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The Principles of Designing Participatory Educational Spaces (Emphasizing the Production of Space and Young Experts' Opinions) *

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Abstract

The transition of the educational system from teacher-centered approach to the constructive approach requires more inclination of architects to create appropriate environment for the participation of students in learning. The purpose of this study is to investigate the effect of factors arising from the theory of space production on various dimensions of student participation in educational spaces. This research is a descriptive correlational study in terms of data collection method and the data have been collected using a survey study method and a researcher-made questionnaire for the statistical population (experts). Accordingly, the questionnaire was prepared according to the objective-content table, using a five-point Likert scale in the form of 34 closed-ended questions. The statistical population of the present study can be considered as a group of young experts aged 25-40 years with a master's degree or higher who had published articles in line with the objectives of the research in the last eight years (n=84). Identification of the effective variables was performed using SPSS software and the relationship between the variables was obtained with the help of the model extracted from Smart PLS software.

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The research results indicate that the factors arising from the theory of space production can be effective in different dimensions of the students participation in the educational spaces, such that a significant relation exists between 1) variables of convertible space and the required space for the variable of academic participation, 2) friendly and intimate space variables, agreeable space and space consistent with the variable of social participation; 3) the variable of varied spaces with the variables of sensory, environmental, and emotional participations.

Keywords: Space design principles, Participatory Educational Spaces, Space Production, Young Experts, constructive learning process.

1. Introduction

One of the reasons for forgetting the mass of material in the memory of students and not applying educational curriculum in their real life can be linked to the lack of opportunities for children to practically use the acquire knowledge and skills. In fact, the accumulation of theoretical material in the student's mind is limited to the final exam and it is discarded after each academic year, having no effect on the future needs of students in the community. Therefore, teaching “how to think and how to learn” to the students can guarantee their practical independence in overcoming different problems in their future life. The question here is what the solution for turning “what to learn” to “how to learn”’ .... Clearly, the answer to this question requires attention to various educational and behavioral aspects.

However, among the many problems related to education and educational spaces, the researcher has focused on the lack of practical participation of students in the learning process, which in addition to being influenced by several factors, is influenced by the principles of designing educational spaces. Nevertheless, among many problems prevailing in the education and educational spaces, this paper highlights the lack of practical participation of students in the learning process, which is affected by several factors as well as the principles of designing educational spaces.

The importance of this issue is highlighted when middle childhood has become one of the most important years for children to learn, because of which the children’s learning is accomplished. Especially since, from a constructivist

point of view, real learning is effective when the learner spontaneously creates meaningful products. Therefore, a great deal of importance should be given to the participation of students in the school environment.

Accordingly, we can point to the learning method derived from the theory of constructivism, which encourages the students to participate in learning by creating a multifaceted relationship. This method of learning "in the field of acquired sciences tries to motivate individuals to acquire and produce information and in the fields of instinct knowledge and innate knowledge, it tries to refine and exploit the God-given information resources by the learner…" (Islami, 2014). The important point to consider is the state of the compatibility of educational spaces with the constructivism approach. The theory of space production can be considered as a coherent reflection of different theories that were able to include different physical, mental and social dimensions of space while maintaining the boundary of distinction between them (Alan & Crookes, 2009; Butler, 2009; Rogerson & Rice, 2009). According to this theory, space cannot be contemplated as a product that has been demarcated and predefined over a period of time. The space is often reproduced over time, by the users and by their activities. Thus, the quality of participatory educational spaces can be effective for responding to the constructivism requirements and the values as well as the needs of the students, due to the possibility of reconstruction by the active users such as students over time.

Hence, the question here is how the relationship between the extracted principles of the space production theory and the components such as the students' participation in the educational spaces is...The research hypothesis indicates that the factors arising from the theory of space production, such as diversity, intimacy, transformability, readability, receptiveness, and fluidity can be effective in different dimensions of the participation of students. Thus, the aim of this study is identifying the effective principles of designing educational spaces in the students' participation in learning, highlighting the aspect that can be effective in perceiving the educational spaces as the interactive spaces with the students, providing new dimensions of such spaces, since the students as active people can change the mental aspects of space in collaboration with the

space and the mental and unconscious features of the phenomena can be considered in addition to objective and conscious features playing an active and timely role for the educational spaces. In other words, the educational spaces should have the principles that are receptive to the students and provide the possibility of the production of space by their participation with no limitation. Hence, identifying the participation criteria of the educational spaces can shed light on the concept of architectural space beyond its physical dimensions as a human environment dealing with other dimensions of the space, which are often ignored by the designers; this, conducting a research in this regard is important.

2.Review of Literature

2.1. Dimensions of participation in the constructive learning process

Regarding the necessity of using different growth dimensions of students in their learning process, the question is what the participation solutions of all the aspects of growth and education of the learners are. To answer this question, identifying different types of intelligence and its corresponding issue and considering the intrinsic and extrinsic dimensions of human beings according to the instinct and innate needs is quite essential. The dimensions beyond intelligence can be found from the psychological views regarding social intelligence, capability of understanding others, and interpersonal relationships. In the book “How we think?”, John Dewey (2012) believed that the necessary and sufficient condition, in addition to preparation of an appropriate space for the growth of cognitive intelligence of the students, is to provide essential facilities for acquiring social and emotional skills. The aim in considering different dimensions of intelligence can be paying attention to different potential and active capabilities of humans such as A) growth of senses and developing the mental images; B) controlling and expressing the emotions; C) learning the skills for holding relationships and collaboration with others; D) responding to the intrinsic needs and relation with the natural phenomena.

A- Sensory perceptions are considered as a part of instinct, which are important in receiving information from the environment and the act of learning. Juhani Pallasmaa believes that architecture is beyond plan views and

sections, since the boundary between human and the surrounding environment is recognized and identified by the senses. Thus, not only the individuals are not static users or receivers in confronting with the environment, but also they select the environmental stimuli and actively interpret them (Saoji & Bahadure, 2012, p. 901). According to Rudolf Steiner model, human senses can simultaneously be effective in the understanding process, knowledge, and learning of individuals from the environment by two or three ways: 1) transfer of the information from the body of surrounding environment; 2) creating the mental image and recallign the memories; 3) positive or negative effect on the spirit of individuals.

