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## The Principles of universal design for learning implementation in design study process

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### Abstract

Starting their studies students have different level of perception and understanding. There is a need for an instructional framework that would allow educational programming, inclusive for all students. Objective of the current study is to investigate pedagogical possibilities to promote design students perception abilities and reasoning skills using in learning process principles of Universal Design for Learning (UDL) in context of student's diversity. In start-up phase students were tested by Santa Barbara Sense-Of- Direction Scale, Spatial Orientation Test, The Visual-Spatial/Sequential Identifier.

Process of studies was performed according to UDL principles and guidelines. Evaluation of design project development was carried out by student's involvement in discussions. Presentations of ideas expression and demonstration varied according to diversity of students' skills and learning strategies. In the final stage – repeated testing. Variety in presentation of information, tasks accomplishment, types of expression and involvement in learning process, is improving the understanding of knowledge interconnection and decision making skills. In order to develop students' spatial thinking and reasoning, as well as understanding of interconnection of knowledge and decision making skills needed for problem solving in design related tasks design study process should be organized according to guidelines and principles of UDL.

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## 1. Introduction

Along with changes in the paradigm of education process, ways of implementation of inclusive education are sought for in education science. Global movement “Education for All” was initiated in the year 1990, in Jomtien, Thailand, in Global Education Conference. Basic document of the Program is the World Declaration on Education for All (1990), based on The Universal Declaration of Human Rights. Objective of the movement is to ensure for everybody basic educational needs including tools and content of learning. That means to create an educational environment providing for everybody an opportunity to survive, to develop own talents, work, participate in development of society, improve own quality of life, to make a considered decisions and continue learning through the all life. Action plan “Education for All” for the period 2010 - 2015 was adopted in the year 2000, in Dakar, evaluating the current situation. Action Plan “Education for All” maintains the idea about high quality learning opportunities for all members of society (UNESCO, 2000). At the same time there is a global movement, objective of which is to find out a universal approach for environmental solutions, that would be, as much as possible, equally applicable and usable for all people and that outlines change of public attitude towards diversity. The term universal design (UD) was coined in 1998 by Ron Mace as a “*design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design and benefits people of all ages and abilities*” (Center for Universal Design, 2010). Understanding a space and environment in the most general meaning the concept and principles of UD developed by a team of architects, product designers, engineers, and environmental design researchers (Story, Mueller, & Mace, 1998), can be attributed to the educational environment as well.

## 2. Problem Statement

Implementation of UD principles in education offers a new approach to development of learning programs and learning process as well as tries to find out solutions how to involve students in learning process of high schools so that each student would become a full scale participant of own professional competence development process, the main emphasis putting on the diversity of solutions and declaring the equal opportunities of education for everybody (Bowe, 2000).

There are several scientifically justified educational methodologies developed on the bases of the UD concept, including Universal Instructional Design (UID; Silver, Bourke, & Strehorn, 1998), Universal Design for Learning (UDL; Rose & Meyer, 2000; Rose, 2001), Universal Design for Instruction (UDI; Scott, McGuire, & Shaw, 2001, 2003). Despite difference in terminology all methodologies are based on implementation of UD principles in education; they are not contradictory and do not compete one with other (Higbee & Goff, 2008). Quite often these headings in scientific literature and research works are used alternately (Koch, 2006), but in other sources (McGuire, 2006) there is described differences between them. All three educational models are focused on implementation of flexible UD principles corresponding learning programs and

pedagogical techniques, which would ensure students' needs for diversity from lesson objectives and materials to instructional methods and assessments (Hall, Meyer, & Rose, 2012). Former empirical investigations confirm that implementation of UD principles in education has provided a positive results for both – pedagogues and students (Rao, Ok, & Bryant, 2014). UDL offer to organise learning process that would provide diversity of display materials, actions and ways of expression, as well as diversity of participation options corresponding to diversity of students' learning strategies and previous experience (Rose, Meyer, Strangman, & Rappolt, 2002). In students focused higher education it is essential to identify the way how students' diversity is expressed in learning process. During the recent 40-50 years a considerable number of research works in educational science are performed in order investigate learning styles of individuals; nevertheless scientists have not get to the common conclusions (Coffield, 2004).

