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Considerations on Developing of Multiple Intelligences in the Context of Science Activities

Elena Ancuța SANTI[1], Gabriel GORGHIU[2]*

Abstract

*Science lessons are the perfect framework for optimal development and valorization of multiple intelligences. Howard Gardner's theory has opened new horizons concerning the understanding of the human mind, individualizing of teaching and streamline of learning. The creation of various educational contexts that respond to each student's cognitive profile represents a requirement of the current quality education and contributes to the conscious assumption and proactive involvement of students in the learning process, as well as the transformation of the teacher's role, from the leader of the lesson to learning facilitator. The traditional approaches related to science lessons involve the exploitation of certain types of intelligence, while the teaching act based on the exploitation of multiple intelligences contributes to the valorization of various types of intelligence in creative ways, supporting student uniqueness and personalized learning. The educational implications and the applications of the multiple intelligence model in the context of science teaching and learning represent aspects which have to be known by the teachers, who are requested to transpose them into the didactic work. The purpose of this paper is to discover how students perceive the science lessons organized in non-formal contexts and to what extent those particular activities capitalize the cognitive profiles and various types of students' intelligence. The students' feedback was recorded during the non-formal activities organized in the frame of the Seventh Framework Programme Project "IRRESISTIBLE - Including Responsible Research and Innovation in Cutting Edge Science and Inquiry-based Science Education to Improve Teacher's Ability of Bridging Learning Environments", exploiting in this respect the opportunities created through the implementation of the national week dedicated to primary and secondary education: "*School in Another Way*: To Know More, To Be Better!"*

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1. Introduction

In the educational process, it can be noticed an incontestable fact, as an underlined prerequisite for a successful teaching process: the *student's uniqueness*. The differences between students lie in their temperament, skills, cognitive and emotional needs, learning styles and motivation, aspirations, interests and values which model their personality. An efficient teacher should start his or her educational approach from the principle according to which the class of students is not made of individuals sharing the same features and educational needs; each individual is a different, a special person. This does not mean that the teacher should teach a lesson in as many different styles as students in the class, but he or she should find a bridge, a lifeline, a channel by which to convey the content in the most appropriate manner, using optimal methods and adapting the needs to the specificity of the students' psycho-pedagogical profiles. As late as 80's, the psychologists considered that the intelligence of an individual was mainly expressed through their verbal and logical-mathematical abilities (measured by IQ tests) and therefore, the traditional educational systems laid more emphasis on the performance of the activities which develop cognitive processes and language. But Howard Gardner's vision on intelligence, known as *The Theory of Multiple Intelligences* (*TMI*) - 1983 (published in a famous paper: *Frames of Mind: The Theory of Multiple Intelligences*) [1], even initially contested, brought a profound change in the contemporary educational thinking and practice, representing an important benchmark in designing and performing a quality student-focused teaching process.

2. The Concept of Multiple Intelligences

Analyzing the human abilities, the most specific human characteristic is represented by the *intelligence*, as it transforms the biological individual into a *homo sapiens*. However, the intelligence is not a material thing, but an abstract concept which is very difficult to be defined.

The intelligence is a specific capacity of human's mental organization that influences the individual's success and activities, being associated to the concept of success in all fields. In Psychology, the intelligence is seen as both a *real* fact and a *potential* fact, as a process and also as an ability or capacity, a form and attribute of the mental and behavioral organization [2: 302].

The intelligence may be defined as "*a psychological function or a suite of functions due to which the body can adapt to environment, express original combinations of behaviors, act and use new knowledge, reason and solve issues, in accordance with the rules designed through formalizations of logic*" [3: 138].

Throughout the time, there have been multiple definitions and approaches of this concept and also a high interest in identifying methods by which this may be measured. Some researchers claim that intelligence is a *unique*, *general ability* (C. Spearman - *g factor*), whereas others consider it to be a *series of aptitudes*, *abilities* and *talents* (E.L. Thorndike, L.L. Thurstone, J.P. Guilford, R. Sternberg). In a widespread acceptance, the intelligence refers to the individual's mental capacities which facilitate the adaptation to environment. In a broader acceptance, the intelligence means the capacity to think, to solve various, complex issues (life situations), to learn.