B- Emotional intelligence has the potentials of identifying and controlling the emotions and excitements of the person, understanding the others' emotions, and exploitation of emotion with respect to the conduction of thoughts for the individuals. In this regard, influenced by Salovey and Mayer (1990), Goleman (1995) provided a model for emotional intelligence and introduced five skills including self-consciousness, self-regulation, self-motivation, empathy, and social interactions. The effect of emotional intelligence on the learning process indicates the direct relation of high emotional intelligence and the independent activities of students, which leads to increasing the pleasant emotions and reducing the unpleasant emotions.

C- The origin of human emotional intelligence can be the inclination towards the society and being sociable, which is due to the individuals' innate needs, since humans are desperate for the help of others for their requirements. Hence, the social interaction of the learners and mutual collaboration of students with each other brings about the sense of responsibility, cooperation, friendship, and equality in them, providing kind relationships between them with the sense of continuity in the minds, activities and learning process of the students. As Goleman (2006) states, the interpersonal relationship increases the individuals' capabilities in performing calm actions with others and improves the control of emotions.

D- Responding to the intrinsic needs of humans was considered a while after expressing the theory of multiple intelligences. By writing the book "SQ: Spiritual Intelligence, The Ultimate Intelligence" (2000), Dana Zohar and Ian

Marshall believe that the spiritual intelligence shows the most appropriate way to the individuals and fills their lives with profound concepts and meanings (Zohar, 2005; Zohar & Marshall, 2004). In fact, confronting with different issues of life requires an intelligence beyond those two categories; in other words, that intelligence that has the potential to control and manage the two mentioned types of intelligences. Confrontation with various phenomena in cognitive conditions can entail the capability of understanding the signs and hence, the learning and recalling, considering the participation of spiritual intelligence and the innate of individuals. Authority and freedom are among the spiritual and ultimate features of humans, making them free to choose happiness or misery. The intrinsic freedom is the freedom of thought, desire and goal, the accomplishment of which depends on the potential to observe and select the required methods to achieve the goals. Therefore, freedom indicates spontaneity, and desire in selecting, having relation with others, admitting responsibilities, participation in personal and collective activities, and finally acquiring experience. In addition to the intrinsic need to freedom, spiritual and innate desire to beauty (desire for beauty and feeling pleased from that) and creativity as well as invention (creation, making and initiation) are institutionalized in everyone (Parsania & et al, 2015, p. 275). In this regard, the Pink theory considers the two terms of high concept (capability of innovations and creating artistic and emotional beauties) and high feeling (feeling of empathy and raising happiness in oneself and others) (Pink, 2005). The surrounding environment can indirectly create relations between these three inclinations, in addition to direct response to the inclinations to freedom, beauty, and creativity. For instance, if the environmental conditions are met for free personal and collective activities, doing group work also provides the expansion, fluidity, and flexibility of the children's ideas. Thus, the importance of human relations with the surrounding environment is significant in its simultaneous responding to some intrinsic inclinations.

Since schools are responsible not only for educational developments but also for the social and emotional growth of children, participation of the students should be considered as a tool for involving different dimensions of the children's growth. Academic participation is contemplated as the

framework of students' participation with emphasis on the cognitive intelligence and acquired sciences, involving the exploring and practical activities for building knowledge and its development by discussions.

Environmental participation occurs in response to the spiritual and ultimate needs to provide the basis for selection, creativity, and aesthetic requirements. Since the children senses are effective factors in perceiving and receiving the information from the surrounding environment, motivation with the associative memory, and the psychological requirements of children, the sensory participation also plays a main role in the students learning process. Emotional participation is also considered relative to the environment and other people in the positive (pleasant) or negative (unpleasant) emotional reactions with high or low grade of provocation, which is important for responding to the emotional needs of students. Finally, social participation is also significant within the framework of the environmental requirements for compatibility with personal and collective activities of the students and participation in the personal as well as social learning processes (Fig. 1).

Figure 1.Dimensions of participation in the constructivist learning process

2.2. Components of participatory educational spaces based on the theory of space production

The primary significant point to express the space participation principles is the reason to deal with this subject based on the issues and limitations that

dominant spaces have created in architecture. Hence, the question that can be asked here is what factors in today's architectural spaces have mainly been considered for the space participation potential. To answer this question, it can be said that conception of space within tangible shapes has raised it according to the coordinates within the limits of Euclidean geometry, while geometric confrontation with the space interrupts thinking about it and only conceptualizes the space for a specific aim. In other words, the reaction of humans relative to the space is not geometric, but the method of human abstraction is geometric.

Thus, the geometric or mathematical spatial idea in the architectural domain encourages the dominant ideas based on assuming architecture as an independent element from the space that has merely got the aesthetic aspect. In fact, although architecture has been understood as a social concern (Tabatabaei Molazi & Sabernejad, 2016, p. 76), its position under abstraction, geometry, and mathematics has reduced its main duty for the production of space. Hence, the abstractive and mono-functional spaces have been transformed to the dominant spaces that have made it into pieces and its homogeneity has been based on the functional specifications in order to control it. Thus, the objective pre-programmed spaces can be regarded as a scientific object with a neutral characteristic, which have emphasized the rigid and flexible process by placing the physical necessities in the environments of the considered users. This dominant approach towards space involves the users in a fixed network of images, signs, and symbols, which are controlled and voided from their outer side (Lefebvre, 2008, p. 355-356; Zieleniec, 2007, p. 61; Shields, 2005, p. 170-185).

