E-learning Platform as a Support in the Technical Education of Disabled People

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Abstract *—E-learning is one of the technologies, which will be improved in the future, because of many problems with classical education. In some cases e-learning can replace classical teaching method, but on technical university it is very difficult. The scope of paper concerns the question how to support teaching of some subjects in technical university and make it accessible for disabled people. Most of students on our university are regular students, having lectures on weekdays. Classical methods of teaching are used, because technical subjects usually require presence of student in laboratory and direct contact with the teacher. However growing number of students and reduced number of lecture hours for specific subjects, caused by growing number of subjects, as well as challenges of modern world, is a reason of searching for the improvements of teaching methods. Next challenge is how to enable studying on technical university for disabled students. Large number of types of disability makes it more difficult because there is no universal, multipurpose method covering all types of disability and its combinations. In our case e-learning is not intended to be used instead of classical lectures, but only as a support. It is very useful especially for extramural and disabled students, having problems because his disabilities, lesser number of lectures and less time to complete subject.*

Index Terms *—accessibility, disabilities, e-learning, Moodle, technical university subjects, teleworking.*

INTRODUCTION

Distant learning and e-learning becomes important part of education systems, allowing people to get education despite of a distance from school and other obstacles. Distant education can be used on all stages of education, giving people from different environments equal chances.
Full implementation of distant learning and e-learning can be difficult at technical university. Technical subjects usually require presence of student in laboratory, manual operation of hardware and direct contact with the teacher. It is possible to replace some laboratories with computer models or virtual laboratories but not in all cases and usually it is very expensive.
In contemporary world disability becomes great social problem. Many countries governments are trying to improve situation of disabled people and to make even their chances. Many of disabled are in productive age. They are facing with some obstacles and limitations resulting in social exclusion and putting them on the margins of society. Obstacles can have physical nature, which limit mobility of disabled people. Also there are informative obstacles restricting access to information. As a result of these obstacles disabled people are experiencing difficulties in acquiring education.
Obtaining the well-paid job is more difficult for disabled than able-bodied person – generally disabled people are problem for employer, because in case of unemployment it is easier to hire able-bodied person than disabled one, requiring special attention and having some limitations as an employee.
E-learning seems to be good solution for some problems with education, also for disabled people, but there are many limitations – ability to use computer is in this case necessary. In many types of disability usage of computer is still possible but in some cases, e.g. for blind people it is strictly limited – there is no possibility to easily display images and drawings.

DISABILITIES IN POLAND

Nowadays we can observe transformation from industrial society into information society. Reduction of requisition for handwork is caused by this transformation. Shrinking of the labour market is a reason of unemployment in many professions and social groups. From the other side, many new workplaces, which are connected with information processing, are created, but high qualifications are necessary to take these jobs. According to the scientific inquiry in our country education level of disabled people is below average (Figure 1).

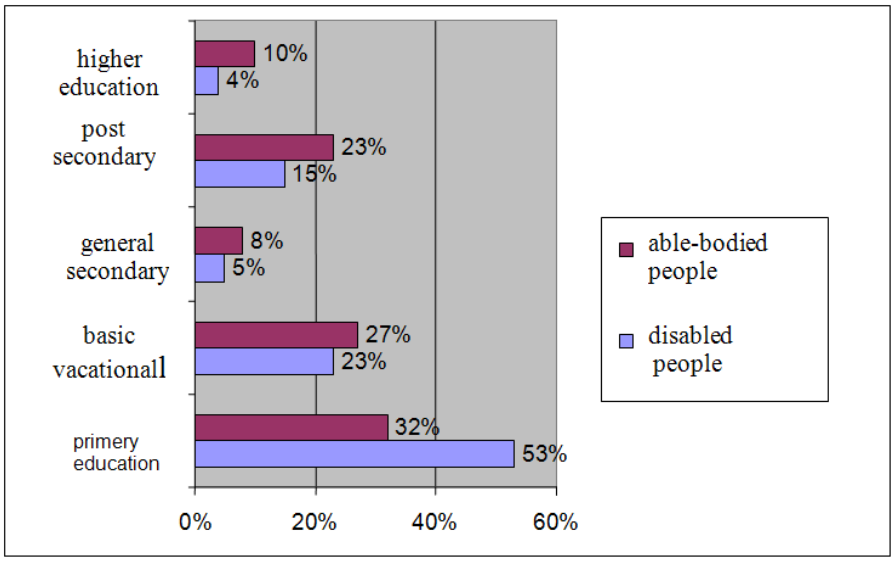

FIGURE 1
COMPARISON OF EDUCATION STRUCTURE BETWEEN DISABLED AND ABLE-BODIED PEOPLE IN POLAND [1]

