TECHNOLOGY AIDED EDUCATION OF STUDENTS WITH DISABILITIES: A CASE STUDY FOR STUDENTS WITH CEREBRAL PALSY

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Abstract: Differences among individual students can have significant impact on learning performances. In case of students with disabilities learning process can require different approaches in order to overcome physical and social barriers and maximize student's potential. In this paper, we discuss educational challenges of students with special needs by a case study of students with cerebral palsy. Also, it is discussed what kind of technological improvements can be helpful in overcoming the issue mention – from assistive technology devices and software to new learning paradigm which change the way of developing, organizing and presentation of learning materials.

Keywords: E-Learning, Personalized learning, Accessibility, Disability, Cerebral palsy, Assistive technology

1. INTRODUCTION

It is well known that differences among individuals have significant impact on learning performances. More often than not, people with various kinds of disabilities are unable to pursue their educational (and later professional) goals in full capacity as a consequence of environmental and social restrictions. Fortunately, in recent years there have been significant improvements in this area. Three fundamental components stand out as necessary prerequisites of such breakthrough:

- Legal acts,

- Technological improvements,

- Adaptive (student-oriented) learning.

By guaranteeing rights of disabled people, preventing discrimination and suggesting standards which organizations have to fulfill, legal acts regarding the accessible education are expression of maturity of a society and one of the main indicators of human rights. Although various countries have different criteria and, as a consequence, different legislation, the modern trend is positive in terms that more and more countries recognized the existing issues and updating laws in order to meet equal opportunity standards. For more information on accessibility legislation, one can refer to [1] [2] [3] [4] [5] [6] [7].

Learning process in general can benefit from recent technological developments, but it is of crucial importance for education of disabled students. Technological improvements often can be helpful in overcoming environmental and physical barriers which prevent disabled student to participate in educational activities in full capacity. Technology can impact the way learning material is created, how it is organized, method in which it is presented and when it is delivered to students. Learning from any place at any time, multimedia learning content, content, games, simulations, augmented reality, location-based and contextual learning [8] have become important parts of learning experience.

Finally, modern trend in education are learning materials developed, organized and presented in such way that each student can plan learning activities according to his or her individual abilities and interests [9] [10] [11]. Although all students have benefit of such approach, it is especially valuable for students with disabilities.

In this paper, we discuss educational challenges of students with special needs by a case study of students with cerebral palsy. The reason for this is twofold. Firstly, Belgrade Metropolitan University (BMU) has certain experience with students who have cerebral palsy. Secondly, cerebral palsy is a disease which can lead to various kinds of disabilities as it is explained later in the paper. Therefore, conclusions resulted from analysis of such case can be useful in many other situations completely unrelated to cerebral palsy. We present challenges which students with cerebral palsy have to face during their education and propose certain improvements in order to make educational process more accessible.

The rest of the paper is organized as follows. In Section 2 we present various types of disabilities caused by cerebral palsy. In Section 3, we present educational challenges resulting from such disabilities. Short survey was

conducted among students with cerebral palsy in order to better understand their problems and needs. In Section 4, several examples of assistive technology are presented. In Section 5, we present current situation on BMU regarding this issue. And finally, in Section 6, we provide short conclusion.

2. DISABILITIES CAUSED BY CEREBRAL PALSY

Cerebral palsy is "an umbrella term covering a group of non-progressive, but often changing, motor impairment syndromes secondary to lesions or anomalies of the brain arising in the early stages of development"[12]. Causes of cerebral palsy in most cases are caused by combination of contributing conditions. Adolescent pregnancy, low socio-economic status and poor health are associated with increased risk of cerebral palsy in children. In as many as 25 percent of affected cases, no definite cause of aetiological factor can be pin-pointed.

As a disease, cerebral palsy can lead to various disabilities – vision related, hearing related, speech related, motor related, and cognitive-related. In particular, those disabilities are:

- **Motor disabilities** - very often when we are talking about cerebral palsy, there are focusing on disorders of movement and posture. Cerebral palsy affects people in different ways and can affect body movement, muscle control, muscle coordination, muscle tone, reflex, posture and balance.

- **Visual dysfunction** - the most common is strabismus: nystagmus, visual field cuts, refractive errors and other oculomoux defects are frequently found. There can be inability to interpret visual symbols, inability to identify letters.