However it can't be denied that cognitive process the same as any other process existing in space goes through continuous interaction between human individuals and surrounding space. Spatial information contains data characterising form, location and path of objects as well as relationship between objects and relationship between objects and reference systems; it is present in the world of human cognition and its mental transformation provides a possibility to manipulate, construct and move in physical world, as well as to success in academic and intellectual activities. The processing and storage of spatial information is a central component in the area of spatial cognition (Chatterjee, 2008), (Freksa, 1999). The first publication on research about „spatial sense” was published in 1938 by Thurstone. He defined a “space” factor determining ability to manage spatial and visual images mentally (Thurstone, 1938). Spatial ability is defined as inherited ability to visualize, consequently - human individual comes into the world with this ability (Silvermann, 2005). Human individuals acquire spatial skills as the result of space cognition as well as studies and learning (Piaget & Inhelder, 1997). As mentioned by McCuiston as the result of various research works there is more and more evidence that spatial skills belongs to the primary sphere of knowledge (McCuiston, 1991). an aggregate of cognitive skills characterised by ability to perceive and express the acquired information as well as to perform mental activities in order to structure, combine or otherwise transform the acquired data.

Spatial thinking as mental activity is required in order to comprehend and analyse spatial information and develop innovative solutions. According to Newcombe spatial thinking is an entirety of cognitive skills needed for ability to perceive and express the acquired information, as well as for mental structuring, combining or other transforming of data obtained (Newcombe, 2010). Spatial thinking is an essential entirety of human basic skills that can be acquired and developed by any student. Spatial thinking can be turned into a valuable mental practice for the all further life by reasonable learning program incorporating in the course of studies advisedly selected supporting tools and technologies, corresponding to students' background (Committee on the Support for the Thinking Spatially: The Incorporation of Geographic Information Science Across the K-12 Curriculum, Committee on Geography, National Research Council, 2006).

Architects and interior designers needs spatial thinking in order to comprehend and analyse the existing space and its elements, mentally create new spatial object as well as construct the designed new spatial object both – mentally and in real spatial environment by understanding basic principles of scale and composition. Technical drawing used by designers, architects and engineers

and needed for exchange with technical information about the object created in vision is the graphical communication language. As described in scientific literature interior designer's needs well developed spatial reasoning skills in order to present the idea of the project effectively and clearly. However in study programs yet this skill is included indirectly as the "ability" required for understanding and solving tasks of descriptive geometry, drawing and reading technical drawings (Contero.M., 2007). Mechanisms of spatial reasoning connecting us with real world in most cases are not direct quantitative data, but qualitative abstraction of reality. Spatial reasoning is necessary also in such areas where conception of space is metaphor for example, speaking about framework of document. Cohn has mentioned about quantitative (distance, dimensions) and qualitative character (mutual location and relationship) of spatial thinking. Role of spatial reasoning has dramatically decreased by development and application of graphical software 3D CAD as virtual models in design process are used. Modelling spatial object by software quantitative data are inputted. If interconnection of these data are not evaluated by qualitative spatial reasoning there is a possibility that implementation of this virtually obtained spatial model is impossible or it's implementation will not meet needs of it's potential user (Cohn & Hazarika, 2001). As mentioned by Field, all CAD users will need a well-developed spatial reasoning ability in future as well, at least until drawings as a graphical depiction of a thought or idea will be used for implementation of spatial solutions (Field, 2004).

Starting studies students have a diverse skills of spatial thinking and unique spatial experience that has been formed as the result of the impact of various cultures, social condition, as well as previous education or family.

Solving learning tasks a different spatial experience of students makes a reference system and starting point for development of new information, understanding and way of action. Standardized program and process of studies do not provide equal possibilities for continuation of cognition process and participation in that.

Based on comprehensive research in the beginning of 1980, Dr. Linda Silvermann came to conclusion that there are two conceptually different learning strategies which she called as: "auditory-sequential" and "visual-spatial." Students having higher level of spatial thinking -"visual-spatial" learners are better at comprehension of concept in general instead of separate facts. They have ability to associate concepts in interrelationships, synthesize and create conceptual schemes, but it is difficult to remember formulas and mathematical facts if they are presented as isolate facts without indication of interrelationship. "Visual-spatial" students learn better by seeing than by listening. Listening verbal presentation, usually they make a drawings in order to fix the obtained information. Developed spatial thinking skills facilitate understanding of abstract concepts and complicated ideas as well as development of inductive learning strategy necessary for interdisciplinary investigations and stimulate creative, original problem solutions (Silvermann, 2005). Traditionally standardized study programs provide mainly for verbal and sequential presentation of information. Conditions set for solution of learning tasks are uniform. Such standardized approach to the development of study process does not promote active involvement and motivation of all students.

