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The assessment of teaching materials science subjects using e-learning method

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ABSTRACT

Purpose: The main aim of this article is to present the advantages and disadvantages of the use of blended learning in teaching Fundamentals of Materials Science and Metal Materials. The purpose of carried research is to analyse the effectiveness of e-learning as means of teaching in blended learning model.
Design/methodology/approach: This article includes a description of blended learning; comparison of students' results in materials science between the traditional method and remote teaching using the Internet; dependencies between the effects of teaching and results of students' tests written using the platform.
Findings: This article includes a description of blended learning; comparison of students' results in materials science between the traditional method and remote teaching using the Internet; dependencies between the effects of teaching and results of students' tests written using the platform.
Research limitations/implications: Larger population of students should be tested so as to give measurable results, which would imply what needs to be worked on and what changes to introduce in order to improve the e-learning process.
Originality/value: The document's research material confirms that e-learning makes it possible to use a new form of education which can connect the advantages of traditional learning and remote education in the field of materials science.
Keywords: E-learning; Computer supported education; Moodle; Blended learning; Diversifying power of a task

1. Introduction

The development of computer technology and access to the broadband Internet and increasingly common ownership of the computers in households, make it possible to become more and more common as the means of communication in education. E-learning is most commonly used for trainings of the workers of big companies, public administration and higher education. Lately, it has been more often used in education both on the level of junior secondary school and secondary school, as well as an academic one. In accordance with Central Statistical Office (Polish: Główny Urząd Statystyczny; GUS,), towards the end of the year 2007 only in Poland 54% of the households was in possession of at least one computer, 41% has the access to the Internet, and 39% of people aged 16-74 are regular Internet users [22]. Especially young generation, with students among it, uses this medium very intensely in order to learn. According to the research done in 2005 [23] more than 90% of Polish students admits that the Internet helps them decidedly in their work and study, 53% of students from Cracow is able to write a simple program, and more than 80% of the whole of students in Poland uses the office package efficiently. Such an intense development

of this teaching method is only possible due to the financial support of the European Union. The main aim of the Union programs is the adjustment of education and teaching systems used in European Union to the economy based on knowledge and computer technologies.

Distant learning in comparison to a traditional one may be treated as an additional method, giving extra information or as a replacement of all the existing traditional courses or only of the particular chosen subject. It is especially important in Polish reality, because the number of adults improving their qualifications is one of the lowest among the member countries of OECD. The report of the European Commission and Council for Education, entitled 'Modernization of the education and training systems: an important input into Europe's well-being and social coexistence.' published in 2006, shows that the degree of literacy of people aged 16-65 in our country is high and the education of working people has little connection with the profession they do. The preparation of a new training offer for grown-ups, the one that is not only convenient but also cheap, may turn out to be a very effective stimuli of the competence development for the economy based on knowledge[1-7].

2. Material ve method

E-learning Platform of the Institute of Engineering Materials and Biomaterials was established in October, 2004 as a modern distant teaching tool and contains teaching materials for lectures and materials science subjects as well as instructions for laboratory exercises carried out in the Institute, self-evaluation tests, and virtual laboratories available for authorized students [1, 2, 5]. What is more this Platform is used for interactive communication with students and Institute staff [7]. E-learning Platform of the Institute was also used to test teaching efficacy of the mixed mode method in Fundamentals of Materials Science for year one students of Mechanical Engineering and Technological Institute of the Silesian University of Technology within Fundamentals of Materials Science (PNOM) and Metal Materials (MM) (Fig. 1).

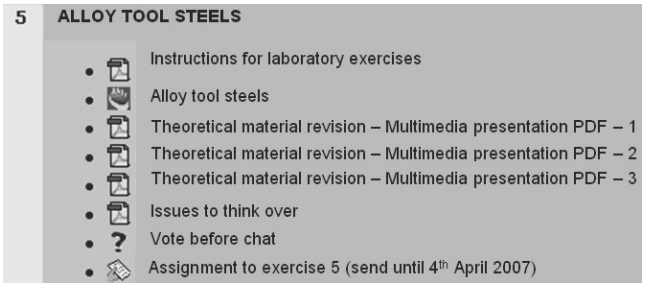

Fig. 1. An example of materials for students on 'Alloy tool steels'

Research was carried out for two terms. Within the first term, the results of teaching were measured in the Fundamentals of Materials Science subject of taught in a mixed mode method to a group of 270 students. Within the second term the measurements were repeated taking into consideration the results achieved by 200 students taking part in the classes connected with the subject of Metal Materials. In both cases students were divided into two equal groups: mixed (in which e-learning method was used) and traditional. In each of the groups students signed for one of the sections of 15 students. Both subjects were taught by the same teachers, each of them was teaching in one traditional group and one that was mixed.