In Howard Gardner's view [1, 4] the *general intelligence* - measured by the *intelligence coefficient* (*IQ*) -, is not only a one-dimensional concept, an inborn feature which dominates the student's potential for development and the only one responsible for exploitation of his or her cognitive resources; there are several different types of intelligences, respectively sets of abilities, skills, talents, aptitudes specific to a certain cognitive sector, which are interconnected, enhanced each other, but yet may also function autonomously.

According to Gardner, there are nine types of intelligence [1, 4]:

- verbal/linguistic intelligence;
- logical-mathematical intelligence;
- spatial-visual intelligence;
- corporal-kinesthetic intelligence;
- musical intelligence;
- interpersonal intelligence;
- intrapersonal intelligence;
- naturalistic intelligence;
- existential or spiritual intelligence.

The *verbal/linguistic* intelligence involves the ability to communicate, to express oneself efficiently in a given context. The students who possess such high intelligence find it easy to express themselves and explain, to work well in a team; they are creative in writing, use technology without difficulty and are easily engaged in conversations. They may create stories or educative scenarios and are persuasive when speaking.

The *logical-mathematical* intelligence implies the ability to use reason, logic and numbers, operate with abstract concepts, exploit inductive and deductive methods for solving issues, use numbers and abstract templates. It

is mainly specific to scientists. Nowadays it is no longer considered to be the expression of human intelligence, but clearly it underlines its manifestation [5]. The children with such high intelligence are extremely good at working with numbers, abstract notions, complex calculations and data interpretation.

The *spatial-visual intelligence* refers to the individual's capacity to see in space, to recognize relations and objects, and to create visual images, to perceive accurately from various angles, to handle and reproduce external and internal images (painting, drawing, sculpting) [5].

The *corporal-kinesthetic intelligence* is manifested in people who use their own body to convey ideas and emotions (in dance, performing acts, sport), to achieve various actions or solve issues. The connection between the body and the mind is exceptionally developed.

The *musical intelligence* concerns the ability to compose, interpret and appreciate music. The child who has such high intelligence is sensitive to sounds and vibrations, recognizes, creates and reproduces rhythms, sounds, harmonies, musical tones.

The *interpersonal intelligence* reflects the ability to understand the others and build interpersonal relations easily, to be empiric. Children which such high intelligence work very well in groups, are efficient verbal and non-verbal communicators, are sociable and capable to teach others, can understand the perspectives of the people around them.

The *intrapersonal intelligence* aims at self-knowledge, at the capacity to understand one's own psychological universe and to become aware of one's self. The children with intrapersonal intelligence develop their metacognitive abilities and use self-reflection to understand their own feelings and experiences using their self-reflection.

The *naturalistic intelligence* facilitates the understanding of processes, natural phenomena, classification and distinction between natural elements (species, phenomena, processes) [5]. The children with such high intelligence enjoy the interaction with nature.

The *existential intelligence* refers to the capacities that help us to approach and solve issues relating to significance and values, understand the meaning of life and existence [6].

The effectiveness of the *TMI* in education may be synthesized as follows: knowing this theory does not change what we are expected to teach; it only helps us to change how we work with students, it helps us to understand that students may be smart in many ways and provides us with the instruments to help them evolve differently [7].

3. Educational Implications of TMI

The theory of the multiple intelligences creates the premises for the development of an educational model which starts from the individuality, the uniqueness of the trainable, the role of the teacher being to get to know the students, to design and conduct didactic activities which should exploit their various types of intelligence using interactive strategies. TMI proposes a different approach of the didactic activity, an activity focused on student, an activity which capitalises the type of intelligences, which fits best the personality structure of each individual; it lays emphasis on differentiated training and on a different approach of the activity, through music, collaborative learning, role-playing, inside reflection, exploitation of various non-formal environments, artistic activities etc.

