

Available online at www.sciencedirect.com**SciVerse ScienceDirect**

Procedia - Social and Behavioral Sciences 46 (2012) 2225 – 2231

Procedia
Social and Behavioral Sciences

WCES 2012

Measuring the architectural design skills of children aged 6-11

Goksu Gozen^{a*}, Dilek Acer^b^a*Faculty of Science and Literature, Mimar Sinan Fine Arts University, İstanbul, 34380, Turkey*^b*Faculty of Educational Sciences, Ankara University, Ankara, 06590, Turkey*

Abstract

The purpose of this study is a) to conceptually define the architectural design skills which enable children to design their own educational environment and living areas, b) to identify the higher order thinking processes related to these skills and, c) to discuss the tools, methods and approaches that can be used in measuring these skills. The discussion is enriched with the construction of a performance task which includes the design of a product by children aged 6-11, requiring the use of creative thinking and visual thinking to illustrate the way of measuring architectural design skills. An analytic rubric has also been developed in order to assess the task in accordance with several criteria. The study is considered as important in expressing how to use the measurement and evaluation approaches which include not only the architectural design product, but also the architectural design process. This study is also important to ensure widespread use of these approaches mentioned above.

© 2012 Published by Elsevier Ltd. Selection and/or peer review under responsibility of Prof. Dr. Hüseyin Uzunboylu

Open access under [CC BY-NC-ND license](https://creativecommons.org/licenses/by-nc-nd/4.0/).

Keywords: Measuring architectural design skills, children and architecture, performance assessment, rubric.

1. Introduction

Design is a complex cognitive, affective and dynamic structure that brings together ideas, drawings, knowledge and many other components in order to create a product that has not existed before. This structure is defined as the process of organizing certain activities with a view to making decisions to change the physical world in line with prefixed goals (Zeisel, 2006). Design is a phenomenon that exists in all fields of life, from glasses we hold to computers we use or from chairs on which we sit to places where we live. Architectural design related to spaces is a process that requires appropriate and expedient use of several skills, mainly creativity and problem solving, allowing societies to stand strongly in the competitive environment of the modern day. There is research conducted to identify the impacts of spaces on people (Barker, 1968; Laike, 1997; Hunter, 2005; Taylor, 1993) in many developed countries. The findings of these studies demonstrate that child behaviors are determined by the psycho-social environment and spaces in which they live rather than personality and intelligence, that spaces designed esthetically have positive impacts on people, that school and play environments that do not meet children's desires and expectations increase introversion and children's tendency to play alone, that places designed spatially support children's acquisition of logical-mathematical skills, and that space designs stimulating children's senses improve intelligence and prevent mental retardation.

Many countries in the world have been implementing systematically, regularly and continuously education programs based on a wide range of activities that encourage individuals to develop awareness about their physical

* Goksu GÖZEN. Tel.: +90-212-2460011/5163

E-mail address: goksu.gozen@msgsu.edu.tr

environment and built environment and sensitivity about space perception, and ensure that individuals develop consciousness about urban life and like architecture. However, in our country, it is observed that such programs are involved only in short-term projects. Ankara Chamber of Architects completed one of the examples of these projects in Turkey in 2004, where the aim was to improve design skills of children by making them gain experience about spaces. Design skills constitute one of the most significant means to assure that individuals develop awareness about the cultural and natural world in which they live. In this respect, it is required to support these skills from early ages with appropriate education programs and to ensure the permanence of initiatives that aim to raise awareness of individuals.