- **Visual-perceptual and visual-motor dysfunction** - many children have problems with matching shapes, distinguishing shapes that appear similar, seeing a drawing as separate from its surrounding background and differentiating between varying directions of lines or forms (example: distinguishing "b" from "d").

- **Auditive dysfunctions** (hearing impairment) are also frequently found at children with cerebral palsy.

- **Other sensory dysfunctions** – problems with two point discrimination, sense of position, sharp-dull discrimination, pain, light touch, and temperature sense.

- **Communication disorders** - communication problem is more handicapping people with cerebral palsy than inability to walk. There are speech defect which is relate with reduced control of facial and respiratory muscles, or the muscles of the toque or lips. Language dysfunction is a frequent problem in communication disorders in children with cerebral palsy and children with central processing deficits need an educational approach suited to extend their knowledge of concepts as well as their use of meaningful communication. Emotional and behavioural problems are very important and that is because children with severe cerebral palsy grow up in a life situation that is very different from that of other children.

- **Cognitive dysfunction** - one of the most commonly associated deficits of cerebral palsy. Children with greatest physical handicaps also have the poorest mental functioning, and there seems to be systematic relationship between the extent of the brain damage and the development of intelligence at the group level of research.

Each one of these disabilities can present a serious obstacle for full participation in regular educational activities.

3. EDUCATIONAL CHALLENGES

In Serbia, Cerebral Palsy Associations estimate that more than 6000 people have cerebral palsy. One of the biggest problems that arises with cerebral palsy is the transition to school, and then to adulthood. Education is very important in this process and it is the key that opens the door to all our future opportunities. Every parent of a child with cerebral palsy must be put considerable through into his child`s education. In order to be fully included in educational process and to reduce barriers to learning, parents of a child with cerebral palsy work closely with educators in the special education program to optimise their child's potential for lifelong learning. For children with cerebral palsy, finding the right school environment is often difficult. Depending on the type of cerebral palsy and the degree of severity, the current trend is to enrol a student into one of the "mainstream" schools and place the disabled child into regular classes with non-disabled children. Although some people with cerebral palsy are able to participate in school educational activities with minimal or no help, many of them during the process need assistant and special attention. It is the reason why people with cerebral palsy often need special education. In it essence, special education can be understand under the paradigm of adaptive learning. Definition of special education by The National Dissemination Center for Children with Disabilities [13] is:

"Special education is instruction that is specially designed to meet the unique needs of a child with a disability. This means education that is developed to address that child's specific needs in order to achieve his or her highest learning potential. Since each child is unique, it is difficult to give a sweeping example of special education. It is individualized for each child. It can consist of early intervention programs to identify specific needs related to physical abilities and educational challenges, evaluations, adaptive techniques and tools to enhance those abilities, transition plans and guidance throughout the process."

Many children with cerebral palsy frequently develop learning disabilities. A child with a learning disability can have average or above average level of intelligence, but has difficulty processing certain types of information. In addition to possibly having a learning disability, many children with cerebral palsy are limited in their ability to communicate. Because of this, they are sometimes considered to have much less intellectual ability than they actually do, as teachers may not be able to tell whether or not the child understands the lesson if they are unable to speak. Due to this, such students are unnecessarily placed into special education programs, many of which focus much of the time in school on different therapies, to the detriment of academic progress. Because of this common misconception of intelligence levels and cognitive ability it is very important for teachers to be educated about the issue so they can respond adequately in such situations.

For the purpose of this paper, in order to more closely investigate this issue, a group of people with cerebral palsy has been interview. Fifteen students participated in the interview, all of which are either from BMU or from Cerebral palsy Association of Serbia at city of Niš. The questionnaire was composed from the following questions.

1.) **Do you have needs for assistive technology hardware?**
Most students responded that they have needs for such hardware. Smaller number of students answered that they are accustomed at normal hardware (as keyboard and mouse), mostly that students with mild form of cerebral palsy.

2.) **Do you use assistive technology hardware in your everyday work?**
Most students responded that occasionally they use such equipment. However, financial issues were mentioned as a usual obstacle in obtaining such equipment. Although, the issue of lack of such devices at the university was raised.

3.) **Do you have understanding from teachers in situations when you need additional help?**
Each student answered that teachers are helpful and cooperative.

4.) **Do you have problem with tiredness after walking or sitting in unsuitable position? Does it affect your concentration?**

Every student answered affirmative to this question.