Development of information technology and availability of Internet access allowed to introduce new form of work – teleworking. It seems to be important possibility of obtaining a job for disabled people (but not only for disabled people) is teleworking, where employee can work at his home connected with employer via Internet connection or other means of contact. Unfortunately teleworking is not very popular of in our country. Estimated number of teleworkers in our country is about 1%, compared to 10% in European Union and about 20% in United States. Popularity of teleworking in the future probably will be growing due to changes in law, simplifying rules of teleworkers hiring. Growing amount of jobs that can be done by teleworking also will cause growth of teleworkers number.
Governments and international organisations try to help disabled people with law acts that make employment of disabled easier, for example, Law Chart of Disabled Persons from 1997 in Poland, and the Convention on the Rights of Persons with Disabilities from 1975 (formally agreed by United Nations in 2006), to protect and enhance the rights and opportunities of the estimated 650 million disabled people in the world. These law acts confirms that disabled people has the rights to education, work and life without discrimination.
Low level of education among disabled people can be caused by [1]:

- architectonical barriers and obstacles – e.g. stairs, lack of lifts,
- difficulties in access to education and rehabilitation aids,
- high cost of education places designed for disabled people (hardware and software),
- low income of disabled people in relation to cost of education and rehabilitation aids,
- insufficient computer equipment and lack of internet connections,
- insufficient knowledge and understanding of disability problems and mental barrier among the rest of the society.

Due to worse education and physical barriers, disabled people have difficulties with job acquiring. Employment structure of disabled people is shown in Figure 2.
Employment index of disabled people was equal 12,8% compared to 44,1% for the whole population able to work (Central Statistical Office 2005). Many of disabled people are low educated and unemployed. Many of employed disabled people have jobs which are low paid. Only small amount of disabled people is well educated and have a good job.

E-LEARNING IN EDUCATION OF DISABLED PEOPLE

Usage of e-learning methods comparing to classical methods of education has some advantages, e.g. possibility of learning at any time at home (journey to school or course-centre is not necessary), possibility of learning speed adjustment for every single course participant and possibility of matching learning style to perception of each disabled person. Possibility of taking part in rehabilitation and learning course at the same time gives disabled people great chance to acquire knowledge and skills, moreover opens access into labour market and new workplaces that was very restricted till now. Thanks to this method it is possible to acquire skilled employees (even if they are disabled) who can be hired for example in teleworking systems. Table 1 presents advantages of using e-learning and teleworking for both employers and employees.

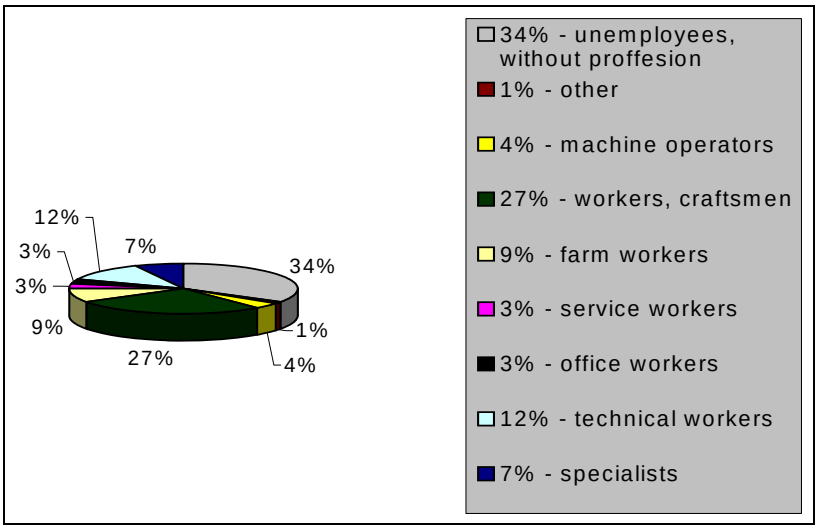

FIGURE 2
EMPLOYMENT STRUCTURE OF DISABLED PEOPLE IN POLAND [1]