In line with the above-mentioned requirement, a research project funded by TUBITAK (The Scientific and Technological Council of Turkey) was carried out in order to adapt into Turkey the "Design Education Program" for preschool children aged 6 and for children from 1st to 5th year of primary education, to analyze the effectiveness of this program in the Turkish context, and to spread its implementation across the country. The "Design Education Program" (Taylor and Vlastos, 1983; Taylor, Vlastos and Marshall, 1991; Taylor, 1993), implemented in the US schools for approximately three decades, aims to enable children from preschool to high school, teachers, parents and school administrators to acquire architectural knowledge and skills, and to ensure that they can design their educational environments. This study, which constitutes a component of the above research project, was conducted in order a) to define conceptually the architectural design skills that allow children to design their living areas and educational environments, b) to identify higher order thinking processes related to these skills, and c) to provide information for teachers and researchers about measurement tools, methods and approaches that can be used in measuring these skills. Accordingly, the study intends to set an example for using measurement and assessment approaches for not only for architectural design products but also architectural design and pre-design processes.

2. Design Skills

In a learning process, the mental behaviors that individuals are expected to acquire show different characteristics. At the end of the learning process, the learner may be expected to memorize basic knowledge such as some concepts, definitions or phenomena, in other words to display mental behaviors based on knowledge skills (remembering information) and adapting this information in similar situations; or may be expected to display behaviors based on more creative activities after assimilating the acquired knowledge and skills. Haladyna (1997) defines the former group as lower order mental behaviors and the latter group as higher order mental behaviors.

Kutlu, Doğan and Karakaya (2008) define higher order mental behaviors as the integration of cognitive, affective and dynamic characteristics that an individual uses when displaying their skills and as an indicator that an individual uses more than one skills combined with their personal characteristics. For instance, in a physical design work, an individual or a team generates ideas to change the physical world and adjust these ideas in order to create a building. In this process of adjustment, a plenty of skills such as perceptual learning, gross and fine motor learning, verbal and visual communication, measuring, comparing, classifying and categorizing, creative problem solving, investigating, experimenting, exploring, discovering, inferring, interpreting data, predicting, application, creative self-expression and cultural valuing should be employed together. The creation of a product by using these skills concurrently is regarded as an indicator of the higher order mental behavior. Taylor, Vlastos and Marshall (1991) also argued that more than one skills should be used to create a design product in the light of generated ideas; and developed the Design Education Program to enable individuals to acquire behaviors related with five mental processes, i.e. a) problem solving, b) creative thinking, c) visual thinking, d) group interaction, and e) communication skills.

Whether it be a program to improve architectural design skills or other skills, for all education programs, it is important to define and identify higher order mental processes, as seen in the above example, in order to perform appropriate testing to observe whether objectives are achieved or not. In this vein, we need to have a full understanding of the relationship between each mental behavior and the architectural design in a process regarding the teaching of architectural design skills. Below is a summary of the relationship between the architectural design process and five mental skills on which the Design Education Program is based, i.e. a) problem solving, b) creative thinking, c) visual thinking, d) group interaction, and e) communication skills:

Öğülmüş (2004) defined **problems solving** as a cognitive and behavioral process during which an individual perceives the gap between the existing situation and the desired outcome and exerts efforts to eliminate the tension that this gap causes. Design process, which consists of systematic steps to create or develop a new product to change the physical environment, may be regarded as a problem-solving process framed by cognitive behaviors. Kömürcüoğlu-Turan and Altaş (2003) describe two main cognitive phases of solving a design problem. The first cognitive phase consists of the ‘productive processes’ that cover cognitive procedures that lay the ground for design. The second phase is the ‘investigation processes’ that involve evaluation and interpretation procedures. In all cases that predicate the design process on cognitive factors, creativity is defined as one of the preliminary components constituting the basis of design.

Definitions of **creative thinking** fall under two different categories. The first category of definitions claims that creativity essentially depends on imagination. To exemplify, we can find definitions of creativity as the act of going beyond available information by seeing something that did not exist before (Bruner, 1973); as a competence that exists in all emotional and mental activities and constitutes the basis of all aspects of development (San, 1979); as encountering one’s own world with a concentrated conscience (May, 1994); or as taking the risk of producing a new discourse, behavior, attitude, skill, product or life philosophy in all cognitive, affective and dynamic activities (Üstündağ, 2003). The second group of definitions principally links creativity to problem solving. For example, Torrance (1995: 23) stated that creativity is the process of perceiving a problem, generating and developing ideas and communicating data. In these range of definitions, the common point on which researchers compromise is that creativity is the process of producing something new and different, and generating fluent, flexible and original ideas (Erdoğan, 2006; Mert, 1997).