A parallel between the traditional teaching-learning-assessing methods and didactic approaches based on TMI, is presented in Table 1.

Table 1. Traditional teaching-learning-assessing methods vs. didactic approaches based on TMI

Traditional approach	Use of TMI
- The teacher represents the expert of the didactic activity, he/she transfers knowledge to students, the student's role beings passive;	- The teacher assumes several roles: moderator, counsellor, guide through the didactic process, motivating agent, whereas students are active actors of their own training;
- The teaching process aims to make students to accumulate knowledge, while the teacher aims to obtain accurate answers from students;	- The teacher designs the activities in order to exploit the individual potential of the students, aiming to develop the students' skills related to efficient communication, cooperation, collaboration, critical thinking, self-assessment, metacognition, problem solving etc;
- The embraced methods enhance the teacher's activity (conversation, explanation, demonstration, lecture etc) and the quality of teaching;	- The proposed methods exploit the multiple intelligences: interactive lecture, debate, problematisation, case study, pair learning, role-playing, project-based learning, scientific demonstrations, brainstorming etc;
- It does not aim mainly to	- It capitalises the teacher's creativity and

develop students' creativity; it aims to carry out classifications in cognitive and behavioural "patterns";	stimulates the students' creativity;
- It creates contexts based on competition between students, experiencing positive and negative emotions;	- It creates contexts of interactions between students, mainly based on exploration and experimenting, enhancing positive emotions;
- The students form a perception of their own skills in line with the received assessments; they may face up incapacity to outline a professional route matching their potential;	- It generates positive effects in terms of students' self-esteem and self-efficacy; - The students reach a good level of self-knowledge, they may assess themselves accurately and follow their path towards choosing the right career, early in their school life;
- The educative context takes the shape of a lesson conducted in the classroom;	- The lessons may be carried out in a formal, informal or non-formal context (in libraries, museums or other learning spaces), each experience (positive or negative, curricular or extracurricular) being seen as an opportunity to learn;
- It aims to develop certain dimensions of the student's personality;	- It aims to reach a holistic, integral development of the student's personality;
- It develops the extrinsic motivation to a higher extent; many students learn because they want good grades;	- It develops the intrinsic motivation for learning, epistemic curiosity;
- It may lead to performance; however, it does not guarantee the success (e.g. students with good school results failed to succeed in their profession).	- It supports performance in various domains, highlights the lines of study where students exceed or need help, certain developed types of intelligence being associated to a successful life.

In the case of science teaching and learning, the educational implications and the applications of the model of multiple intelligences represent aspects which must be known by the teacher who has to transpose TMI aspects in his or her activity.

4. Research Goal and Methodology

Sciences represent the perfect framework for students' optimal development, by exploiting multiple intelligences. The goal of the research consists of discovering the students' perception on gathering scientific knowledge in non-formal settings, as well as the extent to which such activities model the students' cognitive profiles and their intelligence.

Benefiting of the opportunities proposed by the IRRESISTIBLE project, during the non-formal activities organized in 2015 and 2016 with the occasion of the national program "*School in Another Way*: *To Know More, To Be Better*", a sample of 100 upper secondary education students were questioned concerning their interest, indifference or lack of interest concerning scientific topics or issues. The proposed research tool was a questionnaire specially designed with dedicated items for emphasizing on several types of intelligences. The students' feed-back was condensed into a Likert-scale with three steps: *do not like*, *indifferent*, *like*. [8] The results were processed with the help of quantitative statistical method, being expressed in percentage figures.

5. Results and Discussion

The students' answers were synthesized in group of pair items in order to be emphasize on the specific intelligences which can be exploited in science non-formal activities.

