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Students with disabilities and chemistry education: Possibilities and difficulties

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Abstract: Education of students with disabilities in B&H is regulated by law for primary and secondary education by responsible institutions (ministries). It can be implemented in regular schools with or without adopted curriculum, and in special centers for their education. This paper presents results of study conducted in two centers: for secondary school students with visual (CSSDO) and hearing (CSGR) impairments. The aim of the study was to explore their knowledge and interest in studying chemistry at university level. Results showed: (1) there is no significant difference in students' achievements on knowledge test in general chemistry (GC) in CSSDO and CSGR, (2) considering their achievements in GC, they have a chance to enroll to university majoring in chemistry based on earlier entrance exams, (3) majority of students would like to enroll to university after secondary school, (4) but only one student would consider studying chemistry. These results show significant obstacles for students with disabilities to enroll to university, especially when studying science, but also the lack of proper education for teaching staff both at university and in secondary school when it comes to education of students with disabilities.

INTRODUCTION

Education for children with disabilities until 1960s have been carried out in special institutions in segregated educational system, aimed to "fix" the child and to prepare her/him for the community. Nowadays, a large number of children with disabilities are educated in regular classrooms around the world, with the help of teachers and teaching assistants, with main goal being to help students with disabilities to improve their knowledge and quality of their education by individualization of teaching and learning process.

It is essential to properly define and standardize the terminology related to persons with disabilities.

There are a number of terms that are more or less usual in everyday language. It should be pointed out that different terms are considered to be adequate and proper in different countries. Disability is defined as a "physical or mental impairment that substantially limits an individual in performing one or more 'major life activities'. These include everyday activities such as caring for oneself, performing manual tasks, walking, seeing, hearing, speaking, breathing, learning, and working." (Miner et al., 2001). This term includes a variety of congenital and acquired defects different types and levels, such as hearing, vision or speech defects communication disability, intellectual disability, different brain lesions that manifest as difficulty of movement, damage to muscles and nerves (cerebral paralysis), or in communication and social skills overcoming disability (autism) (DUGA, 2013).

Children and young people with special educational or rehabilitation needs are those who, in order to achieve optimal development capabilities and other social and personal positive characteristics of personality, need specially adapted, individualized conditions and procedures" (Organizacija za ekonomsku kooperaciju i razvoj, 2007). In B&H in the last few decades, following terms are generally accepted: for persons under 18 years "children with disabilities", and for those above 18 years "people with disabilities" (Nuić, Kafedžić, Zejnilagić-Hajrić, 2013).

Teaching chemistry to students with disabilities is still not sufficiently explored. Opportunities for students with

visual or hearing impairments to participate in chemistry instruction are diverse and depend on a number of factors. Most important is the heterogeneity of this group of students. From the medical point of view, even though visual or hearing impairments do not entail other forms of damage and disorder (intellectual, cognitive, etc.), they are quite often combined. Other important factors are suitability of classrooms and teaching methods. This particularly relates to whether they are educated in special schools for visually/hearing impaired students, or they are included in regular schools. The school environment, teachers, methods and approaches, textbooks, instructional supplies and technology are factors that need special attention and which should be adapted to students with visual or hearing impairments.

Approximately 11% of school-age children in USA have some form of disability (Norman, Caseau and Stefanich, 1998). According to the Law for Primary and Secondary Education in B&H, children and young people with disabilities can gain an education in regular primary and secondary schools with an adapted curriculum, or in special educational institutions in those cases where it is impossible to provide adequate education in regular schools (DUGA, 2006; Organizacija za ekonomsku kooperaciju i razvoj, 2007; Dmitrović, 2011). According to information available on website of the Ministry of Education, Science and Youth of Canton Sarajevo, total number of children with disabilities in 35 regular secondary schools in Canton Sarajevo, in 2012/2013 school year was 877: most children with behavioral problems (318) and children with chronic illnesses and physical impairments (292), followed by children with intellectual disabilities (166). There also were children with combined (57) and speech disturbances (44), children with visual (29) and hearing impairments (21) (Izvještaj nevladinih organizacija, 2013). Only four schools have adapted interior area designed for students with disabilities; only one school provides information on Braille and sound signalization.