Advantages for employees	*Advantages for employers*
lower importance of space-time factor	territorially unlimited labour market
learning speed adaptation	high qualified personnel
access to labour market, possibility of professional career	lower cost of employees training and lower cost of workplaces in teleworking
objectivity in rating, measured with work done, without any discrimination	enterprise advancement through continual enterprise learning
no social exclusion and better life	tax reduction through employment of disabled people and possibility of new workplaces creation
successful rehabilitation through awareness of self-esteem	awareness of good social mission and better enterprise reputation in society

TABLE 1
ADVANTAGES OF USING E-LEARNING METHODS IN EDUCATION

Limitations of e-learning for disabled people

There are also some limitations and disadvantages apart from many advantages of e-learning. The most important is that there is no homogenous group called "disabled people". There are many types of disability and each of them requires different approach and has own specific character. As e-learning requires access to computer on both sides, depending on type of disability another hardware and software is required. Vision impairment is probably the most difficult case, because sight is the most important sense and it is very difficult to replace it and send information in different ways. In technical education, visual information is very important and only technical university's specialisations connected with management, logistics and the like, where reading drawings and other visual information is less important, are relatively available for blind persons.

Another problem is caused by relatively small number of disabled people continuing learning at universities and big number of universities – there is no possibility to create groups of disabled students and specialisations for them – usually they are treated as regular students. E-learning courses are prepared for able-bodied students and are available for disabled students thanks to additional hardware or software. Development of courses especially for disabled people is

difficult and expensive – additional source of financing is necessary. Different versions of course have to be prepared for people with different disabilities and also different hardware can be required.
In Table 2 a few selected types of disability and its requirements for hardware (apart of computer, which is always needed) and software were described.

Type of disability	*Required hardware*	*Required software*
Dysfunction of hands	Special keyboards, trackballs, pointing devices	Computer control software, voice command recognition software
Dysfunction of legs	No additional hardware required	No additional software required
Dysfunction of hearing	Voice amplifiers	Voice to text engines
Partial dysfunction of eyesight	Magnifying devices, electronic magnifying glass, speech synthesizers, voice recorders	Magnifying software, voice synthesizers, reading software, OCR, voice recorders, voice command recognition software
Dysfunction of eyesight	Refreshable Braille display, Braille printers, speech synthesizers, voice recorders, Braille keyboards, text-reading scanners	Voice synthesizers, screen readers, OCR, voice recorders, voice command recognition software, Braille support software, software for colour modification in case of colour blindness
Combination of dysfunctions	Depending on type of dysfunctions	Depending on type of dysfunctions

TABLE 2
HARDWARE AND SOFTWARE REQUIREMENTS FOR DIFFERENT TYPES OF DISABILITY

E-LEARNING IN TEACHING OF THE TECHNICAL SUBJECTS

Most of students on typical technical university are regular students, having lectures on weekdays. Classical methods of teaching are used, because characteristic feature of technical university education is that technical subjects usually require presence of students in laboratory and direct contact with the teacher and laboratory equipment. However growing number of students and reduced time of lectures for specific subjects, caused by growing number of subjects, as well as challenges of modern world, forced us to look for the improvements of our teaching methods.
Significant amount of educational materials at technical university is now available as many types of computer files, like presentations, movies, animations, drawings, electronic PDF documents and so on. First step in this situation can be sharing of those materials with students using one of available e-learning platforms.
Silesian University of Technology (SUT) [2] is using Moodle [3] as a standard platform for e-learning, so we are obliged to use it with all its advantages and limitations. In a some cases abilities of Moodle are sufficient for requirements of subjects, but many of the technical subjects seem very difficult to be taught using pure e-learning methods.
In many cases main problem is laboratory equipment – it has to be operated manually and requires presence of qualified personnel. Sometimes this problem can be solved using computer models or virtual laboratories, but it is possible only in specific situations.
Methods used in distant learning, that can be adapted for teaching technical subject are described in Table 3. Common feature of all e-learning methods is that computer with fast Internet connection is required. It can be restriction in some cases, where Internet access or bandwidth is limited. Disabled people wanting to use this form of education should have their computer equipped with additional hardware and software, depending on type of their disability.

Course of technological processes design on SUT Platform of Distant Learning

Teaching of less laboratory-equipment demanding subjects can be easily supported by typical e-learning methods like sharing of materials. An example of this kind of subject is a course of technological processes design. In this subject each student individually has to design technological process of exemplary machine part. It requires using of many sources of knowledge, like handbooks, catalogues of tools and norms. In the past educational materials like subject-matter were handed to students in printed form, but students had to find by themselves additional information and literature. In order

to make it easier course of technological processes design was developed using University's Platform of Distant Education. It contains materials essential for completing this subject, like individual themes of project for students, detailed description of requirements, documentation, norms, tables, examples of good and wrong projects and other materials, as well as presentations used by lecturer during classical lectures. Figure 3 shows screenshot of course's webpage.