Figure 1a. illustrates the preference of 50% of students for *reading books and scientific journals*, which exploits their verbal, linguistic intelligence. It is an important percentage - a result of the traditional methods of work and the emphasis placed in the Romanian school on the development of the types of classical intelligences: *verbal-linguistic* and *logical-mathematical.*

Figure 1b. shows the strong preference of 86% of students for activities that involve scientific experiments, context in which several types of intelligences can be exploited: *verbal-linguistic* - by reading various instructions, rules and useful information for performing scientific experiments; *logical-mathematical* - by developing and using algorithms, calculus, logical operations and deductions etc.; *spatial-visual* - by visualizing space and sensing the relations between objects; *interpersonal* - by achieving effective verbal and nonverbal communication, through collaboration, for optimal interpersonal interaction; *intrapersonal* - through reflections and introspective analysis of thoughts, emotions, strengths (or weaknesses) that led to the success (or failure); *naturalistic* - by understanding the natural elements involved in educational activities.

Thus, it can be argued that the experiment, as a working method in science activities, makes better use of student's various type of intelligences, compared to the science lessons held in a traditional manner.

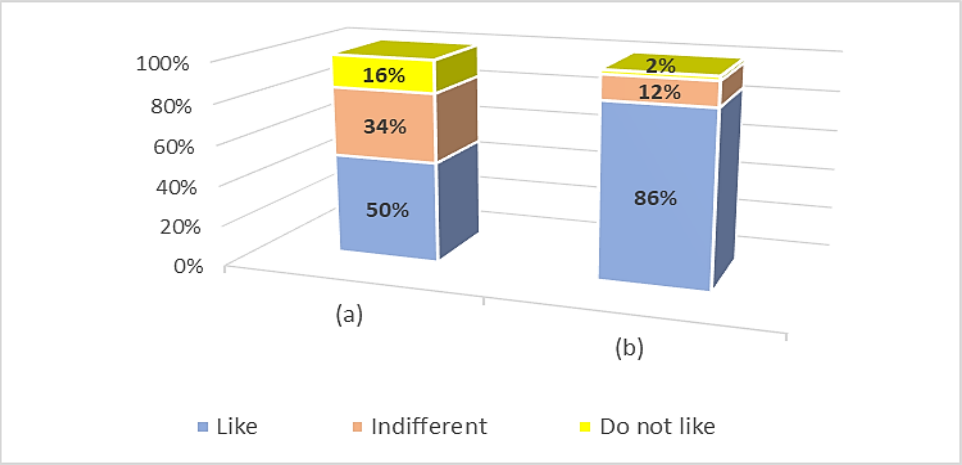

Figure 1. Students' feedback regarding: (a) reading books and scientific journals; (b) performing scientific experiments

Figure 2a. shows the students' preference for using the laboratory equipment that mediates the understanding of scientific issues, activities that involve practical work, practical application of theoretical notions, by exploiting several types of intelligence: *linguistic*, *visual*, *kinesthetic*, *interpersonal*, *intrapersonal*. Around 58% of students appreciated those tools as useful in learning science.

Figure 2b. indicates the number of students who can understand an experiment based on images without actually being involved in its performing. This percentage is specific to those students having *logical-mathematical* or *spatial-visual* intelligence, representing 30% of the sample, a relatively small percentage compared to 50% of students who are indifferent to this aspect. The conclusion is that working in the science lab must be carried out in practical, applied way, and students must be effectively involved in those experiments that can be safely reproduced, that can help them to make connections between the theoretical elements and the real context in which they can be used.