Visual thinking is a type of thinking that combines the acts of seeing and thinking, and is not independent from sensory perceptions and vision (İpşiroğlu, 1994). Visual perception plays an important and primary role in creativity, which is an action process based on designing. Thinking occurs together with seeing in the first place. Arnheim (1969) argues that, in all artistic and scientific activities, real thinking – in the sense of problem solving – always occurs through visual perception of the space. An individual using their creative thinking skills is required to see and use the environment with the aim of designing it and take advantage from all resources, mainly the natural environment, considering the links between verbal and visual communication.

Group interaction is a component of the learning experience used to construct all education programs, including design education whose essence is creative ideas, in a way to ensure that individuals acquire such behaviors as sharing, being thoughtful and assuming responsibility. Learning experiences based on group activities, designed according to individual areas of interest and competence, are important for learners to develop self-confidence and control and generate rational solutions to problems (Sergiovanni and Starratt, 1988).

Communication skills are those that are required to train productive learners who are participative, cooperative and able to view objects in a multi-perspective way; and are taught in an education program related with architectural design, which is essentially a communication process. Design is the whole or partial appearance a product comprised of various elements or properties perceived by human senses, such as line, shape, color, form, texture, flexibility of material or ornamentation (Hasol, 2008). The appearance perceived by senses indicates that design is constantly related to communication or, in other words, communication is the driving force behind design.

3. Measurement of design skills

Defining the above-mentioned mental processes that an individual uses while creating a design product, Kömürcüoğlu-Turan and Altaş (2003) emphasize that not only the product but also design and particularly pre-design processes are important, and that design is not a single-unit or single-phase process. Accordingly, in order to have a full understanding of the pre-design process, it is important to define pre-design mental processes and the construction that is both the outcome of and contribution to these processes. Whether it be a design product or the product of knowledge and skills in another field, the concept of the “measurement of higher order mental qualities” is used to assess the production process together with the product. Performance assessment is one of the frequently used methods in the measurement of higher order mental qualities.

Performance assessment refers to the evaluation, according to certain criteria, of activities (question models) known as “performance tasks” that aim to develop and measure learners’ higher order mental skills. For the purpose of this study, in order to illustrate the process of measuring architectural design skills, a performance task was developed in the context of the education session “Types of Vision” in the Design Education Program. This performance task requires children aged 6 – 11 to use creative thinking and visual thinking skills defined above to design a product; and an analytic rubric was developed to assess children’s performance.

3.1. Development of the performance task

The stages of developing the task are explained below:

- *Identifying the higher order mental processes intended to be observed and associating the performance with the content of the relevant field/subject:* For the purpose of this study, a performance task was developed within the context of “Types of Vision” session in the Design Education Program. In this session where the focus is on eye, vision and types of vision, learning activities encourage learners to think on whatever they acquired from the act of seeing and add different perspectives to their world, and to be aware of what they have seen, have not seen or saw but have not expressed in their lives. The activities in this session are based on seeing and understanding what is in life. In this respect, children were asked to create a lantern as a source of light, and to design a room, reflecting themselves and their dreams, which they can illuminate with the lantern. With this task, children display behaviors of seeing the whole and discovering parts, show how effectively and creatively they use their learning to make sense of visual experiences in an architectural design product and, in other words, how they display their visual, abstract and creative thinking skills. The theme, expected gains, age level and expected outcomes of this performance task are given below:

Content Level	Age Level	Expected Performance	Method of Scoring
Theme: Types of Vision Objectives: <ul style="list-style-type: none"> • Designing a lantern to show how light and darkness affect vision. • Designing the model of a room that includes what they want to see and show. 	6-11	<ul style="list-style-type: none"> • Creative thinking • Visual thinking 	Analytic Rubric

- *Assigning the task:* At this stage of the process, students are presented a problem situation that needs to be solved, in other words a task. The problem situation that students need to solve is described as follows upon receiving the opinions of an expert group consisting of a program development expert, a measurement and evaluation expert, a child development expert and architects.