Sociologists such as Lefebvre, Soja, Massey, and McGregor believe that the space should not merely be considered as a physical compartment, or defined as a fixed geometric space with physical and material coordinates and nature. It should be considered as a social production resulting from the interactions of the environment's physical and social aspects. In fact, space is continuously being produced and reproduced. Thus, the social spatiality can be regarded as the production of space via physical and social interactions, and the spatiality can be used as a theoretical tool for investigating the relations and paradigms

of power. Therefore, the apparently innocent aspects of space, which have applied power via intervention in the social relations involved in the space, create opportunities for changes in the activities and consequently creating modifications and transformations by the production and reproduction of space. Accordingly, the theory of space production has considered the user as the beginning point of understanding the space via the confrontation of the geometric, abstractive, and mental aspects of conceived space and the physical, inclusive and material aspect or the space realization that is under control in resisting against abstractive spaces with no physical body. One of the most important aims of this theory can be the elimination of the common view regarding the geometric space and spatial idea as a void area that has introduced the space with criticizing the dominant views regarding the concept of space as a filled vessel with some contents, which is neither a collection nor an empty space of the contents. However, it is a consuming value that is produced and reproduced with respect to the producing forces (McGregor, 2004: 368; Lefebvre, 2008, p. 27&77; Shields, 2005, p. 168; Elden, 2004, p. 110)(Table 1).

Table 1. Essential components of space production

Spatial action	Perceived space	Objective	Real affair	• It includes material and physical issues occurred all over the space
Spatial representations	Conceived space	Subjective	Symbolic affair	• Space is a tool for engineers and planners, considered as the official knowledge space, involving logical aspects, drawings and mathematics
Representation spaces	Lived space	Social	Imaginary affair	• It is a space full of meanings and symbolism, considered as the unofficial knowledge space, produced and changed over time due to being used

Source: Lefebvre, 2010, p. 55; Meffifield, 2008, p. 108; Beyes & Miches, 2011, p. 524; Torkameh, 2015, p. 176-177

Therefore, the most important principle of the theory of space production can be considered as its triple spatial view, which does not represent three separate real spaces, but represents the characteristics of a single space, changing, fluid and live. By presenting the theory of a single space, Lefebvre

considers a link between the physical, mental, and social aspects, and introduces the triple spatial actions (external material environment), spatial representation (conceptual model guiding action), and representation space (lived social relationship of users with the environment. According to these triple spatial actions, space is introduced as a physical environment that can be understood. Space, on the other hand, is a semiotic abstract environment that encompasses its imagined appearance. This dimension of space affects the subjective drawings and state of using them by different classes of people. Finally, the living representation of the space makes the interactions of people possible with each other. Although the theory of space production did not lead to the principles of objective space, it can provide desirable criteria for the space to be participatory (Table 2).

Table 2. Features of participatory space based on the viewpoints of space production intellectuals

Triple of space	Data	Reference	Code	Subject
Spatial action	A1- The actions of individuals become significant by understanding how space is structured A2- Through the formation of spatial symbolism, the values and behaviors are expressed and material order is considered as a tool for transmitting the meaning A3- Factors that affect the user space are the specific dimensions, scope and activity of the space that are suitable for the presence of users A4- Human perception of space is mediated by factors such as its physical features	Torkameh, 2015, p. 15, 113, 168 & 170	Perceived space by symbols and awareness of activities	Consistent space
Spatial action	B1- By emphasizing the right of participation, Lefebvre argues the importance of space ownership by users, the right of possession and self-improvement B2-Similar to the environment, the places of action must also be dominated by humans, after which the humans achieve their places in space B3- The realm of individual property includes the behavior of living beings regarding the claim to belong to a particular area in which the actions take place	Elden, 2004, p. 110; Lefebvre, 2008, p. 129; Harvey, 2016, p. 338-339; Torkameh, 2015, p. 39 & 44; Norberg-Schulz, 2014, p. 21-24	Exclusive ownership, being part of the space	Friendly space

Spatial action	C1- The human tendency to be in a space is not only influenced by actions but also by the user's feelings towards that space C2- The space is formed through the preferences and needs of the users. In this way, the space is made special by its users C3- Regarding the production of space, Lefebvre, supporting the spatial viewpoints of users, believes that the motivation and tendency of users towards space depends on their experiences in space	Lefebvre, 2008; Torkameh, 2015, p. 319	enhance the space experience	Agreeable space
Spatial representations	D1- Space is a set of functions and includes the products and the relationships between them D2- The possibility of strategic replacement of space functions increases user participation and compatibility of space with a variety of space uses D3- The space is never prefabricated, but shows flexibility for every situation and experience, and is transformed by each actualized opportunity	Lefebvre, 2008, p. 73; Shield, 2005, p. 155; Harvey, 2016	Space compatibility, space variability	Flexible space
Spatial representations	E1- The requirement of releasing space in architecture can be considered as the possibility of its permanent expansion (of space, light, landscape, etc.); In this case, space is similar to inexhaustible energy and changes from one type to another. This releasing of space allows users to gain spatial experiences E2- Self-awareness requires a relationship with another, insofar as being indicates communicating. Man can determine his place by seeing others and giving them a special position in space E3- Space is formed according to motion / immobility, space fluidity and spatial relationships	Torkameh, 2015, p. 26 & 140-143; Foucault, 2020; Grutter, 2014, p. 325; Shadmani Roshan, 2012, p. 80-81; Cring & Thrift, 2018, p. 100	Expanding the space, facilitating physical-visual-mental movements	Integrated space
Representation space	F1- The environment is received by the user's body, so diversity in the perception of environments causes them (environments) to differ from each other F2- The main components that create the human relationship with space can be considered as events or activities and their effects during the time lived in space F3- The right of users to create different spaces allows the absolute action framework of the space to be made flexible	Lefebvre, 2008, p. 73; Kwinter, 2002, p. 5; Berressem, 2005, p. 93; Luci Smith, 2008, p. 168; Shirazi, 2012, p. 82; Torkameh, 2015, p. 92; Harvey, 2016, p. 283 & 338-	Environmental stimuli, individual choices in different situations, relation with natural factors, creating space	Varied space

F4-	A variety of flexible behaviors occur during the transformation or creation of nature and plant growing, through collaborative activities and the free discovery of a relationship with nature	340

