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A model for designing teaching-learning space based on brain-centered approach in physical dimension for primary schools

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The present research aimed to provide a model for designing teaching-learning space based on brain-centered approach in physical dimension for primary schools using a qualitative synthesis method. The research area included all the articles and researches published in the field of teaching-learning space based on the brain-centered approach. In this regard, the design of the teaching-learning environment of primary school based on the brain-centered approach in the physical dimension and its validity were investigated and among 100 Persian articles from 2019-2021, 28 articles and from 50 English articles from 1994-2021, 25 articles selected via purposive sampling. Data collection was provided with the library method and note-taking method. To analyze the data, the roberts research synthesis steps were used. According to the findings, spatial dimension (including 12 categories), appearance characteristics dimension of the environment (4 categories) and arrengment dimension (12 categories) were identified. Also, the findings showed that the designed model has the appropriate validity.

Keywords
design of teaching-learning space, primary school, brain-based approach, physical dimension

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Introduction

Achieving success in scientific fields relies on education and providing suitable and effective learning spaces that align with the country's educational system. According to Lakheide and Werspore, "learning and education always take place in appropriate classrooms and schools with the presence of teachers and students." (Samadi & Vakili, 2019). The location and learning environment are among the most important factors in education and the upbringing of future generations. As Eisenberg said, "in my opinion, the future of our country depends on the type of environment I see for the growth and upbringing of our children." (Taheri, 2017).

On the other hand, brain-based learning principles provide a theoretical framework for effective learning and the best conditions for learning in the brain. Brain-based learning, as a new approach in education and understanding the path that the brain naturally designs for learning, was introduced in 1980, and its research is expanding. In this regard, this study focuses on designing a brain-based learning environment (Jalali et al., 2019). Recent findings on how the brain functions have led to a wave of new insights into topics such as thinking, memory, motivation, learning, and growth. These findings have provided valuable studies on how the brain learns and grows for educators to extract valid educational principles and implications from neurocognitive foundations of learning and education and establish a strong link between the two domains of education and neuroscience (Dadashzadeh et al., 2020).

Since learning is one of the interesting and somewhat challenging areas in psychology and educational sciences that have applications in various fields of education, different theories of learning have been proposed, each focusing on a part of the cognitive and behavioral processes. Their goals have been to empower individuals to use their brain capacity to learn and retrieve the material (Hasani et al., 2016). Brain-based learning also includes principles and strategies that use research in neuroscience and cognitive science to strengthen teacher education. This type of learning is based on the brain's ability to recognize the rules and regulations of meaningful learning and organize teaching based on those rules (Jacob Koola & Michel Olou, 2018). Brain-based learning, by understanding how the brain works and discovering ways to maximize the brain's function, supports and enhances learning, and shows the positive effects of brain characteristics on learning performance, thus mainly seeking progress and improvement of the brain (Dikici & Gozusil, 2014).

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It has been found through reviewing research both inside and outside the country that there has been no direct research on designing the teaching-learning space model of elementary school based on a brain-based approach in the physical dimension. However, some studies have indirectly referred to it in their introduction and obtained different results. For instance, Novzari and colleagues (2019) investigated the effect of brain-based education on the learning and language readiness of preschool students, and the research results showed that brain-based education has a significant positive effect on increasing the learning level, stability, and language readiness of students. Afarakhth and colleagues (2019) designed a comprehensive model of brain-based curriculum in organizational education, and the research results showed that the comprehensive model of brain-based curriculum with five pillars (foundations, theories, approaches, perspectives, and constructive patterns) and ten fundamental elements (determining learner features, content, learning activities, educational goals, teaching strategies, learning resources and tools, space and place, grouping, time, and educational assessment methods) and 88 design features was effective. Amani, Torbatinejad, and Mohammadi (2019) investigated the design of brain-based online learning with an emphasis on electronic and mobile learning. The results showed that constructive approaches and patterns such as experiential learning, problem-based learning, and collaborative learning can be considered as compatible approaches with brain-based learning. Mahjoob (2019) conducted research on an introduction to learning neuroscience and the role of brain-based learning in teaching and learning, and the research results showed that brain-based learning can improve academic performance and behavior of students in the classroom and can also improve relationships between students and teachers.