Type of distant learning	*Description*	*Advantages*	*Disadvantages*
Standard methods of e-learning	Presentations, web pages, web 2.0 pages, e-mails, audio and video materials, lectures audio and video recordings, education games etc.	Small hardware requirements, using standard web-browsing and office software, low costs, off-line operation, materials can be downloaded	Small interactivity, limitations in control of the laboratory equipment,
Virtual desktop, desktop sharing, virtual whiteboard	Teacher can share his desktop or part of desktop, student's feedback possibility	On-line method, full interactivity, excellent method of software usage teaching	Only on-line meetings, additional software requirements, limitations in control of the laboratory equipment
Videoconferences	Extended version of virtual desktop, webcam at teacher's side or on both sides	On-line method, full interactivity, direct contact with teacher, teacher can show things that are difficult to digitalise, laboratory experiments can be shown to people having no chance to visit laboratories	Only on-line meetings, additional software and hardware (webcams) requirements, limitations in control of the laboratory equipment, higher bandwidth usage
Modelling and simulation	Using of simulation software and models	Full interactivity, experiments can be repeated, on-line and off-line operation, non-limited number of students controlling an experiment, separate experiments for each user, safety because of lack of hardware	Special software required, simulation instead of laboratory equipment
Virtual laboratories	Especially designed laboratory equipment, which can be operated remotely via internet browser or HMI/SCADA software, webcams for observation of visual results	Real-time hardware experiments, students can control and observe experiments, presence of teacher is not required in some cases	Expensive hardware and software on teacher's side, need for maintenance and qualified personnel, limited number of students controlling the experiment, risk of malfunction

TABLE 3
METHODS USED IN DISTANT LEARNING OF TECHNICAL SUBJECTS

This course is not intended to be used instead of classical lectures, but only as a support. In fact it is only collection of supplementary information. It is very useful especially for extramural students, having less lectures and less time to complete subject. Thanks to e-learning support students have full-time access to educational materials, but still they have to attend lectures and consult project with teacher. In the last stage project in the printed form is reviewed and accepted by teacher. Results of opinion poll among students proved that this form of e-learning is very useful for them. Materials are available all the time and collected in one place, which is important especially for disabled students.
At present stage of development this course itself can be used by disabled, but it is not dedicated for specific kind of disability.