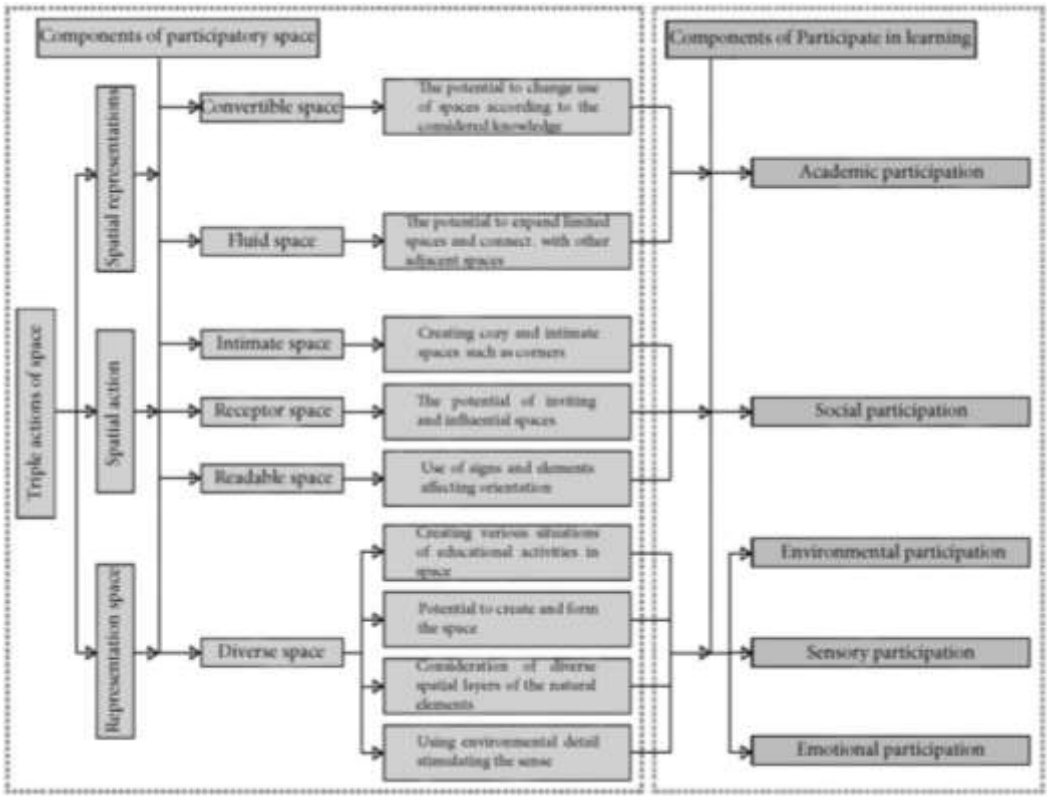

Figure 2. Relationship between the variables

It can be found from all the opinions of experts of this theory that the organized but multi-layered and varied spaces, which allow the internal structure to be changed by user action, are in line with the goals of the theory of space production. Accordingly, an attempt has been made in Table 2 to obtain codes and finally categories for space with the spatial properties derived from the present theory, which are effective to objectify a participatory space. As can be deduced from the above points, the proper organization of spaces and the possibility of changing and transforming it according to the wishes of users leads to an appropriate level of response to their individual and collective needs. In other words, just as people's relationships are affected by spatial

organization, so is its formation. Therefore, spatial configuration, as the main generator of motion patterns, is an increasing or decreasing factor for the representation spaces (Fig. 2).

3. Methodology

The present study is a descriptive correlation in terms of data collection method and quantitative research method has been used to achieve the relationships between variables. The data were collected using a survey study method and a researcher-made questionnaire for the statistical population (experts).

The statistical population of the present study can be considered as the young experts aged 25 to 40 years with inclusion criteria of familiarity with the subject, level of education and scientific experience in the research. Therefore, a group of young specialists with a master's degree and doctoral students or graduates was selected who had published articles in line with the objectives of the research and in relation to children's educational spaces, in reputable research journals, within the last eight years.

Accordingly, the size of the statistical population was 134 people; thus, due to the limited number of experts in the present subject and for increasing the validity of the research, the subjects were selected from the entire statistical population. Exclusion criteria of the samples studied in the present study can be considered inaccessibility and non-cooperation, which eventually led to a sample size of 84 people. It should be noted that the sample size is equal to 80 people based on the Cochran's formula with the error margin of 0.07.

Since there is limited standard questionnaire to determine the attitude of experts about the components of participation in educational spaces, to understand the relationship between variables, a researcher-made questionnaire has been used. Accordingly, the questionnaire of experts has been prepared using the objective-content table. The use of this table can be considered as one of the effective methods in formulating questions in line with the goals and contents of the research, which is based on library studies and research literature.

Accordingly, the contents of the research (Space Production components) are placed in the rows and the objectives of the research (dimensions of participation in learning) are placed in the columns and the intersection of each row with the column is assigned to a question. Therefore, the introductory questionnaire was closed-answer, using a five-point Likert scale (strongly agree, agree, have no opinion, disagree and strongly disagree) and was prepared in the form of 55 questions. Then, after examining the face validity of the questionnaire by experts and professors, the questions that had similarities were corrected or deleted, and finally a questionnaire with 34 closed-ended questions was obtained.

The validity of the research structural tool, which showed the accuracy of the tool in measuring the desired feature, was examined using the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) index and the Bartlett test of sphericity. It can be observed in Table 3 that the KMO variable is greater than 0.7. Hence, the model quality was approved and the data related to the questionnaire of the experts were suitable for the required analyses. In addition, since the P-VALUE in the software output of P-VALUE was less than 0.01, it could be inferred that the quality of the model was confirmed at the error level of one percent, i.e. the confidence level of 99 percent (Table 3). On the other hand, Cronbach Alpha method was used to estimate the reliability of the questionnaire. The value of Cronbach Alpha coefficient in all the factors of the experts' questionnaire was 0.934 and greater than 0.7. This amount does not increase significantly by removing the questions of the questionnaire. Hence, the factors of the experts' questionnaire were at a reasonable level in terms of reliability, and reliability of all questions of the experts' questionnaire was approved.