Dear Student,

As you know, physical appearances of people are different from each other. Although some people may resemble each other, when you look closely, you notice that their hair, hands or eyes are very different. For instance, everybody’s eyes are in different size, form and color. Looking around with different eyes, people see different things. For instance, everybody looking at an object, a flower, a picture or a room sees these with different lights and shadows and has different feelings. How about you? Do you want to show the others the world you see with your own eyes? You are expected to complete the following tasks to show your world.

- You have to design a small lantern on which you can cut holes in different shapes to allow the light out.
- Using 20x30 cm cardboards that I will provide you, you have to design a room named “*My Dream Room*”, reflecting you and your dreams, which you can illuminate with the lantern you created.

- *Drawing up the instructions:* This part explains to students the points they need to consider before, during and after carrying out the defined task. The following are the instructions formulated in line with the opinions of the group of experts:

Points to Consider When Carrying out Your Work

- Do not construct one of the walls of the room so that the inside is visible and your dream room is open to everybody.
- Use as many types of materials as possible when you are designing the room and its interior.
- Do not forget that the source of light should be located at the most critical point of the room. When the location of lantern is changed in the room, the appearance of the room and whatever you highlight in the room will change. That is why you need to place the lantern at the location that most reflects your personality and your dreams in order for the audience to view your dream room from your eyes.

- Before fixing the location of the lantern in the room, place it at different locations and observe various reflections resulting from light to ensure that the room represents you and your dreams in the best way.
- For this model create whichever furniture and element you want to see there; do not forget that this is your room and everything should be as you wish. For instance, you can place windows in different geometric shapes and levels on the walls, or add stairs into the room and place your bed at a high level that you can reach by these stairs. There may be a table, toys, armchairs, books, etc. in the room.
- Given that your room model will be exhibited in the school, assure that your model is complete, elaborate and interesting.
- You are required to complete this model in one course hour.

- *Determining the method of rating:* An analytic rubric is used for assessing the performance product completed. The criteria regarding this rubric and relevant definitions are provided under the following title.

3.2. Development of a rubric

For the purpose of this study, an analytic rubric that provides detailed information about success level of the student with regard to various aspects of the performance was developed. The phases of the development of the rubric were: identifying the aim of the rubric, defining sub-dimensions of performance that the student may show while carrying out the task, determining the level of performance that the student may show for each sub-dimension and defining in a detailed way the performance that the student is expected to show for each sub-dimension at each level. The general and specific criteria for the rubric and relevant definitions are provided in Table 1.

Table 1. Criteria used in the evaluation of two- or three-dimensional design process or product