Recruitment commission data and evaluation survey, which was conducted at the end of second term, make it possible to characterize questioned population in greater detail. All respondents had unlimited access to a computer but in mixed groups for 7.39 years and in traditional one for 7.2 years. Only during studies a computer was bought by 3 people from mixed group and 4 from traditional group. While conducting the survey all students owned a computer connected to the Internet (for 4 years on average). During studies 11 people from mixed group and 12 from traditional one started to use the Internet where they lived. The quoted data show that having a computer connected to the Internet was not a reason for choosing a particular teaching method. More than 80% of those polled has no time limit while connected to the Internet (Fig. 2).

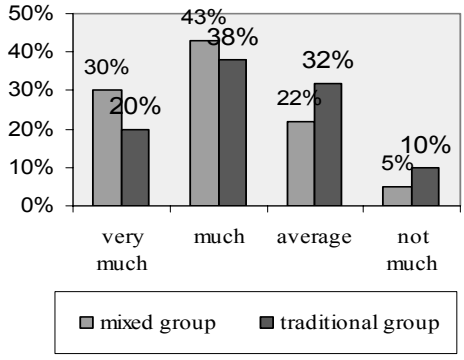

Fig. 2. Time spent on the Internet in student's subjective opinion

Clear differences were observed in the answers to the following question: 'How much time do you spend on the Internet in your subjective opinion?'. Students who chose mixed teaching method use the Internet more often and longer (Fig. 3).

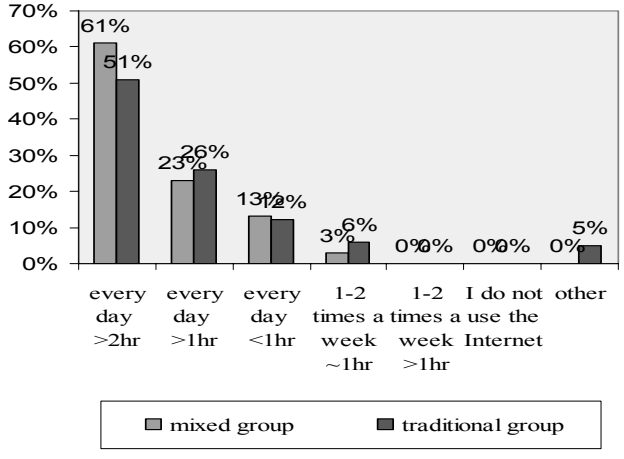

Fig. 3. Time spent on the Internet by the questioned students

On the basis of the results gathered it was found that all mixed group students and 95% of traditional group students are the Internauts, which means that they use the Internet at least once a month, whereas 60% and 50% respectively uses the Internet sources every day for at least two hours. Similar survey [106] was conducted among students of AGH University of Science and Technology in 2005. It was observed there that 49.9% of those polled uses the Internet for more that two hours every day.

The traditional group had two types of classes: in even weeks – laboratory exercises, where students got acquainted with the equipment and made measurements following the instructions and board exercises. In odd weeks, teachers checked whether students were prepared theoretically and discussed the results of measurements, or possibly solved odd exercises. The mixed group, in even weeks, had identical classes with the traditional group, but instead of board exercises they participated in the Internet course *online*, included in the institute educational platform. The combination of distance learning with traditional one within the same subject can be also defined as a complementary education. It is developed in many academic centers e.g.: in Maria Curie-Skłodowska University in Lublin, in Warsaw School of Economics and in Gdańsk University of Technology. [22, 23]

Separate courses were prepared for both subjects. They included the following tools: exercise instructions, presentations, self-evaluation tests, tasks, short tests checking students on their preparation for the synchronous discussion, discussion forum, chat.

Mixed group students could use the platform resources any time they wanted. They simply had to log in using the given password. The time of the chat was set by the teacher and the students. Students were individually informed about the results of tests checking their knowledge with reference to each exercise, as well as about their marks and comments referring to a task. The results of test or marks acquired from the tasks did not influence getting the credit from the subject. The credit was given on the basis of the final test taken by both groups at the same time and checking the same knowledge and skills.

3. Results and discussion

3.1. Result of the research

In Table 1 there are the results of the final test in the Fundamentals of Materials Science (PNOM) and Metal Materials (MM). In the first case each participant could gain maximum 23 points, and in the second one 36.