5.) **How long can you stay at college due to the physical difficulties? Do you have problem with sitting at the desk for several hours?**

Most students tell that they have problem after sitting 2 or more hours. It was overwhelming reason for skipping lectures.

6.) **Do you prefer coming to university building for classes or distance learning from home (e-learning)?**
Most interviewed students have significant motor problems and they prefer for learning from home.

7.) **How would you describe environmental conditions at the university?**

Most students expressed need for environmental adaptation. Adapted furniture, curb ramps and elevators are mentioned as potential upgrades.

8.) **Are you capable of finishing usual tasks like exams and homework in the established timeframes?**
Each student answered that usually more time is required. Extent to which additional time is needed vary mostly as a result of degree of motor disability because it slows down writing and typing.

9.) **Would it be helpful to split an exam into several smaller chunks which can be completed in shorter period?**

Each student answered affirmative to this question.

4. ASSISTIVE TECHNOLOGY

Assistive technology "*includes assistive, adaptive, and rehabilitative devices for people with disabilities and also includes the process used in selecting, locating, and using them.*" [14] It is key component in modern education which enables people with disabilities to perform tasks that they had great difficulty accomplishing and, therefore, allows them to participate in various educational activities. Assistive technology products useful for students with cerebral palsy:

- **Alternative keyboards** — Alternative keyboards use different designs to attempt to

change the user's posture. Usually, such keyboards have larger or smaller than standard keys, alternative key configurations, adaptive key configurations and keyboards for use with one hand. Examples of such keyboards are presented in Figure 1 and Figure 2.

Image 1: Clevy Keyboard II - English Lower Case [15]

Image 2: A keyboard which allows various layouts. [16]

- **Special mouse devices**, adapted for humans with special needs. Several examples are shown in Figure 3.
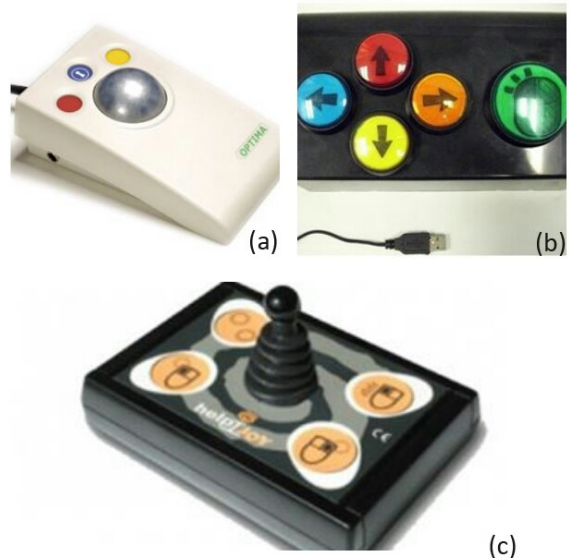

Image 3: Several special mouse devices. [15]

- **Mouse emulators** — used to control the cursor on the screen without use of hands. Devices used include ultrasound, infrared beams, eye movements, nerve signals, or brain waves. In Figure 4. One such device is presented (tracker pro Electronic pointing device). This device is used to help people who are unable to control a mouse and enables controlling the pointer on a computer screen by head movements. Another example of mouse emulator is Sip-and-puff systems—activated by inhaling or exhaling (Figure 5).

Image 4: Mouse emulator - Tracker pro. [18]

Image 5: Mouth-controlled mouse emulator.
[17]

- **Accessible software** has become more common option included in popular software packages. The well known example is Microsoft Accessibility set of programs. It includes the following useful features:

  o Keyboard options which include filters with correction for erratic motion tremors and slow response time, filters for typing aids, such as word prediction, abbreviation expansion tool and add-in spelling checkers.

  o On-Screen Keyboard - an image of keyboard (standard and modified keyboard) on computer screen which allows user to select keys with touch screen, mouse, trackball, joystick etc.

  o Speech recognition or voice recognition programs - people can give commands and enter data using their voices rather than a mouse or keyboard using a microphone attached to the computer. These programs can be used to create text documents.

  o Screen enlargers or screen magnifiers which work like magnifying glass by enlarging a portion of the screen.

  o Text-to-speech or speech synthesizers suitable for people who suffer from visual impairing and reading disabilities.

