

Subjective Factors in Natural Science Education

¹ Danijela Branković

² Bojan Đerčan

¹ University of Novi Sad, Serbia

Faculty of Sciences, Department of Biology and Ecology,

Trg Dositeja Obradovića 3, 21000 Novi Sad

E-mail: brankovic.d@gmail.com

² University of Novi Sad, Serbia

Faculty of Sciences, Department of Geography, Tourism and Hotel Management

Trg Dositeja Obradovića 3, 21000 Novi Sad

E-mail: bojandjercan@yahoo.co.uk

Abstract.

Managing the learning process in a modern school should be based on scientific facts that show large differences in the abilities of students. For students in upper primary school, differences in certain aspects of their mental development are up to eight years of schooling. Uneven development leads to their uneven progress in education. Due to the fact, a class even approximately does not represent an equal level of knowledge, but includes the various levels of individual students. In order to insure favorable conditions for learning to all students of class, teaching adapted to the capabilities of an average student has to be completed by the procedures of individualization. Therefore, modern education can not be imagined without the procedures of individualization, because only in such conditions of education, there are opportunities for the full development of each student.

Keywords: education, student, teacher, individual differences.

Introduction

Learning theory has always sought to answer the question of what and how to teach and learn in order to acquire knowledge and develop skills, and how to organize and implement educational process (Zgonik, 1967). All these considerations refer mainly to intellectual, or cognitive - logical side of teaching (Bakovljević, 1998).

However, although the intellectual side of teaching has been largely elaborated in detail, although the didactics had answers to many questions how to perform the educational process in its macro and micro processes, however, in spite of all that we hear constantly lament that students do not like school, run away from school, they are inattentive and undisciplined, they manifest publicly their negative attitude towards school in different ways.

The causes of this situation can be found in the fact that teachers are addressed by solutions what and how they must teach students, while the issues relating to the psychological attitude of students towards everything about school are not solved. Problem is, in fact, imposed in how students perceive and experience the entire teaching process, i.e. whether they find work interesting or uninteresting, attractive or repulsive, pleasant or unpleasant, full of joy or apathy, whether teaching inspires or embitters them (Poljak, 1966; Solarević et al., 2013) .

Engagement of students, absence from school, dictation in addition to existing textbooks problematic ways of assessment, insufficient success of a large number of students, the discontinuity between success in elementary and secondary schools, negative personal status of students in the school, spreading of new, often problematic patterns of behavior from the environment into school, poor cooperation with families and the local community - these are questions that are being posed today as one of the central problems of modern teaching (Tate, 2008).

Student as a subjective factor of teaching

Conceptions of the role of teachers and the role of students in the learning process derive from the concept of the teaching. The concept of education is determined by the concept of school as a core institution of the education system. The education system should be based on the concept

of education as an activity which has certain social and individual functions (Bandur, Potkonjak, 1999). Thus, in the range between teacher – student relation, on one hand, and society - education system relation, on the other hand, there is a very large number of important issues that are not decided by a teacher or a student, which largely determine their position and role in educational process, and their overall social status (Apple, 2012).

At the center of the school life and work is the student. Around him, like concentric circles, it is developed a network of labor and social relations involving many stakeholders - teachers, parents, support staff and school principal, school council members and experts from the local community, experts and officials in the administrative institutions of school system (Popov, Jukić, 2006). Everything that exists in the educational system, either directly or indirectly is a function of education students. The whole work of the school is focused on planning, organizing, directing, articulating and monitoring the effectiveness of students' activities (Jovičić, 1971). Hence, the only authentic and valid measure of the quality of functioning of the school, and through it, the whole educational system, is real structure of student activities (Hoz et al., 1990). Making certain type of environment, school establishes the conditions for the development of a wide range of activities for students that are known or assumed to lead to significant educational and developmental achievements (Žderić, Miljanović, 2001).

