THE NEXUS OF SPATIAL INTELLIGENCE AND LOGICAL-MATHEMATICAL INTELLIGENCE

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Abstract. This study is a comparative analysis that tries to find an answer to the following question: "Is there any relation between spatial intelligence and logical-mathematical one"? The Howard Gardner's theory about multiple intelligences is considered to define the intelligence concept. This work proposes a framework of debate. The results of examinations in Technical Drawing and Computer Aided Design, Mathematics and Physics are compared. The analysis was made at the end of the paper using the statistics methods. The conclusions suggest the nexus of spatial and logical-mathematical intelligences.

Key Words: Graphics education, logical-mathematical intelligence, spatial intelligence, visualization

1. Introduction

Leonardo da Vinci said that the artist is the eye of the universe and the art is the mirror of the world. This shows the importance of the observation as a method of work. This is why it is essential in graphic education, because it offers the possibilities to obtain that 'regard with intention', that always try to discover 'something' in relation with the studied object.

Spatial aptitude is very useful in activities related to architecture and engineering. Following the Carrol's classification [1] – [3] we can distinguish in spatial aptitudes several sub-aptitudes like: visualization and mental rotation. Mental rotation is defined [1] by the speed in which one rotates mentally simple shapes while visualization is the ability to manage complex shapes mentally. In Table 1 we can see that spatial abilities are typical activities assigned to the right hemisphere of a human mind [2].

Left hemisphere	Right hemisphere
Speech	Images
Logic	Intuition
Analysis	Insight
Linear	**Spatial**
Temporal	"Here and now"
Partial	Holistic
Explicit	Implicit
Argument	Experience
Mind	Intuition
Logic	Emotion
Active Thinking	Passive Thinking
Mathematics	Artistic

Tabel 1: Cerebral hemisphere and cognitive activities

Howard Gardner [5] considers that central to spatial intelligence are the capacities to perceive the visual world accurately, to perform transformations and modifications upon one's initial perception , and to be able to re-create aspects of one's visual experience, even in the absence of the relevant physical stimuli. He is the author of the Multiple Intelligences Theory, in which Spatial one is included.

Gardner studied six men and one woman who early in the XX century were instrumental in formulating consciousness in the West. Each – Sigmund Freud, Albert Einstein, Igor Stravinsky, Pablo Picasso, T.S. Elliot, Martha Graham and Mahatma Gandhi- exemplifies one of the seven intelligences (linguistic, musical, logical-mathematical, spatial, bodily-kinesthetic, inter/intra personal).

He made this classification in his book 'Frames of Mind', in 1983, when he defined intelli

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gence, like many scientists, to be an interaction between, on the one hand certain proclivities and potential and, on the other hand being the opportunities and constraints that characterize a particular cultural setting [4]. In his theory he realized a distinction among intelligences, domain and field. These intelligences are thought of in neurobiological terms. Human beings are born into cultures that house a large number of domains – disciplines, crafts, and other pursuits in which one can become acculturated and then be assessed in terms of the level of competence one has attained. Domains can be thought of in an impersonal way – because the expertise in a domain can in principle be captured in a book, a computer program, or in some other kind of artifact. The field – a sociological construct – includes the people, institution, award mechanisms, and so forth the render judgments about the qualities of individual performance.

To his mind , a human intellectual competence must entail a set of skills of problem solving – enabling the individual to resolve genuine problems or difficulties that he or she encounters and, when appropriate, to create an effective product – and must also entail the potential for finding or creating problems – thereby laying the groundwork for acquisitions of new knowledge [6].

Intelligence should be thought of as entities at certain level of generality, broader than highly specific computational mechanism (like line detection) while narrower than the most general capacities like analysis, synthesis, or a sense of self. The possession of intelligence is most accurately thought of as a potential: an individual in possession of intelligence can be said to have no circumstance that prevents him from using that intelligence. In the study of skills and abilities there is a distinction between know-how (tacit knowledge of how to execute something) and know-that (propositional knowledge about the actual set of procedures involved in execution).

Gardner considers that constraints, paradoxically, can be suggestive and ultimately freeing [4] and the seven kinds of intelligences would allow seven ways of teaching, rather than one.

This is the reason why the students need the development of different intelligences during educational process.

2. Research Objective

The goal of the present research was to study the nexus of spatial intelligence and logical-mathematical one using educational process. So, we wanted to see how and to what extent intelligence dimensions are influenced by variables such as gender, faculty or academic performance.

- **Major hypothesis**

  Students‘ intelligence dimensions are influenced by variable such as gender and faculty type.