Design Skills	General Criteria	Sub-criteria	Definitions
Production Process and Product Skills	Spatial Awareness	<ul style="list-style-type: none"> • Sensitivity to Physical Environment • Observation and Data Collection • Solution Offers 	<ul style="list-style-type: none"> • Identifying the location and functions of objects in a place • Viewing the place from new perspectives and establishing a link between objects with different qualities
	Visual Thinking and Creativity	<ul style="list-style-type: none"> • Originality • Imagination • Attractiveness • Flexibility 	<ul style="list-style-type: none"> • Sketching until design ideas come up • Elaborating on design ideas • Visualizing the development steps of an idea or a product • Developing sequential original ideas or products • Explaining the comprehension of a creative process (inspiration for a new product; discovery and research; waiting period; illumination and revision) • Seeing objects from a multi-perspective and in a detailed way • Saving eyes and mind from stereotypes • Being flexible, adapting to changes resulting from the emergence of an unexpected effect
Investigation Process and Product Skills	Surveillance, Analytical Thinking and Critical Thinking	<ul style="list-style-type: none"> • Establishing Links • Use of Interdisciplinary Concepts • Use of Materials • Questioning 	<ul style="list-style-type: none"> • Taking into consideration various interdisciplinary approaches when generating an idea or a product • Producing evidence for the trial period / experience • Producing evidence for the transformation of the process into product or idea (e.g. examples of drawings)
	Technical Competence	<ul style="list-style-type: none"> • Product Development Phases • Visual Effect • Theoretical Effect • Three-dimensional Structuring • Quality of Materials 	<ul style="list-style-type: none"> • Explaining specific characteristics, limitations and space of materials • Drawing schemas, plans, levels and perspectives (where nuances and shadows occur) • Structuring three-dimensionally both the process and the product • Making use of basic principles and concepts of mathematics, sciences or technology
	Detail and Holistic Esthetics	<ul style="list-style-type: none"> • Detail • Holistic Esthetics 	<ul style="list-style-type: none"> • Showing evidence that they understand functional structure as opposed to esthetic structure • Developing qualified style, design, colors, rhythm and repetitions. • Adding a subtle meaning to the expression • Merging all elements in a meaningful, balanced and harmonious way
	Clarity and Fluency in Communication	<ul style="list-style-type: none"> • Clarity • Fluency 	<ul style="list-style-type: none"> • Explaining the function of the idea or product fluently • Communicating the idea or product clearly through visual means with graphs

The highest and lowest levels expected from students' performance for each sub-dimension are defined as follows: students who cannot fulfill the desired performance receive 0 point and student who show a superior performance receive 4 points. The other performance levels are 1 point for low performance, 2 points for fair performance and 3 points for good performance.

The analytic rubric that we developed was evaluated by a Turkish Language and Literature expert and two Measurement and Evaluation experts in terms of a) language and expression, b) appropriateness of context for desired objectives and students' developmental level, and c) appropriateness with respect to measurement and evaluation. We initiated the pilot study after making the arrangements required according to the data obtained through this informative stage concerning the validity of the rubric.

The aim of the pilot study was to identify whether multiple raters using the same rating scale at the same time and/or in different periods produce consistent rating or, in other words, to test the reliability of the rubric. The pilot study was conducted with two teachers responsible for the session of "Types of Vision" and 10 students from each age between 6 to 11. In order to test reliability, Fleiss' Kappa formula (1971) was used, which handles the level of consistency between the two teachers (raters) on the basis of each criteria in the rubric. Accordingly, we obtained reliability coefficients ranging from 0,58 to 0,84 for 20 criteria in the analytic rubric related with the desired performance. According to Landis and Koch's (1977) table for interpreting Fleiss' Kappa coefficient, we may conclude that the level of agreement between the two raters range between moderate to almost perfect agreement.

4. Conclusion and discussion

Architectural design is a production activity that aims to bring an esthetic harmony to the environment through creativity. The skills to make architectural design may be acquired through various education programs that focus on developing individuals' awareness about physical environment and sensitivity about space perception. These internationally widespread programs designed especially for children intend to assure that children acquire behaviors based on higher order thinking processes such as problem solving, creative thinking, visual thinking, group interaction and communication skills. This study attempts to differentiate between higher order thinking processes related with architectural design skills, and to discuss measurements tools, methods and approaches that may be used in measuring these skills. To lay the ground for this discussion, we developed a performance task that requires the use of creative thinking and visual thinking in order for children aged 6 to 11 to design a product, and developed a valid and reliable analytic rubric related to this task. We believe that this study may play a guiding role for teachers and researchers as it illustrates how to use measurement and assessment approaches during and before architectural design processes. Further, the study is of particular importance to ensure widespread use of these approaches.