Given the multitude and variety of achievements to which should lead, the school activities are numerous and varied in terms of objectives, content, organization, degree of formalization or degree of spontaneity. All of these activities and their effects get pedagogical, psychological and social meaning to the extent where they encourage, support, guide and cultivate the development of students' personality (Milošević, 2010). Schools are expected to provide a gradual and synchronized development of two closely inter-related processes - the process of individualization of student's personality and the process of his social integration by shaping their interior environment and communication with the local community. This expectation is, among other things, based on the fact that the students form many years covered by the primary (mandatory) and secondary (practically unavoidable) education, go through periods of their most intense physical, mental, and psychosocial development. Researches of students' perceiving of school indicate the need for redefining the efficiency of schools and social- psychological effects of schools (Havelka, 2000). Since the entire program is subordinated to the student, of great importance is the knowledge of his general properties characteristic for a given level of mental and physical development, but also individual differences, starting with the positive to the deviant ones. Although the one age level of children has common traits, though among them there are individual differences that may be of importance in the educational process. Hence, if one of relevant characteristics in the hierarchy is more important, inasmuch a teacher is obliged to take them into account when selecting modes (Romelić, 2003).

Some authors highlight the following individual differences among students that are crucial for success in learning:

- Level of knowledge and experience
- Learning abilities, i.e. cognition
- Interests
- Motivation for learning
- Health and functioning of the nervous system
- Environmental conditions.

In addition, the success of students' work is influenced by various traits. Of particular interest are: perseverance, diligence, initiative, hard work, laziness, accuracy, consistency, discipline, willpower, affection or fear of overcoming difficulties, irresponsibility or responsibility to this obligation (Romelić, 2003).

Differences in physical characteristics of students

Even the most superficial observation of students of a class will show us that it contains physically unevenly developed students. Some students are significantly taller than their classmates in the classroom, and some are much shorter than the average high. Between the tallest students in the class and the shortest, there is the whole gradation with respect to the height of individual students. The most frequently we meet the grades in which, given the height, there are

approximately equal numbers above-average and below-average students (Đorđević Potkonjak, 1988).

More accurate answer, however, to the question of the size in differences in some physical properties of the students can be given by the measurements of these properties in a number of subjects. Based on these measurements it was found that the differences in height and weight in children of school age are the largest in fourteenth year of life - in height is 38 cm, and in weight is 37.5 kg. It was also found that the differences in height and weight increases with age, and at fourteen reach climax. As children get older, the differences in their body height and weight are increasing. After fourteen years of age and these differences are reduced, but still are higher than in the nineteen than in the eight (Vilotijević, 1999). The uneven pace of physical development leads to large individual differences in other physical properties, such as the vital capacity of the lungs, chest circumference and others. It is quite understandable that the differences in the physical properties of the students must affect not only the organization and teaching of physical education, but also the organization of other life and work of students at the school. The specificity of geographical teaching process is lessons in nature and field studies. Such teaching must be adapted to students with certain physical problems. If it is a seriously ailing health, students should be free of field work related to the teaching unit of orientation in space or relief, because these classes usually require a lot of great physical effort (Orion, Hofstein, 1994). Overcoming differences in the physical properties of the students to some extent is done by distribution of students sitting in a classroom. Shorter students sit in the front seats and taller ones sit in the back. Thus, the objective conditions of teaching are adapted to physical abilities of students. From the back seats taller students will easier follow the teaching process than the shorter ones.

Similarly to this is the adjustment of working conditions to students who see and hear weaker. Putting them in the benches near the board, we create favorable conditions for them to effectively follow teaching. This also improves the health conditions of their workplace. But while in the students of uneven height it is relatively easy to match their state of development with condition of teaching by distribution of seating and appropriate furniture, in the students of uneven vision and hearing it is much more difficult to achieve (Poljak, 1990).

In order to determine, for every student who has bad eyesight or poor hearing, the most appropriate distance from the table to the seating position, we should have data of medical examination of students. Unfortunately, in our country such examinations are not made regularly, and where there are the occasional examinations, results are not use sufficiently. Distance between the student seating and table usually is set in students with very poor eyesight. Students with minor visual impairments mostly do not receive adequate assistance, and to an even greater extent it applies to students with hearing impairments (Markovac, 1970).

The differences in the mental development of students

Much greater difficulties arise when the conditions of teaching should be adapted to the characteristics of their mental development. The difficulties stem primarily from the fact that differences in the development of psychological characteristics of students are not directly observable, such as height of students. Individual differences in intellectual development of students can be judged objectively only on the basis of results achieved by individual students.

Every teacher knows from his experience that the students from one class have differences in reading, writing, in reading comprehension, in observation, description, etc. However, such data relating to the size of individual differences are not entirely accurate. More accurate data on the size of the differences in students can be given by an objective test. Using the results of various tests, today we can quite accurately determine how students differ in the same class (Popov, Jukić, 2006).