The results turned out to be very similar for both groups, which may mean, that supporting traditional teaching with the distant teaching is equally efficient as the traditional methods. In the first final test a statistic student got 52% points, whereas in the second one 66.6 %.

Such a big difference seem to result from the following: the weakest students give up their studies after the first term, and also the subject Metal Materials is a kind of continuation of the Fundamentals of Materials Science, which results in a natural increase of knowledge and skills in this area.

To corroborate the validity of the thesis that "the efficiency of education in range of Material Science using mixed method is comparable to the efficiency of education using traditional method", a statistical test of an equality of the two averages was carried out, based on a model which is used when the populations have a normal layout or other and the variances σ_1^2 and σ_2^2 are unknown or finite. The great numbers of the tested populations are bigger than 30, that is why, the verification of the cases of large groups was carried out. A standardized variable value was estimated using the formula:

$$u = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

where : $\bar{x}_1$ and $\bar{x}_2$: average values, s_1^2 and s_2^2 variances, n_1 and n_2: great numbers of groups [24]. On the basis of the results presented in the Table 2 it may be assumed that for the established level of relevance 0.05 the average tests' results from the Fundamentals of Materials Science and Metal Materials are equal for both analyzed groups.

In addition to that, the results of students' education on the former educational stage were compared. It was assumed that the objective criterion are going to be the points assigned by the recruitment commission department because the students have been recruited from the schools in which, both, old and new final exam systems of the high school finals were held (Table 3). Also in this case based on averages equality test there has been approved a thesis concerning the recruitment results' equality for the students of traditional and mixed group.

Table 1.
Statistic description of the final test results from the Fundamentals of Materials Science (PNOM) and Metal Materials (MM)

Subject		The Fundamentals of Materials Science		Metal Materials	
Group		Traditional	Mixed	Traditional	Mixed
Average	points	11.90	11.99	23.94	24.02
	%	51.17	52.13	66.50	66.72
Median . points		12	12	25	25
The highest result. points		21	21	33	32
The lowest result. points		4	5	10	12
Standard deviation		3.04	3.30	4.75	4.02

Table 2.
The averages equality test's results from the final tests

Subject	Variable value U	Value $U_{0,025}$ (from the tables)
The Fundamentals of Materials Science	-0.5876	~ 1.96
Metal Materials	-0.2677	~ 1.96

Table 3.
Recruitment results of traditional and mixed group

Group	Ttraditional	Mixed
Numerical force in groups	104	92
Recruitment results' average, %	35.000	36.457
Standard deviation	16.232	16.391

Table 4.
Correlations between the test results and the average evaluation from the tests on a platform

Subject	Pearson's correlation coefficient	Test value t-Student	Value $t_{0,025}$ (from the tables)
The Fundamentals of Materials Science	0.32145	3.2199	~ 1.99
Metal Materials	0.2106	2.066	~ 1.99

An interesting detailed issue of the research was finding the answers to the question, whether the results of the tests and other tasks solved on a platform are correlated to the final test results for the students who participate in classes in a mixed mode. "Moodle" platform offers the teachers finished reports of students' achievements, that is, marks from the tests and other tasks carried out online, detailed answers for particular open and closed questions. In order to define the relation between these variables, Pearson's linear correlation coefficient was set, and the evaluation of this coefficient was based according to the test t – student.

Values presented in a Table 4 confirmed the fact of the existence of the relationships between the final exam results and marks from the tests and other tasks solved individually and asynchronous in the time of studying with materials prepared.

Ipso facto, there is a justifiable conclusion, that for students' achievements in complementary education of Metal Materials subjects, the biggest influence has got their commitment and systematic work throughout the whole term.

In order to define the level of students' preparation to the studies concerning particular groups who study using different learning methods, the average numbers of points reached in the recruitment process were compared to investigate whether the results gained in former educational stages have an influence on the educational effects during studies. After carrying out the parametric test, the following values have been reached (Table 5). Trying to interpret these results, one may draw a conclusion that on students' achievements during the first term of their studies, the greatest influences have their achievements gained in high school, but during next terms the same influence is smaller and smaller and more and more influence is put on the teaching methods used by academics and students' motivation to learning. For people who already learn during second term using traditional methods no correlation between these variables was found, and in the mixed group the correlation between the examined features was noticed, however, the correlation coefficient is much lower from the analogous to the results from the Fundamentals of Materials Science lectured during the first term.