5. ACCESIBLE LEARNING AT BELGRADE METROPOLITAN UNIVERSITY

We analyzed current state of accessible learning at BMU. After conducting interview with students, special attention has been given to the following questions:
- Distance learning,
- Personalized learning,

- Examination process and assessment,
- Assistive technology and environmental conditions.

BMU offers distance learning since 2005. Currently, there are about twice as many students enrolled into traditional program than students who chose e-learning.

As previously described, the key to successful integration of students with cerebral palsy into educational system is adaptive, student-oriented learning which recognizes individual differences among students. At BMU, increasing number of courses based on learning objects paradigm which are adapted to recognize individual differences among students and their needs. BMU decided to use learning objects of fine granularity approach because fine granularity of created learning objects enables easier personalization of online lectures [19]. Additionally, BMU lessons support different levels of engagement (so called "ABC structure, see Figure 6) which can be used for further personalization of learning materials [20].

A student may, according to his interests, needs and abilities, choose appropriate level. Also, during preparation of learning material, creators should be aware of possibility that materials will be used by students with various types of disabilities. Although, personalized learning in its full capacity remains as a goal for future R&D, significant steps are made in this direction. Collection of useful recommendations and standards for creation of such materials can be found in [1].
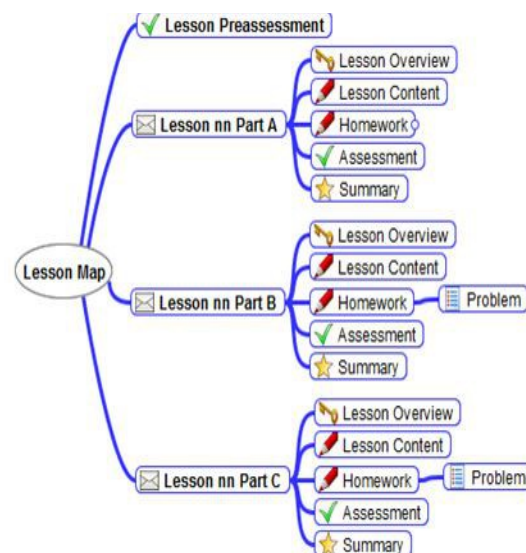

Image 6: Lesson structure at BMU

Assessment of student's work is unavoidable part of any educational system. Continuous evaluation and building student's e-portfolio became preferable over traditional approach to examine students in written form at the end of

the course [21]. At BMU the final exam is only part of the final grade. Homework, activity, projects and online tests are also integral part of the final grade. Such approach discourage students from procrastination and stimulates their active engagement. Evaluation in e-learning conditions has its specific issues, especially regarding estimating level of engagement of student in testing activities [22]. It is the reason why at BMU essentially there is no difference in grading policy and procedure between traditional and e-learning students. Additionally, assessment became integral part of each lesson. Each lesson has set of preassessment and postassessment questionnaires. The role of preassessment is to check student's ability to absorb new material, while postassessment checks student's understanding of the presented material. Such approach can be useful for professor's evaluation of student's performances as well as for student's selfassessment. Each of these questionnaires can be in one of the following format:

- True/false answers,

- Choose one correct answer,

- Choose multiple correct answers,

- Connect correct answers.

Multiple choice questions are usually more adequate for student with disabilities and should be used more frequently. For these students, extra time should be reserved if necessary. Additionally, after an exam, students should be offered an evaluation questionnaire. The questionnaire should be composed of the following key points:

- Level of satisfaction by conditions during the exam?
- How much additional time was necessary?
- How much help was necessary from a teacher?
- Which additional equipment (special devices) was necessary?

Such questionnaires would be helpful in collecting data which can be used for further improving quality of the examination procedure.

And finally, use of assistive technology and environmental conditions are areas in which further improvements can be made. However, usual obstacles are financial issues.

6. CONCLUSION

Students with disabilities are usually prevented from full participation in educational system. Significant effort should be invested in order to enable such students to be actively engaged and maximise their potentials. New technologies reduce physical restrictions, and new learning paradigms enable acquiring knowledge and degree according to individual needs, abilities and interests. At BMU, such paradigms are adopted through new e-learning framework recently introduced.

Finally, there should be noted that significant part of education is social interaction with other colleagues. This is probably even more important in the case of people with disabilities. Therefore, e-learning and its benefits should be combined with elements of traditional schooling to provide full satisfaction alongside quality education for each student.

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