The general picture of mental development of children shows that all children do not develop at the same rate. Because of the uneven rate of mental development of students there are big individual differences between them. It is important that individual differences in mental development increase with age: as students get older, the differences in their mental development are increasing (Bakovljević, 1983). Among eleven years old children it can be found children with a mental age of six years and those with a mental age of sixteen. The difference between the most developed children and those with slow development, therefore, is ten years of mental development. Such differences are in children whose development is considered as normal. We see,

therefore, that children of the same chronological age are very much different in mental abilities. As the grouping of students in grades is usually done according to chronological age, we should expect the same range of individual differences in mental age in each individual class. The higher mental development means a higher degree of intellectual work, and it is therefore illusory to expect that the students of a class in which intellectual abilities are so different to be capable of the same classes and the same tasks (Monk, Stallings, 1975).

Unequal mental development leads to unequal rate of students' progress in the classroom. Mentally more advanced students can progress in their education much more progress than those who are underdeveloped. Such students are prepared for higher requirements than those which are placed upon them by teaching of their class. These are students who could finish school in less than prescribed. That is why these students need to be provided with more knowledge in the form of work in geographical sections or additional classes (Ormrod, Cole, 1996). In contrast, there are students that are mentally underdeveloped. Their progress during education is significantly slowed, and requirements placed upon them, often exceed their capabilities. Among these students are potential candidates for grade repetition. The difference in the rate of students' progress during the school could actually be much higher than what we encounter in schools. The reason is that intellectually more developed students have no possibilities for rapid transitioning from class to class. This creates the illusion of equal advancement of students of the same chronological age.

The analysis of the students of the same chronological age shows that according to certain properties there are large individual differences. This situation exists, if we look at a group of students according one aspect of their development. If we look at students of a class according to many aspects of their development, the situation in terms of individual differences becomes much more complicated (Rudić, 1991). Namely, those students who are at the same level of mental development substantially differ in other properties. There are large differences in the development of certain mental factors in students with the same IQ. Thus, individual differences in memory in students with equal IQ are about five years. For students with lower IQs, we find even greater differences in memory, reasoning, verbal skills, etc. (Markovac, 1970).

The differences in chronological age of students

The differences in the chronological age of students of the same class are also an important factor of unequal students' progress in lessons. Certain studies suggest that age differences in the tested classes are 3.6 years. It is characteristic that the differences in the age of students are the highest in the fourth and seventh grades and amount five years, and the lowest in the third and eighth grades, and amount three years (Trnavac, Đorđević, 2002).

As in every class there are plenty of students younger and older than their age, which is required for a particular grade, we can ask what is the relation between the success of younger and older students, on the one hand, and the success of students of appropriate age, on the other. Are the age and greater experience of older students of a class an equivalent for bigger and better success, and vice versa?

The difference between the average success of older and younger students increases from grade to grade in favor of younger students. If we compare in individual classes the results of older students with students of appropriate age, we see that the older students achieved lower results. In contrast, the younger students in all grades achieved better success than students of appropriate age (Griffin, 1953). Older students of one class consistently achieved lower scores than younger students of the same class. In addition, older students of class also consistently achieved lower scores than students of appropriate age, required for the respective class.

If we ask ourselves which students are older the age of a class, we will find that these are mostly repeaters. Therefore, consideration of success of older students raises the question about the effectiveness of repetition as a measure for raising student achievement. The placement of students in grade repetition bases on the assumption that in the repeated grade student's knowledge will significantly increase and so the gaps in his knowledge will be eliminated. It would therefore be necessary to consider what kind of relationship exists between success and repeaters and those students who according to the existing criteria must repeat grades, but they moved to higher grades.

Bearing in mind the large differences in the individual characteristics of the students of the same class, we can ask ourselves what actually remains from the usual concept of a class as a group

of students of equal knowledge? It can be concluded that a class should be seen as a group of students with very unequal knowledge and capabilities. Large differences among students necessarily lead to limiting the application of the teaching process equal for all students. Appropriateness of teaching to abilities of students is one of the most important factors for the success of the acquisition of knowledge, but where for all the students it is applied the same teaching, adapting education to students remains only wishful thinking. If we want to adapt teaching to students, it is important to get rid of the shackles that force us to look at the class as a group of students of equal knowledge and capabilities (Trnavac, Đorđević, 2002). Class does not even approximately represent a certain level of knowledge, but different, unequal levels, corresponding to the individual students. Therefore, students should be accepted as they are, and teaching should be adjusted to them, not the other way around, to set them to teaching (Markovac, 1970).