Table 3. Analysis of the model quality and KMO test

Variable	No. of items	Bartlett test significance	KMO variable
Expert questionnaire	Items 1 to 34	P value<0.001	0.827

Analyzing the expert's questionnaire and identification of the effective variables were performed using SPSS software and the relationship between the variables was obtained with the help of the model extracted from Smart PLS software and the path analysis method (at the significance level of 0.01).

In fact, the path analysis can be considered as a type of modeling that provides a linear model and the relationship between the variables and the accuracy of the model is checked by using the fitness test.

4. Findings

4.1. Effective variables

The variables of the experts' questionnaire were factorized based on the main components and the factor loading was used to extract the factors and components. Accordingly, 9 factors remained from the questionnaire of experts in analysis, which were extracted by the software, having the factor loading and eigenvalues of greater than 0.8. These 9 factors could express 87.305% of the variance of variables. In this regard, after examining the obtained variances for each factor and based on order of priority, the first factor is 34.906%, the second factor 4.054%, and the third factor 11.837%. In addition, the fourth, fifth, and sixth factors are 8.088%, 6.56%, and 3.331%, respectively, while the seventh factor is 3.305%, the eighth one indicates 2.852%, and the ninth factor shows 2.528% of the common variance. Then, the displacement of extractive factors has led to a their more uniform distribution, so that the factors are effective in such an order that the first factor is 16.595%, the second one 16.039%, the third factor 14.8%, the fourth factor 13.745%, while the fifth one indicated 5.709%, the sixth factor 5.366%, the seventh factor 5.226%, the eighth factor 4.914% and the ninth factor is 4.911% (Table 4).Studying variables.1% and 20.3% of respondents.

Table 4. Extraction of main factors

Factor	Primary eigenvalues			Eigenvalues of extracted factors without displacement			Displaced eigenvalues of extracted factors		
	Eigenvalue	Variance (%)	Cumulative variance (%)	Eigenvalue	Variance (%)	Cumulative variance (%)	Eigenvalue	Variance (%)	Cumulative variance (%)
1	11.868	34.906	34.906	11.868	34.906	34.906	5.642	16.595	16.595
2	4.778	14.054	48.96	4.778	14.054	48.96	5.453	16.039	32.634
3	4.025	11.837	60.797	4.025	11.837	60.797	5.032	14.8	47.434
4	2.75	8.088	68.885	2.75	8.088	68.885	4.673	13.745	61.179
5	2.076	6.105	74.99	2.076	6.105	74.99	1.941	5.709	66.888
6	1.234	3.631	78.621	1.234	3.631	78.621	1.824	5.366	72.254
7	1.124	3.305	81.926	1.124	3.305	81.926	1.777	5.226	77.48
8	0.97	2.852	84.778	0.97	2.852	84.778	1.671	4.914	82.394

9	0.859	2.528	87.305	0.859	2.528	87.305	1.67	4.911	87.305

4.2. Explanation of the research model

Figs. 3, 4 and 5 show the design of the final structural model between the variables of the experts' questionnaire, in which the path coefficients between the variables and the factor loadings of each of the questions related to the factors are examined.

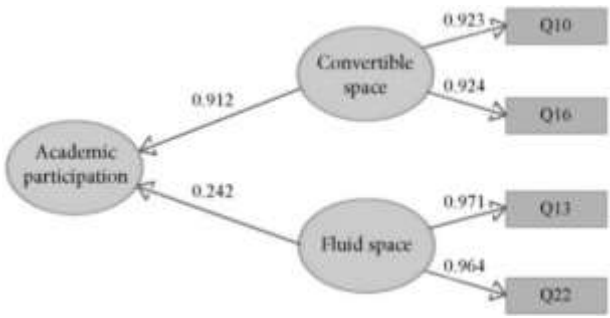

Figure 3. Model of standard coefficients related to academic participation

Table 5.Investigating the relationships and effects within the structural model of academic participation

Hypothesis (Significant relationship between the variables)	Estimation of the path coefficient	Sampling error	Significance coefficient	Test results
Flexible space **on** academic participation	0.912	0.046	19.98	confirmed
Integrated space **on** academic participation	0.242	0.068	3.578	confirmed

* The factor regarding "flexible space" is effective in "academic participation".

Based on Fig. 3 and Table 5, it can be said that at a significant level of one percent, the path standardized coefficient between the factor of "flexible space" and "academic participation" is equal to 0.912, which indicates that the flexible space is directly affecting the changes in academic participation by 91%. Therefore, the quality of flexibility, as a subset of space adaptability, can provide multi-layered spaces by making it possible to change the space from one land use to another and by changing the physical aspects of the space. In other words, when a space can be transformed into different spaces based on educational needs at any time, it has the required potentials. On the other hand, lateral concept of reversibility in spatial transformability, simultaneously

responds to the individual and collective spatial needs of students and increases their participation in the acquisition and study of science.

* The factor regarding " fluid space" is effective in "academic participation".

The second path shows that at a significant level of one percent, the standardized coefficient of the path between the factor of "fluid space" and "academic participation" is equal to 0.242, which indicates that fluid space affects academic participation at a rate of 24%. This potential facilitates the physical and visual movement of students by expanding limited spaces and connecting them with other adjacent spaces, and by having another aspect of the concept of adaptation, enables the change from one spatial action to another. In fact, continuous and fluid space allows people to move or look in a continuous continuum and is usually understood along with the nature of movement, which subconsciously causes a sense of action and movement in students.