In general, studies conducted inside and outside the country have shown that designing the teaching-learning space model based on a brain-based approach can have a positive impact on the learning process and academic progress of students. Using brain-based learning approaches and principles in designing learning spaces, educational programs, and teaching methods can lead to significant improvement in student performance. Additionally, using these approaches in organizational training and e-learning can also have a positive impact on learning and meeting the educational needs of individuals. Based on these results, it is suggested that the design of teaching-learning spaces in schools and educational institutions be based on a brain-based approach, and its principles and methods be used in educational programs and teaching. Furthermore, providing training related to brain-based learning approaches to teachers and those responsible for education

can lead to significant improvement in the learning and development of students and individuals interested in learning.

Jackie and Shah (2018) conducted a study titled "Neuroscience, Learning, and Practical Training: Challenges and Applications" that examined the relationship between neuroscience and learning. In another study, Doman (2010) investigated the effect of brain-based learning on the academic progress of students with different learning styles. The results showed that the use of brain-based learning had a greater impact on the academic progress of learners in the experimental group compared to the control group, but there was no significant difference in the academic success of students with different learning styles in the experimental group. Pookie and Estelle (2007) in a study titled "Improving Students' Progress through Brain-Based Strategies" found that brain-based strategies can increase students' confidence and reduce their negative behaviors, leading to academic progress. Similarly, Reisberg and Latfi (2006) in research titled "Brain-Based Learning and the Role of Fine Arts" showed that fine arts are a suitable way to challenge students' minds with brain-based learning principles. In Sprengher's (2002) research on "The Effects of Music on Brain Changes and Human Health", it was found that music increases the secretion of endorphins in the brain, thus relieving physical discomfort.

In this regard, it should be noted that the learning environment plays a fundamental role in the social and cultural structure of society. The educational system, teaching methods, and educational content, on the one hand, and the learning environment, on the other hand, are two essential components of the educational system. The school building should be designed in such a way as to stimulate the freedom and continuous learning process of children, rather than imposing one-way and controlled learning on them. Given that the current empty spaces that students are studying in do not have the necessary quality, and considering the virtual education that has emerged in the last two years due to the health crisis and technology, designing a brain-based learning environment in the physical dimension is usable for the macro-level curriculum planners in the Ministry of Education and school administrators.

Given the above, the main research question for designing a brain-based learning environment for elementary school students in the physical dimension is how to approach it. This can be considered as important research in the field of education and training because designing a brain-based learning environment can facilitate the improvement of students' academic progress and enhance their learning process. Therefore, it is necessary to seriously investigate the effective factors in

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designing a brain-based learning environment for elementary school students in the physical dimension to benefit from the advantages of this approach in improving the quality of education and training in elementary school.

Materials and Methods

This qualitative study was conducted using a synthesis approach. The sampling method was purposive, and the research area included all published articles and research studies on the topic of teaching and learning environments based on brain-based learning. The design of the elementary school teaching-learning environment based on a brain-based approach in the physical dimension and its validity were investigated in this study. To collect data, 28 relevant Persian articles from 100 articles published between 1388-1400 and 25 English articles from 1994-2021 were selected and gathered using a library search and a fishbone tool. Roberts' stages were used to analyze the data as follow:

Stages of Synthesis Research

Stage 1: Identification of Needs, Preliminary Search, Clarification. The design is intended to be based on the synthesis of relevant research studies.

Stage 2: Conducting Research to Retrieve Studies. This stage involves searching for sources that meet the research's primary needs, as described in the sampling method and design.

Stage 3: Selection, Refinement, and Organization of Information. This stage involves reviewing and selecting studies relevant to the research's needs. The review requires criteria for selecting and categorizing studies, as described in the sample size and measurement method section.

Stage 4: Cognitive Framework and Integration with Analyzed Information. This stage is a linking framework that combines the information obtained around it.

Stage 5: Processing, Combining, and Interpreting Concrete Outputs. Based on the research's objectives, all components were extracted through the coding process, and then, through selective coding, all components were categorized according to common concepts. Therefore, based on the coding process in stage 1, each question is answered in this section.

Stage 6: Presenting Results. In this section, the synthesis research process for designing a teaching-learning environment based on a brain-based approach in the physical dimension is presented in a comprehensive view.

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Results

In this study, a synthesis approach was used to identify the design model of the elementary school teaching-learning environment based on the brain-based approach in the physical dimension. To provide a more detailed description of the benefits of the results obtained in this research, empirical evidence was used to identify this pattern. Therefore, 53 articles were used for the final analysis after identifying and eliminating irrelevant studies. The most important result of each study is provided in detail in the form of open and selective coding in the table 1and figure 1.