ADAPTING TEACHING TO INDIVIDUAL DIFFERENCES OF STUDENTS

In our schools we encounter most often the teaching, which is the same for all students in the class. This means that it is assumed that all students of the class can be equally successfully take part in such teaching and that they are capable of the same teaching. Due to the fact that the students from one class there are big differences, it is conceivable that the same teaching will not ensure favorable conditions for learning to all categories of students. It is common that in our schools teaching is adjusted to abilities of average students. All other students who are according to their success in a teaching area above or below the average of class remain aside in teaching process implemented in that manner. Their active participation in class is hindered by unsuitable teaching for them. In this teaching, many students of the class come under very unfavorable conditions in contact with the teaching material that they study, between them and the material there is no optimal communication that enables successful learning. Students who are below the level of teaching can not successfully adopt new skills because of too big gap between their old knowledge they possess and the new knowledge they must adopt (Milošević et al., 2013). Those students who are above the level of teaching are slowed in learning because their abilities are much greater than such teaching assumes (Miljanović, 2004). Both, however, they lose the optimal communication with material given by teaching. Some research suggests that only about 25 % of students are at level of grade in which they are. Thus the level of teaching provided for the some class is appropriate only for one quarter of the students while the majority is outside of the maximum effectiveness of such teaching (Markovac, 1970).

Given the fact that in our country individual differences in knowledge of students have not been systematically studied, it is understandable that it could not be any significant attempts to adapt teaching to individual students' abilities. It would be wrong if you thought that in our schools there is no form of individualized teaching. There are such forms, but because of some subjective and objective reasons they do not apply enough. There is individualization by educational leaflets, which is the most common form of adapting teaching to individual differences of students (Miljanović, Topić, 2010).

An individualization through additional class also allows adjusting teaching to the individual needs of individual students. These classes are intended not only to those students who can successfully follow the course of teaching in the class, but also to those students who find such teaching too easy. Task of additional teaching is to ensure the adoption of the subject matter in a way that best suits their individual abilities (Westerback et al., 1984).

In addition to use of educational leaflets and supplementary education, teaching can be adapted to individual differences of students through group classes. Well-organized and student's opportunities based group classes can contribute much to involve each student appropriately in the teaching process (Markovac, 1970).

Grouping the students into classes based on their abilities

The first attempts that have been undertaken in order to group in the same class pupils with equal abilities and equal knowledge led to the division of students into classes. This is how the school is organized by grade. In the same grade were students born in the same year as it was assumed that students of equal age have the same knowledge. Hence there was a conclusion in that

way grouped students would be able to follow the same classes. Later intensive studies have shown that students of equal age are not nearly so much like each other as had been assumed.

Contrary to attempt to mitigate individual differences dividing students into classes on the basis of chronological age is an attempt to divide students into classes based on abilities. The criterion of division in such a case is intellectual development of students.

The protagonists of this idea believe that an organization, teaching can be more appropriate for the students because among students of each group there are apparently large individual differences. Each of these groups has organized a curriculum adapted to students' abilities of the group.

Attempting to mitigate individual differences dividing students into classes based on abilities has several disadvantages. Grade assembled in this way, although more homogeneous than unselected groups, it is heterogeneous in other properties. The division of students into classes based on their abilities has the disadvantage of creating a gap between "smart" and "dumb" students. Want to admit it or not, the fact is that children who are in the group of weak perceive inconvenience that usually manifest in mental disorders (Romelić, Ilić, 2011).

INDIVIDUAL DIFFERENCES AND TEACHER

Socio-cultural, systemic, organizational and group factors, conceptualize the role of teacher and the role of students generally as two asymmetric and by the principle of complementarity tightly linked action systems. However, differences within the personal factors contribute to large qualitative differences between the roles of teacher and student, and the asymmetry of these roles is manifested not only in complementarity but in certain contradistinction and even antagonism.

Given the implications arising from the position that the student has in school and the developmental period in which he is, we can distinguish three main areas of his activities:

1. activities in the classroom and in relation to teaching,
2. activities in the class and other school groups,
3. activities that contribute to the satisfaction of age and developmental needs.