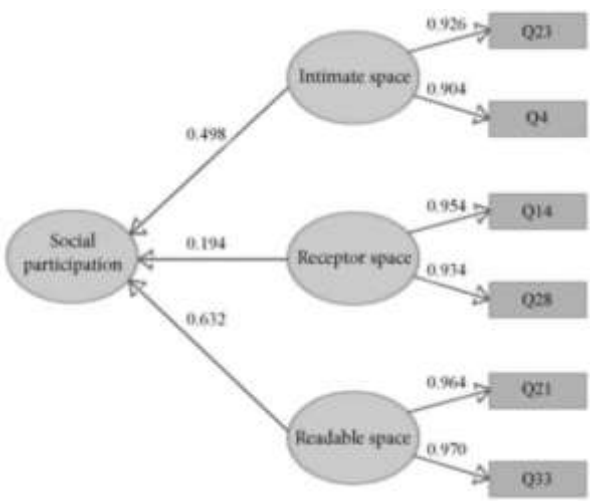

Figure 4. Model of standard coefficients related to social participation

* The "friendly space" factor is effective in "social participation".

According to in Fig. 4 and Table 6, at a significant level of one percent, the standardized path coefficient between the factor of "friendly space" and "social participation" is equal to 0.498, which indicates that friendly space is directly affecting the social participation by 50%. In fact, the exclusive ownership of space users is achieved by having a sense of belonging to it, which is

associated with the concepts of considering the ownership and being part of the space. By making pausing spaces available, the friendly space allows people to dominate the space and perform individual or collective activities away from the crowds of others. On the other hand, human scales and spatial dimensions of space lead to its perception and create more comfort and intimacy in the space. In addition, the base of an intimate space leads to finding a desirable space with the ability to observe the activities of others, for students who are hesitant to participate in the activity.

Table 6. Investigating the relationships and effects within the structural model of social participation

Hypothesis (Significant relationship between the variables)	Estimation of the path coefficient	Sampling error	Significance coefficient	Test results
friendly space **on** social participation	0.498	0.084	5.967	confirmed
Agreeable space **on** social participation	0.194	0.054	3.606	confirmed
consistent space **on** social participation	0.632	0.087	7.244	confirmed

* The factor of "agreeable space" is effective in “social participation”.

The effect of “agreeable space” variable on the “social participation” is analyzed for the fourth path, which at a significant level of one percent; the standardized path is equal to 0.194, indicating that the agreeable space is affecting the social participation changes by 19%. The reception or inviting the space can be equivalent to creating a desire or motivation to be present in the space, which increases the capability of users' choice to move from one place to another. This concept is considered as a subset of the influential quality of space, which increases students' use of space and encourages them to re-experience it. Thus, this dimension of space can increase the willingness to participate, and promote the ability to socialize by affecting the functional aspect and behaviors of students.

* The factor of "consistent space" is effective in “social participation”.

It can be inferred from the fifth path that at a significant level of one percent, the standardized path between the consistent space and social participation is equal to 0.622, and this confirms the effect of the consistent space on the social participation by 63%. This factor can be considered as another motivating factor for the users' participatory behaviors and their

spontaneity. Students' tendency to choose group activities may require them to be aware of the outcome of their choice, and this can prevent skepticism or fear of participation. Thus, students feel safe and they will be aware of the meaning of their decision by taking advantage of visual communication and the ability to understand the space through signs and symbols. Therefore, coordination inside and outside the physical environment, highlighting ongoing activities, and facilitating the orientation for presence in the space can increase the students' ability to interact with others.

Table 7. Examining the relationships and effects within the structural related model to sensory, environmental, and emotional contributions

Hypothesis (Significant relationship between the variables)	Estimation of the path coefficient	Sampling error	Significance coefficient	Test results
creating various situations of educational activities in space **on** sensory participation	0.39	0.058	6.686	confirmed
creating various situations of educational activities in space **on** environmental participation	0.309	0.042	7.412	confirmed
creating various situations of educational activities in space **on** emotional participation	0.353	0.045	7.797	confirmed
potential to create and form the space **on** sensory participation	0.377	0.054	7.006	confirmed
potential to create and form the space **on** environmental participation	0.384	0.043	9.038	confirmed
potential to create and form the space **on** emotional participation	0.476	0.059	8.067	confirmed
consideration of varied spatial layers of the natural elements **on** sensory participation	0.314	0.049	6.438	confirmed
consideration of varied spatial layers of the natural elements **on** environmental participation	0.391	0.033	11.81	confirmed
consideration of varied spatial layers of the natural elements **on** emotional participation	0.206	0.072	2.859	confirmed
using environmental detail stimulating the sense **on**	0.246	0.078	3.142	confirmed

sensory participation using environmental detail stimulating the sense **on** environmental participation	0.249	0.07	3.551	confirmed
using environmental detail stimulating the sense **on** emotional participation	0.252	0.071	3.544	confirmed