Table 1. Open and selected codes related to the physical dimension

Open codes	Selective codes
,56diversity of learning materials and resources -57-61-63-79Color, landscaping and flexibility -46Space and place -9Providing a combination of small and large spaces -70Space and flexible furniture -76The location and size of the space in the spatial organization of the whole building -80Open and roofed space per capita -81Communication between inside and outside space -2Creating a suitable educational physical environment -91Open space development -95Interference of open and closed spaces -112Open space of schools and increasing learning	**Spatial dimensions**
-59-64-65-66a 74-physiological dimensions of temperature, ventilation, light and noise -75Semi-fixed elements of space (decoration, motifs, color, texture, materials, shape, signs and symbols) -67Natural effects -96Reconstruction of natural stimulus elements such as light, water and plants	**Appearance characteristics of the environment**
-60U-shaped configuration, round tables, game spaces, personal spaces, public learning space -77Classroom layout criteria -78Traveling in space -82Furniture and landscaping -71Semi-private spaces -8Comprehensible spatial and physical structure -11More control of the child over the environment -123Using technology in school -14Design for social interaction -15Compliance with the design principles of learning spaces -45Learning resources and tools -19-85The effect of design and architecture on learning	**Layout**

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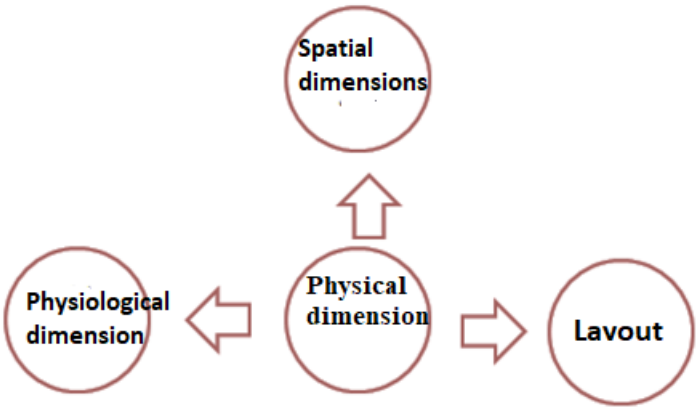


Figure 1. Selective codes related to the physical dimension

Discussion

The aim of the present study was to identify the design model of the elementary school teaching-learning environment based on the brain-based approach in the physical dimension. The results showed that designing the teaching-learning environment of elementary school based on the brain-based approach in the physical dimension includes spatial dimensions (diversity of learning materials and resources, color, landscaping and flexibility, space and location, providing a combination of small and large spaces, flexible furniture and space, position and extent of space in the overall spatial organization of the building, open and covered space ratio, internal and external space connection, creating a suitable educational physical environment, developing open spaces, interference between open and closed spaces, school open spaces and enhancing learning), environmental physical characteristics (temperature, ventilation, light and sound elements, semi-static space elements, natural effects, reconstruction of natural motivators such as light, water and plants), and arrangement (U-shaped configuration, round tables, play spaces, personal spaces, public learning spaces, classroom layout criteria, circulation in space, furniture and semi-private space partitions, perceptible spatial and physical structure, greater control of children over the environment, use of technology in school, design for social interaction, adherence to principles of learning space design, learning resources and tools, effect of design and architecture on learning). The research findings are consistent with some of the studies conducted by Azeemi et al. (2016), Malekian (2018), and Eskandari et al. (2019) and indicate that thephysical environment of the school, including space design, colors used, light, and other physical characteristics, has a significant impact on student learning, and the more attractive the physical environment, the more

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it contributes to students' learning. A school with beautiful and clean colors, decorated with green space and colorful flowers, a classroom with cheerful and uplifting colors, and so on, create a facilitating learning environment and unconsciously affect the level of learning.

Therefore, based on the results of this study and its alignment with previous research, it can be concluded that designing the teaching-learning environment based on the brain-based approach in the physical dimension should be considered as a priority in educational programs in schools. Architects, interior designers, managers, and teachers should pay attention to designing and optimizing learning spaces in a way that makes the school's physical environment attractive and facilitates the learning process for students. Finally, this study can serve as a useful guide for designers and builders of learning spaces based on the brain-based approach in the physical dimension to improve the quality of education and learning for students.

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Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

EM and MB contributed to the study conception and design, material preparation, data collection and analysis. All authors contributed to the article and approved the submitted version.

Ethics statement

The studies involving human participants were reviewed and approved by ethics committee of Islamic Azad University, Isfahan Branch (Khorasgan), Isfahan, Iran.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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