- **Secondary hypothesis**

  1. There are important differences concerning intelligence dimensions of students because of the gender variable.
  2. The intelligence dimensions of students depend on the faculty type.

2.1. Selecting and testing subjects

The study was applied on 63 students enrolled in the first year at the ‘Dunarea de Jos’ University of Galati, among which 32 female and 31 male. The subjects were chosen from Electronics Engineering Faculty (EEF- 26 students) and Computer Science Faculty (CSF- 37 students). They obtained at least 8 mark at mathematics, algebra or physics. The standard deviation (Std. Dev.) values of admission exams are 0.78 and 0.73 according the gender variable (female/male) and 0.81/0.6 for faculty type (electronics engineering/computer science).

2.2. Defining variables

Independent variables

- Gender: masculine and feminine;
- Faculty: electronic and computer science.

Dependent variable

- Intelligence dimensions: spatial intelligence (graphics disciplines) and logical-mathematical intelligence (mathematics, algebra, physics);
- Academic performance expressed by results examinations of the students.

The experiment was carried out between October 2004 and January 2005. The examination was applied to groups of students from the above mentioned faculties in January and February 2005.

3. Results and interpretation

The results were analyzed and interpreted using the Excel Data Analyses. Statistic analyses were made using the Pearson correlation between the spatial intelligence and logical-mathematical intelligence variable relatively to both the faculty variable and the gender variable.

3.1. Verifying the secondary hypothesis 1

The hypothesis is confirmed for intelligence dimension called logical-mathematical (mathematics and algebra). In this way it is a significant correlation between graphics discipline and mathematics (p=0, r=0.287098 for female and r=0.215213 for male). The lower value for male showed that they used logical-mathematical intelligence less than female (Table 2). But the values of the academic performance at the graphic disciplines are almost the same for male and female. This conclusion is reliable as the boys used spatial intelligence in understanding the graphics discipline.

The backward correlation obtained for male (p=0, r=- 0.25554) at algebra receive no interpretation because of inadequate standard deviation value.

	Graphics disciplines		Mathematics		Algebra		Physics	
	Female	Male	Female	Male	Female	Male	Female	Male
Std.Dev	1.524002	1.054433	1.216486	1.194071	2.161802	1.86363	1.778002	1.605769
Count	32	31	32	31	32	31	32	31
Pearson			0.287098	0.215213	0.053852	-0.25554	0.035714	0.071762

Table 2: Study of intelligence dimensions according to gender variable

3.2. Verifying the secondary hypothesis 2

The hypothesis is confirmed (Table 3). Based on the statistic analyses results, it can be concluded that there is a correlation between graphics disciplines and mathematics (p=0, r= 0. 233314 for EEF and r= 0.280974 for CSF).

	Graphics disciplines		Mathematics		Algebra		Physics	
	EEF	CSF	EEF	CSF	EEF	CSF	EEF	CSF
Std.Dev	1.608152	0.965625	0.992278	1.325427	2.213247	1.853493	1.238485	1.909357
Count	26	37	26	37	26	37	26	37
Pearson			0.233314	0.280974	0.1193	-0.15143	0.135178	-0.11971

Table 3: Study of intelligence dimensions according to faculty variable

The admission results show that the students from Electronics Engineering Faculty received lower marks than their colleagues from Computer Science Faculty, which can explain also the differences between correlation values.

4. Conclusions

The entire research reveals once more that:

- male used spatial intelligence more than female in understanding graphics discipline;
- students who used logical-mathematical intelligence in their training have the tendency to use it also instead of spatial one;
- the study of graphics disciplines is useful to develop the spatial intelligence.

The nexus of this two kind of intelligence studied above is a problem of awareness of their importance in development cognitive abilities of an engineer.

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KORELACJA INTELIGENCJI PRZESTRZENNEJ I LOGICZNO-MATEMATYCZNEJ

Niniejsza praca podaje opis oraz analizę przeprowadzonego studium porównawczego, którego celem było znalezienie odpowiedzi na pytanie: Czy istnieje korelacja pomiędzy tzw. „inteligencją przestrzenną" a „logiczno-matematyczną"?. Przytoczono definicje inteligencji wprowadzonej przez Howarda Gardnera. Eksperyment badawczy przeprowadzono wśród studentów I roku, na dwóch wydziałach: Elektroniki oraz Informatyki Uniwersytetu im. Dunarea de Jos w Galati (Rumunia). Analizie statystycznej poddano wyniki egzaminów z przedmiotów: rysunek techniczny, komputerowe wspomaganie projektowania, matematyka oraz fizyka.