There are many reasons why inclusive education in B&H is not as present as it could and should be. It requires the full adaptation of curricula, schools, forms and methods of teaching. However, the biggest problem in the inclusion of children with disabilities in regular schools is lack of awareness on this subject as well as a lack of willingness by educational personnel (and government in general) to apply inclusion. Inclusion implies involvement of students with disabilities into regular classes and provides opportunities for them to participate in activities that modern school requires (Dmitrović, 2011). However, inclusion is also referred to students who do not have disabilities, but also learn how to perceive individual differences among their friends and classmates.

Models and variants of individualized teaching, especially in dealing with below-average students and also with above-average students are often appropriate in inclusive teaching as well (Ilić, 2009).

This study points to the problem of education of students with visual or hearing impairments in B&H, especially in teaching chemistry, as well as the problem of their enrollment to higher education institutions, such as Faculty of Science (Department of Chemistry).

RESEARCH METHODOLOGY

Participants

The study was conducted in school year 2013/14, in "Center for Blind and Visually Impaired Children and Youth (CSSDO)" and "Center for Hearing and Speech Rehabilitation (CSGR)", both located in Sarajevo. Total number of participants was 25 students: 11 students from CSSDO and 14 students from CSGR. The students who were tested are of high school age, attending different classes and orientations. Sample of 25 students is chosen based on teachers' and principals' recommendation, since students' disabilities are diverse and therefore they are all unique and there are different variables that affect their achievements.

Research hypotheses

H1- there is no statistically significant difference in knowledge of general chemistry between students of two Centers

H2- students from both Centers have the same probability for passing the "threshold" required for admission to the Faculty of Science, considering results of the test of knowledge, noting that they should have good results and grades in chemistry during their education

Instruments for collecting data

In this study general chemistry knowledge test (GCKT) and a questionnaire were used. Both instruments were designed for the purpose of this research; they were identical, voluntary and anonymous for all participants.

GCKT contained 19 items related to the basic concepts and theories of general chemistry. Some items required filling the statement, or grouping terms according to their properties (for example, compounds and mixtures), multiple choice questions etc. Instruments were adequately adapted for visually and hearing impaired students.

Altogether students were able to gain a maximum of 22 points. Passing threshold was set to be 40% (8.8 points).

The questionnaire contained 19 questions partially based on Likert-type, whose aim was to get insight into attitudes of participants about their potential enrollment to higher education institutions such as the Faculty of Science (Department of Chemistry).

RESULTS AND DISCUSSION

GCKT

For items 1-6, 9, 14 and 18 students had to choose correct answer and were able to gain 0.5 points/question. Items 7, 16 and 17 required grouping given terms. Every correct answer was worth 2 points. Items 8, 10-13, 15 and 19 required inserting adequate words in the sentence.

The percentage of CSSDO and CSGR students who completely answered given questions are presented in Figure 1.