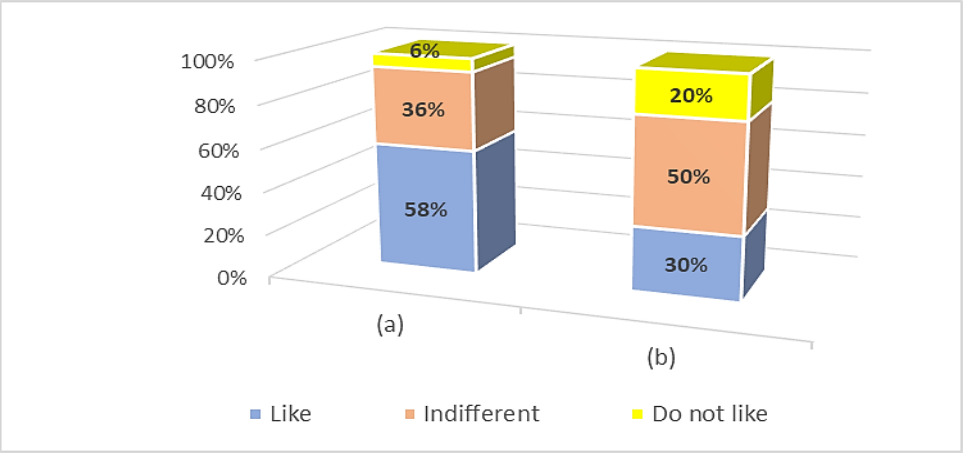

Figure 2. Students' feedback regarding: (a) using laboratory equipment for enhancing the understanding of scientific issues; (b) interpreting the image-based laboratory experiments

Figure 3 illustrates the students' perceptions of (a) modern methods used in science activities, which exploit interpersonal intelligence (verbal and nonverbal communication skills, teamwork, acceptance of the viewpoints diversity, emotional management) and (b) reflective techniques used to evaluate and improve personal results that harness intrapersonal intelligence (the ability to realize an objective analysis, to accept the limits, to identify the ways of optimizing the personal effort, self-motivation etc.). It is noticed that a higher number of students (51%) exploit the *interpersonal* intelligence in the activities dedicated to study scientific issues, compared to only 27% of students, who use *intrapersonal* intelligence, which can be explained by the fact that, at this age, not all the students reach a certain level of maturation that allows them to correctly self-appreciate and objectively recognize their own value. In addition, the traditional education system, which emphasizes the importance of marks, does not form proper self-evaluation capacities, the student having a self-perception as a competent person according to the obtained school results (marks).

However, the big proportion of students who are indifferent may indicate their inability to assume own point of views as result of lack of self-knowledge or knowledge, and also a limited exploitation of the methods based on group work and reflective techniques.

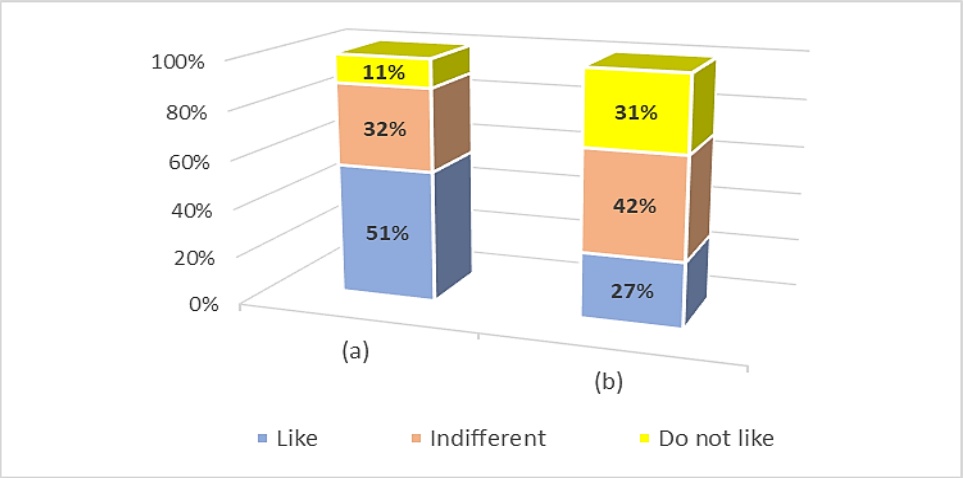

Figure 3. Students' feedback regarding: (a) solving proposed problems based on group-working; (b) using reflective techniques for assessing solutions for problems

Figure 4 illustrates two items that refer to (a) students' naturalistic intelligence and (b) students' musical intelligence. The naturalistic intelligence is very important for understanding science disciplines, it helps students to understand phenomena and facts of nature and living environment. Apparently without much importance for learning science, the musical intelligence represents an advantage for students, allowing to make fines connections, developing the sensitivity, aesthetic and artistic sense, the taste for the beauty of everything which surrounds us. The resulting percentages indicate a *naturalistic* intelligence developed in 52% of the students, and a *musical* one in the case of 43% of them.