### **3. Research Questions**

What is diversity of students learning strategies?

How can be facilitated students spatial perception ability and their expression and cooperation skills?

### **4. Purpose of the Study**

Objective of the current study is to investigate pedagogical approach to promote design students perception abilities and reasoning skills using in learning process principles of Universal Design for Learning (UDL) in context of student's diversity.

### **5. Research Methods**

In the beginning of learning process students were tested by Santa Barbara Sense-Of- Direction Scale, Spatial Orientation Test, The Visual-Spatial/Auditory-Sequential Identifier.

Evaluation of design project development during study process was carried out by student's involvement in discussions. Presentations of ideas expression and demonstration varied according to diversity of students skills and learning strategies. In the final stage of the learning process – repeated tests.

### **6. Findings**

The test results revealed that the students could conditionally be divided into three groups:

1. high level of spatial abilities – more than 60% of correct answers,
2. medium level of spatial abilities – 60% to 30% of correct answers,
3. low level of spatial abilities – less than 30% of correct answers.

Process of studies was performed according to UDL principles and guidelines (Rose, Meyer, Strangman, & Rappolt, 2002), as following:

#### *Principle One: Multiple Means of Representation*

1. Provide option for perception
2. Provide alternative options for applied mathematical expressions, symbols and language signs
3. Provide versions for perceptions options

Investigation of architectonic space pereformed within the scope of study program using PowerPoint or Prezi presentation prepared beforehand and containing symbols, text, pictures and schemes as well as ArchiCad virtual models. Narrative was supplemented by application of the traditional 'chalk-and-talk' lecture method in order to provide detailed explanations of separate

terms and interrelationships. Investigation of form of individual design objects or constructions (stairs, room dividers, doors) were carried out and simple cardboard spatial models used for spatial construction. Depictions of 2D and 3D sections of objects as well as their mutual location and scale were evaluated during lecture. In general a class provided an opportunity to perceive information both – sequentially and in accordance with the diversity of students learning strategies and previous spatial experience. Retaining informative framework of the presentation, variation in presentation or media helped to maintain attention and facilitate deeper learning approaches in lecture. (Risko, Anderson, Sarwal, Engelhardt, & Kingstone, 2012).

*Principle Two: Multiple Means of Expression*

1. Provide different options for physical actions
2. Provide different options for communication and expression
3. Provide variety of options for tasks solutions

Students performed a complex independent research on interior constructions, their history, form, construction and option of technical solutions in space in order to ensure understanding of usefulness of information provided during the study process. In the final phase solutions of design project tasks were implemented by solving real problem in the premises of university. Research was performed individually and in groups, freely choosing issues, type of cooperation and way of presentation. Problem-based learning environments improve motivation and cognition (Bellanda, 2013).

*Principle Three: Multiple Means of Engagement*

1. Provide opportunities to attract the interest
2. Provide opportunities to maintain intensity of studies and persistence of students
3. Provide opportunities for self-organisation

In the end of study program students carried out reorganization project of multifunctional premises of university, repeatedly presenting the development process of design idea, talked over and evaluated during discussions. The learning process is characterised by continual dialogue. Students learned from sharing information with one another and critiques of the instructors. By involvement in discussion design students had an opportunity to observe development of design ideas proposed by other students and compare with own methods and development speed. Students learned by experiencing, reflecting, thinking and doing in the process of finding solutions to assigned design problems. Students learned spatial reasoning skills by explaining their own considerations.

The analysis of the obtained results of the testing shows an increase in the level of the spatial abilities, as compared to the results of the testing at the beginning and the end-point of the studies. (Table 1).

**Table 1.** The results of the testing at the beginning and the end-point of the studies.

Testing	High spatial ability	Medium spatial ability	Low spatial ability
Baseline testing	34.8% n=8	47.8% n=11	17.3% n=4
End-point testing	56.5% n=13	34.8% n= 8	8.7% n=2

The results of the testing indicates that the activities performed during the process have facilitated the improvement of the spatial abilities in students with various levels of spatial abilities.

## 7. Conclusions

In order to develop student's spatial thinking and reasoning, as well as understanding of interconnection of knowledge and decision making skills needed for problem solving in design related tasks design study process should be organized according to guidelines and principles of Universal Design for Learning (UDL).

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