuitable height, which does not exceed 38 cm. In contrast, Mandal recommended the provision of furniture in different sizes appropriate for each age group, with the possibility of adjusting height and inclination according to children's physical development and learning tasks. Fisks (1984) argued that prolonged sitting imposed on young children on excessively low furniture may constitute a major risk factor for Scheuermann's disease, which involves abnormal curvature of the thoracic and lumbar spine, due to the poor adaptation of chairs and desks to children's body dimensions. This indicates that the school furniture used in Algerian primary schools does not comply with ergonomic design standards that ensure pupils' health and safety.

Study by Taibi Naima (2014): "The Application of Ergonomics in the Educational Process"

This study aimed to examine the issue of school bags by investigating the impact of their weight on pupils' health and by assessing the extent to which school bag weight complies with ergonomic standards, which recommend that the bag should not exceed 15% of the pupil's body weight. The researcher adopted a descriptive approach and conducted the study on a sample of 32 pupils aged between 9 and 11 years, all enrolled in the fifth grade at Omar Bouchakor Primary School in Buzareah, Algiers.

The study was guided by the following questions:

- Is the recommended weight limit for school bags applied in the educational environment?
- Will the school bag continue to represent a heavy burden for pupils?
- What solutions can be proposed to address this serious problem?

The findings revealed that pupils' body weights ranged between 32 and 37 kg, while the weight of school bags ranged between 8 and 10 kg. This means that the bag represented between 22.85% and 28.16% of the pupil's body weight, which far exceeds the recommended 15% limit. This indicates that pupils carry an excessive load on their way to and from school.

Given these results, the excessive weight of school bags is likely to pose serious risks to pupils' health, as indicated by ergonomic studies worldwide, particularly with regard to musculoskeletal disorders at this early age, including spinal deformities such as forward trunk inclination, head and spinal flexion, and shoulder elevation.

General Discussion

After presenting the results of these two studies, it is important to emphasize that the purpose of relying on previous ergonomic studies conducted in the Algerian context is to introduce ergonomics in general, and educational ergonomics in particular, in line with the objectives of this scientific conference. This is mainly due to the relatively recent emergence of the ergonomic approach in various fields, including industrial, economic, social, and educational domains. Academic efforts in this area continue to face numerous challenges, as evidenced by the difficulties encountered each year in teaching ergonomics-related courses, particularly due to the lack of resources and facilities necessary for conducting applied field research with students.

This situation is reflected in the findings of the two studies presented, which reveal limited consideration of ergonomic standards in the design of school buildings, far below expectations, as well as the persistent problem of school bag weight. Despite years of scientific discussion regarding its risks and negative effects on pupils' health, solutions have largely remained confined to academic forums, conferences, and reports, without being effectively implemented in practice.

Currently, newly constructed educational institutions in Algeria provide a certain degree of comfort through the use of modern building materials, reinforced concrete, large glass windows, and bright colors. However, these efforts remain insufficient to break away from the traditional architectural model characterized by schools organized around a long internal courtyard surrounded by similar classrooms, with a staircase at the end leading to upper floors and a central open yard used for breaks. Schools are typically enclosed by walls or fences that isolate them from their surrounding environment. This situation is mainly attributed to financial constraints and cost-driven priorities, which favor quantity over quality. Educational administrations often impose strict financial and material criteria that limit architects' creative freedom and prevent the adoption of innovative and ergonomically appropriate designs.

Similarly, the issue of school bags remains a serious problem due to the wide gap between scientific recommendations regarding acceptable weight and the actual weight carried by pupils.

Recommendations

- Ensure the application of ergonomic standards in the architectural design of schools and in the selection of their locations.
- Pay attention to the aesthetic and functional aspects of schools and classrooms, and improve physical conditions such as lighting, noise control, and ventilation.
- Install sound insulation in schools located in noisy environments in order to reduce the impact of external noise.
- Avoid planting trees directly in front of classroom windows, especially those facing the external courtyard, as they reduce natural light and limit pupils' exposure to sunlight.
- Avoid painting or covering window glass with paper to reduce glare; instead, use appropriate sunshades or curtains to regulate sunlight intensity.
- Maintain daily cleanliness of classrooms.
- Reconsider the school furniture currently used and redesign it according to ergonomic standards.
- Establish a database of anthropometric measurements of Algerian pupils in order to design school furniture adapted to their physical dimensions (Ouens Yasmine, 2018).
- Address the issue of school bag weight by coordinating daily curricula with the weight of textbooks, notebooks, and supplies to ensure that the overall load is kept within safe limits.
- Reduce overly dense curricula.
- Support pupils in organizing their school bags according to their daily schedules.
- Provide appropriate lockers in schools to reduce the need for pupils to carry heavy loads.

Conclusions

Evaluating the design of school buildings requires considerable effort and detailed information in order to provide high-quality educational services that respect pupils' psychomotor, biological, psychological, and health-related needs. The school environment should ensure comfort, safety, and psychological well-being for all participants in the educational process.

Addressing all components of school design therefore requires multidisciplinary collaboration among specialists from different fields, in order to achieve the highest levels of quality through a holistic perspective that takes into account all factors shaping the educational process. This includes respecting pupils' psychomotor, biological, psychological, and health needs during their interaction with the school environment, which should provide comfort and physical and psychological safety. Consequently, there is a need to reconsider the school furniture currently used in Algerian schools, which poses health risks due to the incorrect and unhealthy postures it imposes on pupils.

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