Knowing all those aspects that attested the presence of multiples intelligence of the questioned students, the teacher can create a wider range of activities, capitalizing different scholar and extra-scholar contexts, compatible with their cognitive profiles and intelligence, transforming in this way the science activities into real opportunities for capitalizing the students' cognitive, affective and motivational potential. Thus, science activities become the expression of didactic hands-on, creative, and innovative expression of students.

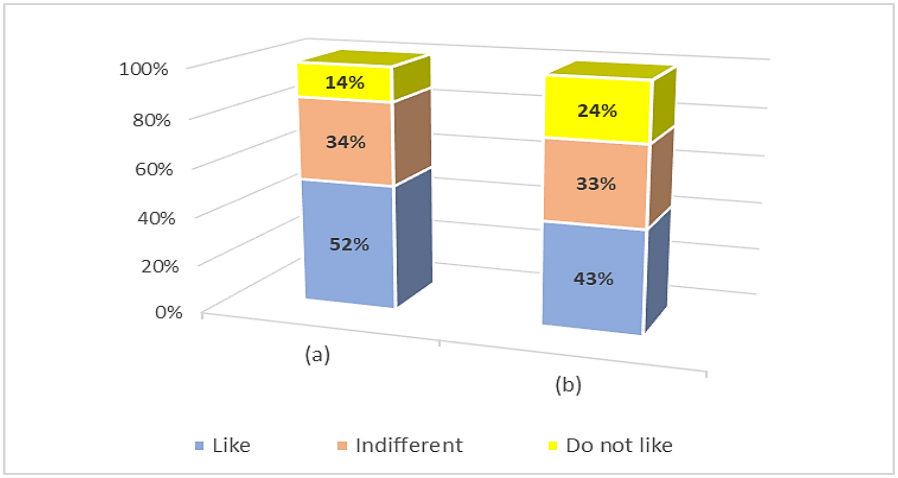

Figure 4. Students' feedback regarding: (a) understanding nature and life; (b) recognizing sounds from nature and life

6. Conclusions

Gardner's vision has generated controversies in the academic environment and, regardless of the various criticisms attached to it, it cannot be contested its applicative value in relation to the teaching process. *The Theory of Multiple Intelligences* uses the potential of the individualised, differentiated approach when working with students. It exploits the predominant type of intelligence of each student, both in formal and non-formal or informal context, and it contributes to streamlining the instructive-educative process and to increasing the school performances.

The traditional model approached in science classes stresses the importance of using the verbal and logical-mathematical intelligence, in particular, and is focused less on other types of intelligence which students may possess. In contrast to this approach, the teaching model based on exploiting multiple intelligences brings the idea of combining them in creative manners in order to reflect the student's uniqueness [9]. By recognition of the unique cognitive profile of each student, the application of TMI in science classes contribute to enhance the cognitive interest and the active involvement of students, compared to the traditional approach which is focused mainly on verbal and logical-mathematical intelligences.

The creation of some varied educational contexts which should be in line with each student's cognitive profile is a prerequisite of the quality education at present, as it maximises the students' intellectual potential, contributing to a conscious assumption and proactive involvement of

students in the learning process, and turns the teacher's role into the leader of the educational activity: the *learning facilitator*.

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The authors state - on their own responsibility - that all the students who participated in the research have been informed concerning the voluntary nature of their participation, the understanding of the received information and the fact that the withdrawal from the research process can be done at any time without any negative consequences on participants. The whole research respected the actual ethical standards and the participants expressed their consent to participate in the proposed research.

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