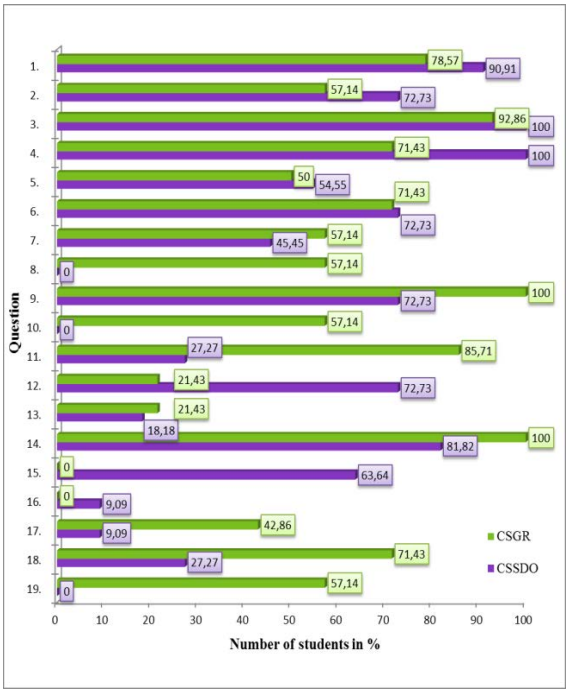

Figure 1: Comparison of CSSDO and CSGR students' correct answers on GCKT

Only on the 3rd (unit for amount of substance) and 4th (valence of hydrogen) item all CSSDO students gave correct answer. On the other side, all CSGR students have answered correctly only the 9th (location of metals in PTE) and 14th (concept of isotope) question.

Following items did not result in maximum number of correct answers: 8th (number of protons, electrons and neutrons in given example), 10th (charge of the given particle) and 19th (valence shell and valence electron).Interesting fact is correct answer of all CSSDO students on the question about valence of hydrogen, but at the same time they didn't know the meaning of valence theory. Unlike the CSSDO, CSGR students did not gain maximum points on only two questions: 15th (regarding reactants and products of chemical reaction) and the 16th (regarding classification of substances according to polarity).

Comparison of achieved points in GCKT is presented in Figure 2.

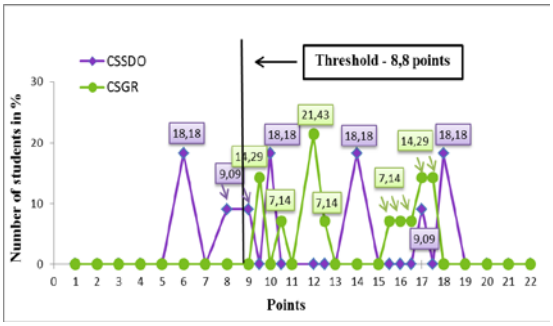

Figure 2: Comparison of students' achievements on GCKT

CSGR students gained slightly better results than CSSDO students. However, none of tested students have gained maximum score of 22 points; also there were no students with zero points. Highest score CSSDO students was 18 points (18.18%), while the highest score of CSGR students was 17.5 points(14.29 %).

Threshold was set to be 40%, or 8.8 points. More than half (72.73%) CSSDO students and all CSGR students passed the threshold. The lowest score of CSSDO students was 6 points (18.18%), while the lowest score of CSGR students is 9.5 points (14.29%).

The value of calculated t-test was $t = 2.11$. For the significance of 0.05 and confidence within the 95% theoretical t-test is $t = 2.11$, and for significance of 0.01 and confidence within the 99% theoretical $t = 2.90$. Based on these results first hypothesis can be partially accepted.

Questionnaire

In the first part of questionnaire, students were asked to give certain personal information about them.

In the second part of the questionnaire we wanted to found out the general attitude of the participants towards chemistry as a school subject using the Likert-type scale questions: (1-completely disagree; 3-partially agree; 5-completely agree).

In the third part, students were expected to offer a short and honest answer to questions also related to chemistry as a school subject, in addition to three issues related to the chemical industry and chemical products as well as how they imagine the job of a chemists.

Fourth part of the questionnaire was aimed to give information whether surveyed students with visual or hearing impairments would like to study in general and whether they are interested in studying chemistry. At the end of the questionnaire there was a possibility for students to write a comment.

The questionnaire revealed that students of both Centers consider chemistry as a difficult school subject. They said they have problems with learning and understanding chemistry and that they need more time for learning chemistry than some other school subjects. Many of these students do not want more hours of chemistry per week than prescribed by Curriculum.

Majority of students in both Centers do not doubt the importance of chemistry in everyday life, but certain percentage of disagreement gives a dose of concern. This may indicate that some students do not know how to link theory to everyday life and that they probably have never thought about importance of chemistry or that chemistry is present in their everyday lives, other than merely as a school subject.