Asymmetry of the role of teachers and students is quite natural, and their complementary is logical and obvious. The teacher is an adult and teacher - the one who knows and who teaches, the student is a person in the development and "learner" - one who develops and who is taught (Havelka, 2000).

Under the guidance of the teacher students in teaching process acquire the knowledge, skills and habits - a teacher is a direct supervisor of their learning (Kundačina, Bandur, 2003). He manages not only the learning that takes place in the class, but partly the learning out of those classes. Because of the large role of the teacher in the teaching process it has is a large responsibility for the success of this process. The success of the acquisition of knowledge, skills and habits in the teaching process depends, among other things, on the compliance of teaching with individual students' abilities. A degree of compatibility of classes and individual students' abilities largely depend again on the teacher who is the most direct organizer and executor of the teaching process. His understanding of the nature and size of individual differences ultimately decides on whether he will want and know to fulfill a condition of success of teaching referring to the unequal opportunities of students (Gojkov, 2002).

The most important question that arises here is the question of how the teacher knows the basic facts about the differences in students. Full awareness of teachers about the size of these differences will affect primarily the change in his thinking about the value of education equal for all students. Such a teacher, that's for sure, will much faster than the others feel the need to individualize the learning process and thus adapt to students' abilities (Öztürk, 2012).

Awareness that students differ exists in most teachers. The situation, however, is different when it comes to a full understanding of the size of these differences. Very few teachers that based on the experience can assume that individual differences among students in higher grades of primary school amount in all subjects seven, eight or more years of schooling. The reason is that the size of individual differences can not be reliably judged solely on the basis of experience, but it is required for this precise scientific research. If we bear in mind that understanding the importance of individualized teaching stems primarily from the knowledge of individual differences, it is understandable that teachers who do not know them will not understand the need to adapt teaching to students. One can not, in fact, feel and understand the importance of what

they do not know and the classes that are taught by teachers who do not know enough about individual differences will be more or less the same for all (Milošević et al., 2013).

In relation to student, the teacher is not only an adult, experienced and educated person. Position that he has objectively puts him in a role that is very normatively defined - in the role of representative of the adult world. In doing so, the teacher is a special kind of representative - he is professional, specially trained representative, a professional representative of the world. Teacher is authorized representative, and he can always be replaced by any person who has the same powers. When a teacher is sick, he can be replaced by another teacher, when he goes to another job in his place come another teacher etc. Thereby, the role of the teacher does not much change. Student in the school does not represent anyone because he personally came to school to be educated. He personally is "responsible" for his role and he can not be replaced at the school when he is sick, no one takes over his role when he leaves school. Thus, the role of the student is fully personalized, and the role of the teacher is only partially (Nikodinovska-Bančotovska, 2006).

This asymmetry in the degree of personalization of roles brings in the relationships between teachers and students the germ of an impersonal, bureaucratic, authoritarian, inhuman feeling and behavior. The teacher can always pull behind a secure fence of his formal role, his legal status, rules that determine his rights and obligations. In his decisions and actions a teacher can always rely on the regulations, those "above" himself, the circumstances and the like. The student, however, no matter what he does, always is alone with his actions and their effects. What does happen happens to him, under his name, he sees with his own feelings and temperament, he links to his abilities and his character, and his personality.

Conclusion

Better and intense knowing students revealed large differences in the development of their mental and physical properties. These studies have shown that large differences in the development of their properties are the rule and extent of these differences is very large. In students in upper primary school, differences in certain aspects of their mental development amount up to eight years of schooling.

Uneven development leads to their uneven progress in the classes. Due to the fact that class does not even approximately represent equal level of knowledge, but also includes the various levels at which there are individual students. Viewed from this perspective, class is a group of students of unequal opportunities and unequal knowledge.

Teaching adapted to the capabilities of the average student can never be appropriate for all students of class. Terms of learning and progress in such teaching are unfavorable to below average and above average students. To ensure to all students of class favorable conditions for learning, teaching adapted to the capabilities of the average student should be completed by procedures of individualization. Group of students should be taken for what it is and should be teaching should be adapted to students, not students to teaching. Because the principle of individualization can be successfully achieved by adjusting the teaching to abilities of students, not by grouping the students into classes formed on the basis of talent of students.

Managing the teaching process in a modern school should be based on scientific facts that show large differences in the abilities of students. Therefore, modern education can not be imagined without the procedures of individualization, because only in conditions of such teaching, there are opportunities for the full development of each student.

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