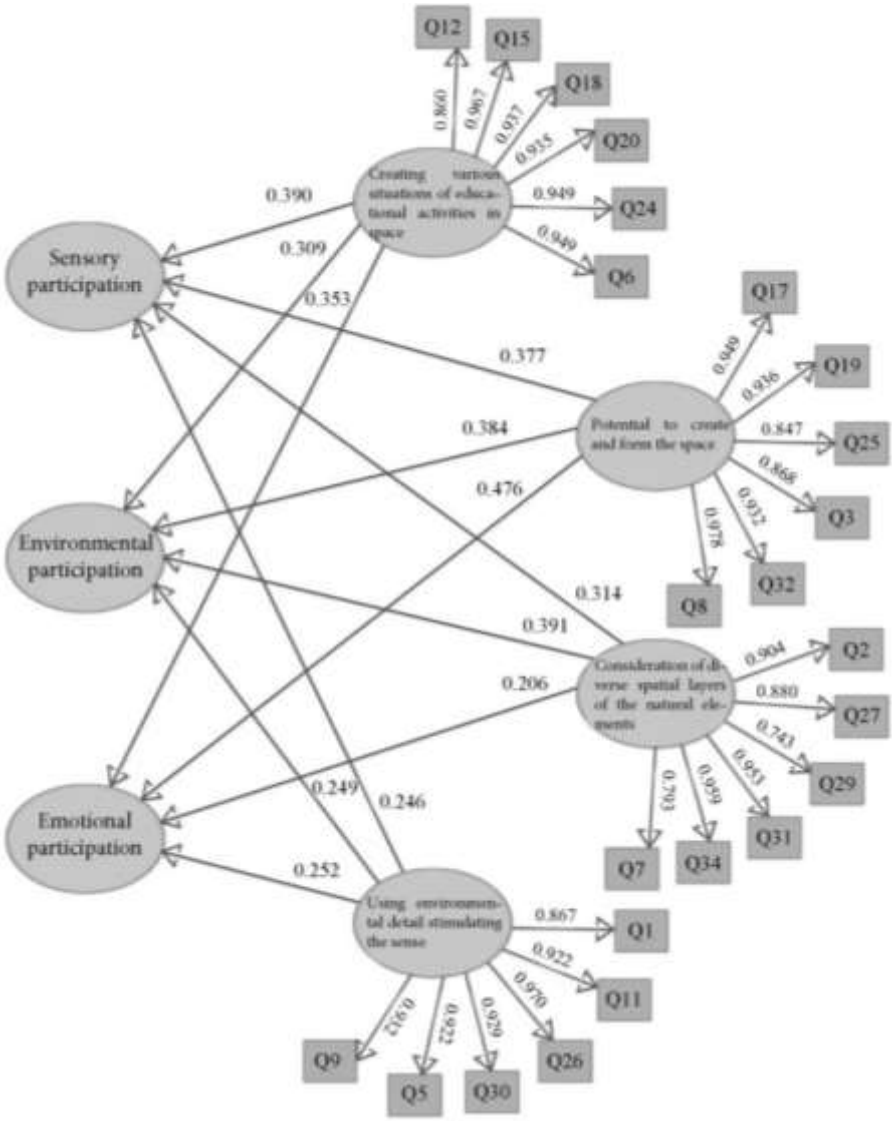

Figure 5. Standard coefficient model for sensory, environmental, and emotional contributions

* The factor of "varied space (creating various situations of educational activities in space)" affects the factors of "sensory", "environmental" and "emotional" contributions

Fig. 5 and Table 7 indicate that at a significant level of one percent, the standardized paths between “creating various situations of educational activities in the space” and "sensory", "environmental" and "emotional" contributions are equal to 0.39, 0.309, and 0.353, respectively, which shows that the creation of various situations of educational activities in the space is directly affecting 39%, 31% and 35% of the changes of sensory, environmental and emotional participations, respectively. In other words, students have extensive and different capabilities and choices, which highlight the importance of paying attention to the spatial capabilities of their individual differences. This factor increases the quality of the space and creates a good platform for different choices of students. In addition, the variety of educational activities can lead to the widespread use of students' senses and the formation of more events to enhance the subjective images and their belonging to the school environment. This factor is also effective in promoting the pleasant feelings of the students and creating a suitable environment for their active presence for creations and innovations.

* The factor of "varied space (potential to create and form the space)" affects the factors of "sensory", "environmental" and "emotional" contributions

The effect of the factor “varied space (potential to create and form the space)" on sensory, environmental, and emotional contributions was investigated in the seventh path, indicating that at a significant level of one percent, the paths are equal to 0.377 0.384, and 0.476, which shows that the potential to create and form the space is directly affecting 38%, 38% and 48% of the sensory, environmental and emotional contributions, respectively. Therefore, it can be inferred that the possibility of creating the own space can increase the level of perception of the environment in students and their participation. In fact, the availability of changeable materials and providing opportunities to change the environment at the request of students not only activates the senses and increases the potential of initiation and innovation but also creates a sense of ownership and peacefulness in the students.

* The factor of "varied space (consideration of varied spatial layers of the natural elements)" affects the factors of "sensory", "environmental" and "emotional" contributions

It can be inferred from the eighth path that at a significant level of one percent, the standardized path between the factor of consideration of varied spatial layers of the natural elements and the factors of sensory, environmental and emotional contributions equal to 0.314, 0.391, and 0.206, which shows that the consideration of varied spatial layers of the natural elements is directly affecting 31%, 39% and 21% of the sensory, environmental and emotional contributions, respectively. Consideration of various natural elements such as trees, plants and fountains, on the one hand, leads to a decrease in the unpleasant feelings in students, and on the other hand, creating a suitable environment for children to explore their surroundings can lead to their environmental experiences and learnings. It should be noted that water flow and vegetation create a wide range of scents, sounds and, visual attractions that are effective in developing the students' senses.

* The factor of "varied space (using environmental detail stimulating the sense)" is effective on the factors of "sensory", "environmental" and "emotional" contributions

The nineth path indicates that at a significant level of one percent, the standardized path between the factor of using environmental detail stimulating the sense and the factors of sensory, environmental and emotional contributions equal to 0.246 0.249 and 0.252, which shows that using environmental detail and stimulating the sense is directly affecting 25% of the changes in the sensory, environmental and emotional contributions, respectively. The ability to visualize through a variety of environmental characteristics is increased in addition to the natural factors that affect the sensory, environmental and, emotional participations of children and the use of a favorable range of diversity of physical and artificial details that can purposefully determine the appropriate level of environmental stimuli. In fact, using a suitable range of environmental stimuli such as color, texture, and light, as well as equipment such as audio equipment that affects children's senses, can bring more relaxation, curiosity, and student participation.

4.3. Testing model fitness

Since the appropriate value for Cronbach Alpha and combined reliability (CR) is 0.7 and for convergence validity (AVE) is 0.5 and the criteria have suitable values in measuring factor loadings, it is possible to confirm the appropriateness of the CR and AVE of the research. It should be noted that in the study of Cronbach Alpha coefficient, the variables of academic and emotional participation coefficients with values of 0.651 and 0.646 are not acceptable. However, since all the indices are equally important in calculating the Cronbach Alpha coefficient, while the indices with higher factor loadings are more important for calculating the CR coefficient, the appropriate CR criterion and the acceptable values for these variables that are equal to 0.813 and 0.79 can provide the possibility of ignoring the Cronbach Alpha coefficient for these two variables (Table 8).