Acknowledgements

This study was carried out within the Project No. 110K269 titled "The Adaptation into Turkish Culture of the Design Education Program (Architecture and Child Instruction Program), Analysis of Its Effectiveness and Extending the Use of the Program", funded by TUBITAK (The Scientific and Technological Research Council of Turkey).

References

- Arnheim, R. (1969). *Visual thinking*. CA: University of California Press.
- Barker, R.G. (1968). *Ecological psychology*. California: Stanford University Press.
- Bruner, J. (1973). *Beyond the information given: Studies in psychology in knowing*. New York: Norton Publication.
- Erdoğan, Y.M. (2006). Yaratıcılık ile öğretmen davranışları ve akademik başarı arasındaki ilişkiler. *Elektronik Sosyal Bilimler Dergisi*. Online: www.e-sosder.com, 5(17), 95-106.

- Fleiss, J.L. (1971). Measuring nominal scale agreement among many raters. *Psychological Bulletin*, 76(5), 378-382.
- Haladyna, T.M. (1997). *Writing test items to evaluate higher order thinking*. United States of America, Boston: Allyn and Bacon.
- Hasol, D. (2008). *Ansiklopedik mimarlık sözlüğü*. Extended 10th Ed. İstanbul: Yapı-Endüstri Merkezi (YEM)Yayınları.
- Hunter, K. (2005). *Environmental psychology in classroom design*. University of Cincinnati, Master of Architecture, UMI number 1430367.
- İpşiroğlu, N. (1994). Duyu algılarının eğitimi. *Çağdaş Eğitimde Sanat*. İstanbul: Çağdaş Yaşamı Destekleme Derneği Yayınları, 13-20.
- Kömürcüoğlu-Turan, N., & Altaş, N. E. (2003). Mimarlık, planlama, tasarım. *İstanbul İTÜ Dergisi*, 2(1), 15-26.
- Kutlu, Ö., Doğan, C.D., & Karakaya, İ. (2008). *Öğrenci başarısının belirlenmesi: Performansa ve portfolyoya dayalı durum belirleme*. Ankara: Pegem Akademi Yayıncılık.
- Laike, T. (1997). The impact of daycare environments on children's mood and behavior. *Scandinavian Journal of Psychology*, 38, 209-18.
- Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*. 33, 159-174.
- May, R. (1994). *The courage to create*. New York, NY: W. W. Norton & Company.
- Mert, İ. S. (1997). *Karar vermede yaratıcı problem çözme*. İstanbul: Marmara Üniversitesi Sosyal Bilimler Enstitüsü. (Unpublished Master's Thesis).
- Öğülmüş, S. (2004). *Ben sorun çözebilirim*. Ankara: Babil Yayıncılık.
- San, İ. (1979). *Sanatsal yaratma ve çocukta yaratıcılık*. Ankara: Tisa Matbaası.
- Sergiovanni, T.J., & Starratt, R.J. (1988). *Supervision: Human perspectives*. (4th ed.). New York: McGraw-Hill.
- Taylor, A. (1993). The learning environment as a three-dimensional textbook. *Children's Environments*, 10(2), 104-17.
- Taylor, A., & Vlastos, G. (1983). *School zone: Learning environments for children*. Albuquerque, NM: School Zone Inc.
- Taylor, A., Vlastos, G., & Marshall, A. (1991). *Architecture and children teachers guide*. Architecture and Children Institute, Washington.
- Torrance E. P. (1995). *Why to fly? a philosophy of creativity*. New Jersey: Norwood Alex.
- Üstündağ, T. (2003). *Yaratıcılığa yolculuk*. Ankara: Pegem A Yayıncılık.
- Zeisel, J. (2006). *Inquiry by design: Environment/behavior/neuroscience in architecture, interiors, landscape and planning*. New York: W.W. Norton & Co Ltd.