Majority of CSSDO students, when asked if there is something to change about school subject chemistry wrote "How teacher teaches" or just "The teacher." The rest of the students wrote that they would reduce the theory they need to learn and bring more experiments and practical work. This may indicate that they are not satisfied with the methods and forms of work that the teacher uses. Teachers' choice of methods and types of teaching depends on the conditions in educational institution or in the chemistry classroom.

In teaching students with any kind of disability it is necessary to use adapted teaching aids. If the educational institution is unable to provide them, it is expected that a teacher cannot fully satisfy the demands of modern education of students with visual impairments. Encouraging is the fact that students are aware of the importance of practical work in teaching chemistry and

that regardless of the their disability they want to experience as much of this practical work as they can.
Some of CSGR students also stated they would like to reduce the theory and to bring more experiments. One student said that he would like to visit different factories or to go to some other kind of school trip. It should again be emphasized that educational institution should provide adequate laboratory equipment and supplies, but also the teacher needs to be creative.
Probably the most important questions for this study were: "What do you intend to do after graduating high school?" and "Would you like to study chemistry (at university level)?".Students' answers can be seen on Fig 3 and Fig. 4.

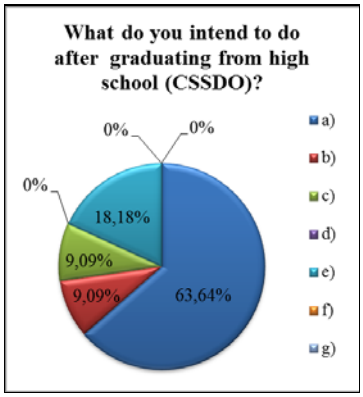

Figure 3: Answers of CSSDO students

(Legend: **a)** I intend to go to university (specified field); **b)** I intend to go to university but I still haven't decide what; **c)** I intend to look for a job in the profession I was educated in; **d**) I intend to look for a job but not in the profession for I was educated in; **e)** I intend to go on further training (courses etc.); **f)** I haven't yet decided; **g)** Other (please specify)

Figure 3 shows that 72.73% of CSSDO students want to continue their education at one of the higher education institutions and 63.64% students even know which faculty they wish to go to. A very low percentage of 9.09% of these students want to look for a job and work in their profession and 18.18% want to go on further training and courses.

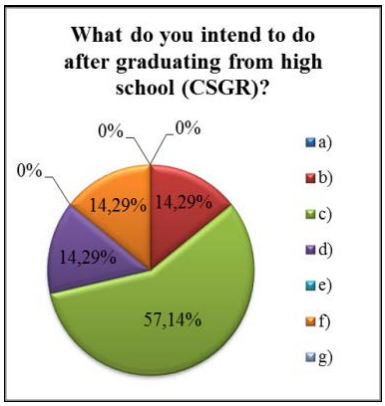

Figure 4: Answers of CSGR students.

Legend: **a)** I intend to go to university (specified field); **b)** I intend to go to university, but I do haven't decide what; **c)** I intend to get a job in the profession for which I was educated; **d)** I intend to get a job but not in the profession for which I was educated; **e)** I intend to go on further train (courses etc.); **f)** I haven't yet decided; **g)** Other (please specify)

Figure 4 shows that 57.14% CSGR students would like to work in the profession they are educated in and 14.29% students wish to work but not in their profession. The same number of these students has not yet decided. An alarming fact is that only 14.29% of CSGR students want to study at university level, but none of them yet decided what. This indicates that the students are not interested in further education or perhaps they are discouraged by the current situation in B&H regarding education of persons with disabilities at higher education institutions

Students' answers to the question "Would you like to study chemistry?" can be seen in Fig. 5 and Fig. 6.

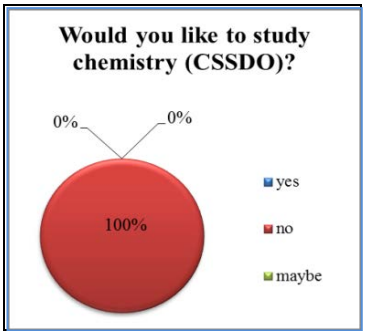

Figure 5: Answers of CSSDO students on question "Would you like to study chemistry?"