Table 8. Cronbach Alpha values, CR and AVE of the questionnaire variables

Variables	Cronbach Alpha values	CR	AVE
flexible space	0.828	0.921	0.854
fluid space	0.933	0.967	0.937
academic participation	0.651	0.813	0.609
friendly space	0.806	0.911	0.837
agreeable space	0.879	0.943	0.891
consistent space	0.931	0.966	0.935
social participation	0.719	0.817	0.479
creating various situations of educational activities in space	0.97	0.976	0.871
potential to create and form the space	0.963	0.97	0.845
consideration of varied spatial layers of the natural elements	0.937	0.951	0.767
using environmental detail stimulating the sense	0.966	0.972	0.854
Sensory participation	0.814	0.86	0.442
Environmental participation	0.891	0.91	0.467
Emotional participation	0.646	0.79	0.491

Based on the values of the Q^2 criterion in Table 9, the prediction rates of the research dependent variables including academic, social, sensory, environmental and emotional participations are consistent, and this indicates that external factors (independent) are appropriate in predicting the dependent factors and the fitness of the structural model is approved (Table 9).

Table 9. Q^2 coefficient and predictive potential of relationships between the variables

Variables	Q^2>0.35
academic participation	0.59
social participation	0.422
Sensory participation	0.392
Environmental participation	0.431
Emotional participation	0.43

5. Conclusion

The main purpose of this study is to achieve the principles and criteria of participation of educational spaces based on the theory of space production and based on the assumption that factors arising from the theory of space production can affect various dimensions of student participation in educational spaces. Accordingly, by having a researcher-made questionnaire for professionals, to analyze the relationship between the factors arising from the theory of space production (including diversity, familiarity, transformability, readability, acceptability and fluidity) and the five dimensions of student participation (including academic, social, sensory participation, emotional and environmental) and the effect of these factors on the dependent variable was confirmed. The findings of the present study indicate that:

1. Among the spatial factors affecting the increase of dialogue, exploratory and practical activities, the flexible space factor has the most impact. This suggests that considering flexible classrooms with the ability to change dimensions and furniture enhances the ability for students to get together and have group opinions and discussions. In addition, using the open space of schools and turning them into educational space with mobile facilities is appropriate in creating a suitable platform for discovering natural sciences and carrying out practical activities. In this regard, Fallah et al. (2020) also believe that having a method of discussion and conversation in the school classroom can increase the academic motivation of students. Therefore, it is suggested that the spaces between the classrooms have temporary connections and movable blades so that the classrooms can be integrated and expanded if necessary. In addition, transforming the open space of schools into purposeful micro-spaces with the ability to have natural elements can be effective in fostering practical activities.

2. Space consistency is another factor that has the greatest impact on the components affecting social participation. As Lynch (2018) believes, paying attention to the signs, nodes, areas, edges and ways of accessing spaces can increase the consistency of space and thus social interactions. In other words, when students 'perception of space is facilitated, their sense of security and

awareness of the surrounding space and educational activities is enhanced, and in this case, students' desire to participate in activities and interact with new friends increases. Therefore, it is suggested to use the signs and interactive points of the index in the access routes of schools, to turn blind spots into spaces with appropriate visual communication, and to use spatial pauses and interspaces to increase student interactions.

3. The component of various situations of educational activities with little difference affects sensory participation more than other variables. This suggests that in addition to doing pre-determined activities such as answering lessons and sitting at desks and chairs, ignoring how information is received from the environment, lacking motivation and lack of memories cannot be effective in cultivating students' senses. He gets rich from school. According to this view, the findings of Obaid (2013) indicate that the use of various activities to nurture students' senses increases their learning in theoretical and practical courses. Therefore, it is suggested that spaces appropriate to purposeful educational activities be developed to cultivate a variety of students' senses in the school environment.

4. The ability to create and shape the space is another factor that, according to the evaluation, is slightly more effective in emotional participation than other variables. Therefore, if students can build and change the space and furniture with safe and changeable materials and create spaces with each other to meet their educational needs, they can learn self-awareness and self-regulation and feel good during it and have an effective and positive performance in space. As Ghasemizad et al. (2019) believe students with a higher level of self-efficacy are more successful in educational activities. In other words, learning decreases with low self-efficacy and increases with high levels of self-efficacy. In this regard, students' relationship with the space and the desired feeling of the right to create space in the school is improved and a sense of belonging and security emerges in them. Therefore, it is suggested that part of the school environment belongs to flexible spaces that can be changed and reconstructed by students.

5. Considering various spatial layers of natural factors with a slight difference from other variables, affects environmental participation. This

means that paying attention to the combination of natural spaces with artificial spaces in schools can provide suitable environmental conditions for free and group activities and communication with natural aesthetic elements. Thus, a variety of creative experiences, choices, and behaviors occur during plant breeding and the discovery of order and relationships in nature through collaborative activities. The results of Shams Dolatabadi et al (2018) research are in line with the view that the application of outdoor design features in schools can be effective in improving student learning. Therefore, it is suggested that natural factors be used in the open space of schools to define students' recreation space, transition thresholds such as tree-lined walkways and nesting paths.

6. The component of the use of environmentally stimulating details of the senses has an equal effect on sensory, environmental and emotional participation. Accordingly, when environmental stimuli such as texture, color, light and sound equipment are installed in different parts of educational and recreational spaces, it can provide three dimensions of participation. Therefore, it is recommended to use semi-bright communication spaces with colored glass and with different directions of light, to help students' imagination. Also, the use of multisensory stimuli in communication paths, to draw students' focus from one component to the connections between the components of space, and the use of sensory connections between related spaces, to prepare the student to enter another space (such as different floor texture on both sides of the entrance to the spaces) can be effective in cultivating their senses. In addition, the use of qualitative elements of emotion in the main spaces (such as intense light and warm and active colors) and calming quality elements in the main spaces (such as moderate light and cold and passive colors) is effective in students' desirable feelings and emotions.

Accordingly, it is suggested that in future research, the principles and strategies be obtained from the present study in a specific period and be applied to a group of children and the impact of these components on students' participation in learning to be assessed and evaluated. In addition, paying attention to the principles of children's participation in other spaces that witness

their presence (including urban and public spaces) can be effective in generalizing the research findings.

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