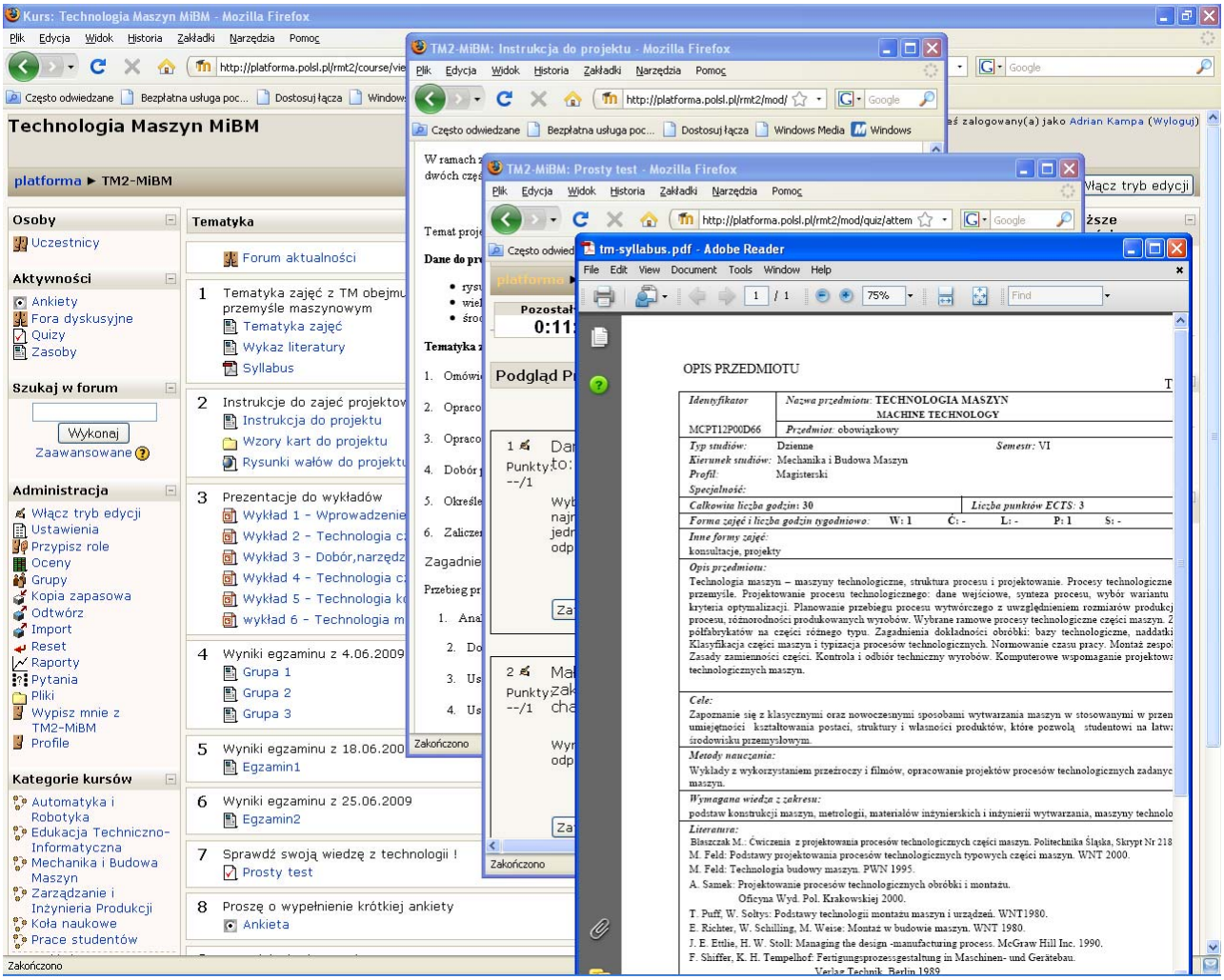

FIGURE 3
SCREENSHOT OF TECHNOLOGICAL PROCESSES DESIGN COURSE

ACCESSIBILITY OF E-LEARNING CONTENT

The term "accessibility" is associated with the requirements of the disabled. Generally it means a requirement for access to information by individuals with different abilities, requirements and preferences, in a variety of context of usage [4]. System is accessible if any target user can understand and use its functions and get their results, irrespective of technical resources and personal disabilities. Accessibility should enable equal access to resources for users with disabilities.
Many sets of guidelines answering the question how to make e-learning course accessible can be found in literature. One of these is IMS Global Learning Consortium's set of general principles and "best practices" [5] helping teacher to develop accessible applications or content for e-learning. The cited document presents six principles guiding author of publication for people who have sensory or mobility impairments:

- allow customization based on user's preferences,
- provide equivalent access to auditory and visual content based on user's preferences,
- provide compatibility with assistive technologies and include complete keyboard access,
- provide context and orientation information,
- follow IMS specifications and other relevant specifications, standards and/or guidelines,
- consider the use of XML.

Detailed guidelines for developing accessible communication and collaboration tools, for developing accessible interfaces and interactive environments, and for ensuring accessibility of specific topics like mathematics and the sciences, are also quoted in this publication.
The problem is that every teacher has been a student and benefits from his personal experience when choosing the best didactical content while preparing a lesson, but the difference between learning experience of an able and a disabled student can be dramatically different. In consequence developed content is not suitable for disabled.

Creating contents for e-learning author have to take into consideration many aspects of his work [4]:

- didactical aspects,
- pedagogical aspects,
- technical aspects,
- usability aspects both for able and disabled users.

SUMMARY

Advantages of modern internet technologies and e-learning solutions presented in the article indicates possibility of using it for continual education of disabled people. E-learning gives disabled people great chance for acquiring skills and good job. For employers it is a chance to obtain good qualified personnel that can be employed in teleworking system or directly in company, considering type of their disability. Most of problems with access of disabled people to e-learning systems can be solved, it is only question of expenditures for hardware, software and creation of courses. All forms of distant learning, like virtual desktop, modeling / simulation, virtual laboratories can be prepared according to the needs of significant amount of disabled people.
Teaching of technical subjects is more expensive than e-learning of not-technical ones because of special software and hardware requirements, but the same situation is with classical technical studies – it is always more expansive than humanities.
Full implementation of e-learning requires changes in organisation of studies. Currently completing the full program of technical studies using only e-learning courses is impossible. Development of e-learning courses by teachers is not remunerated, what is next reason why number of well designed courses is small.

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