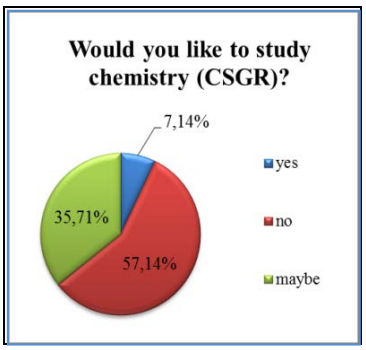

Figure 6: Answers of CSGR students on question "Would you like to study chemistry?"

None of CSSDO students would like to study chemistry at university level. Most of these students wrote they are not interested in science, or that chemistry as a school subject is too difficult and complicated. Devastating fact is that half of CSSDO students wrote that they would not be able to study chemistry because they have vision impairment. Obviously, these students are not familiar with the possibilities offered to them in modern chemistry education, but also in modern chemistry as a science, and that there are many blind and low-vision scientists who have very successful careers as a chemists and in other professions related to science.
From the Figure 6.it can be seen that most CSGR students (57.14%) would not like to study chemistry at university level, 35.71% students would consider this option and 7.14% surveyed students would like to study chemistry. Most of the students have not explained their answer. However, one student wrote that he would be interested for job as a forensic scientist. Only two CSGR

students are not interested in chemistry. It is interesting that none of surveyed CSGR students has noted his/hers impairment as a reason for not studying chemistry.

CONCLUSIONS

Results of the study showed:

(1) There is no significant difference in students' achievements on knowledge test in general chemistry (GC) in CSSDO and CSGR;

(2) Considering their achievements in GC, they have a chance to enroll university study of chemistry based on earlier entrance exams;

(3) Majority of students would like to enroll to university after secondary school;

(4) Only one student would consider studying chemistry.

Opportunities for students with visual or hearing impairments to participate in chemistry class are diverse and depend on a number of factors. There are ways to "bring chemistry" and to adapt teaching methods and supplies for teaching students with disabilities, where teachers' role is especially emphasized. The role of the teacher in teaching process is irreplaceable, but her/his role in teaching students with disabilities has another dimension because there are additional factors that need to be cared for. Creativity of chemistry teacher is particularly evident in teaching students with disabilities – in addition to the knowledge of chemistry and education of chemistry, a solid knowledge on specifics of teaching chemistry to students with disabilities is needed. However, due to many problems, students with disabilities are rarely enrolled to university courses. Students with disabilities are often demoralized during their education and this can be one of the reasons that they do not sufficiently attempt to enroll on higher education institutions.

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Summary/Sažetak

Obrazovanje učenika s teškoćama u razvoju u Bosni i Hercegovini regulirano je Zakonom o osnovnom i srednjem obrazovanju odgovarajućih institucija (ministarstava). Obrazovanje se može provoditi u redovnim školama sa ili bez prilagođenog nastavnog plana i programa, te u specijalnim centrima. U ovom radu prikazani su rezultati istraživanja provedenog u Centru za slijepu i slabovidnu djecu i omladinu (CSSDO) i u Centru za slušnu i govornu rehabilitaciju (CSGR). Cilj istraživanja bio je ispitati mogućnosti i interes učenika za studiranje hemije na fakultetu. Rezultati su pokazali: (1) ne postoji statistički značajna razlika u postignućima učenika ova dva centra na testu znanja iz opće hemije, (2) prema rezultatima testa znanja, postoji mogućnost njihovog upisivanja na studij hemije, prema ranijim kriterijima polaganja prijemnog ispita, (3) većina učenika bi se voljela upisati na fakultet, (4) ali samo jedan učenik bi razmatrao studiranje hemije. Ovo istraživanje ukazuje na problem uključivanja učenika sa oštećenjem vida ili sluha u studijske programe prirodnih nauka na fakultetima, a također i nedostatak potrebnog obrazovanja za nastavno osoblje na fakultetima i u srednjim školama kada se radi o obrazovanju učenikas teškoćama u razvoju.