Table 5.
The correlations between the test's results and the number of points gained during the process of recruitment

Subject	Group	Correlation coefficient	Test's result	Value $t_{0,025}$
The Fundamentals of Materials Science	Traditional	0.3081	3.2707	~ 1.99
	Mixed	0.4528	4.8178	~ 1.99
Metal Materials	Traditional	0.1609	1.6545	~ 1.99
	Mixed	0.2342	2.3106	~ 1.99

There were significant differences stated between the average results in particular sections, in which different teachers were teaching the school (Table 6).

In order to check whether in distance teaching in a mixed mode the teachers who have classes in sections have any influence on the results of students' education, in other words whether any differences noticed are essential, the analysis of variances was carried out. According to the preliminaries, the variances analysis was applied to confirm the detailed thesis, which tells us that averages of the points from the recruitment are equal in particular groups (Table 7). There have been made the calculations for data concerning both, The Fundamentals of Materials Science (PNOM) and Metal Materials (MM), because after the first term the numbers of sections and their personnel have changed. The analysis of variances allows submitting the rightness of the thesis about the equality of the average points gained from the recruitment concerning particular section.

The identical method was applied to prove the thesis of the equality of the final test's results from both subjects, concerning particular sections (Table 8). On the basis of presented calculations it was claimed that in traditional teaching method, the teacher who has classes has also got a big influence on the educational results of the Metal Materials subjects. In mixed method teaching the rightness of this thesis has not been confirmed, so the influence of the teacher on the educational effects is smaller than in traditional teaching. The cause of this kind of variances analysis results is the way of planning and carrying out the classes with the usage of the Internet.

Table 6.
Comparison of the results in particular sections

Section	Group	A	B	C	D	E	F	G	H	I
The Fundamentals of Materials Science	Traditional	10.16	12.93	12.75	11.36	10	12.43	11.4	12.6	13.62
	Mixed	11.33	11.26	12.86	12.27	10.25	11.36	10	12.13	13.67
Metal Materials	Traditional	23.25	26.09	24.04	22.89	25.09	21.42	24.00	25.66	-
	Mixed	24.33	24.00	24.53	24.84	26.83	21.87	17.89	26.25	-

Table 7.
The analysis of the variances in view of the number of points from recruitment in particular sections

Subject	Group	Source of variability		F	Fα, r-1, n-r (from the tables)
		Between groups: r-1	Within groups: n-r		
The Fundamentals of Materials Science	Traditional	8	95	0.9677	~2.03
	Mixed	8	83	1.0394	~2.06
Metal Materials	Traditional	7	97	1.2325	~2.11
	mixed	7	86	1.1197	~2.12

Table 8.
Analysis of the variances in view of the results of the final test in sections

Subject	Group	Source of variability		F	Fα, r-1, n-r (from the tables)
		Between groups: r-1	Within groups: n-r		
The Fundamentals of Materials Science	Traditional	8	95	3.14	~2.03
	Mixed	8	83	1.81	~2.06
Metal Materials	Tradional	7	97	4.36	~2.11
	mixed	7	86	1.82	~2.12

where: F – value of statistics, Fα, r-1, n-r – value of F-Snedecor's fractile

All the didactic materials placed on the educational platform were common to every section. Particular teachers could influence the way of carrying out the classes and its effectiveness only during a textual synchronic discussion, or through the analysis of the students' activeness on the platform.

However, even the big part of the time meant for the synchronic conversations was the discussion on the topic of issues prepared before and common for every section. Naturally the teachers could individually discipline the students to the systematic work, part of the discussion move to the discussion forum, but it should be claimed that better influence on the teaching effectiveness had the regularity of such planned classes.

After the finished experiment an evaluation survey was carried out, it gave much information concerning complementary education of Metal Materials, and also about the way of using the Internet to work, study, and communication. Full discussion on the survey's results will be presented in a doctoral thesis which is being prepared [19]. The most important conclusions are:

- Students accept distance teaching methods and when there is a possibility of choice they willingly use this offer. It also refers to the 29% of the people who studied using traditional mode. (Fig. 4).

- E-mail more and more frequently serves as a communication between students and academics. Only 5% of students from mixed group and 53% of traditional group do not use this method.

Only 3% of students claim that teachers' relation towards this form of communication with students is negative.

From the survey carried out among the teachers who took part in the experiment it appears that almost everyone was satisfied with the possibility of teaching the school with the usage of the Internet. They also suggest organizing training to the teachers before introducing this educational method to the students. Its aim would be acquainting everyone with new tools offered by consecutive versions of "Moodle" platform.

All surveyed people claim that using the Internet in order to communicate with students has much more advantages than disadvantages.

According to study feature, the obtained results can be given in discussion part and/or in the conclusion section.

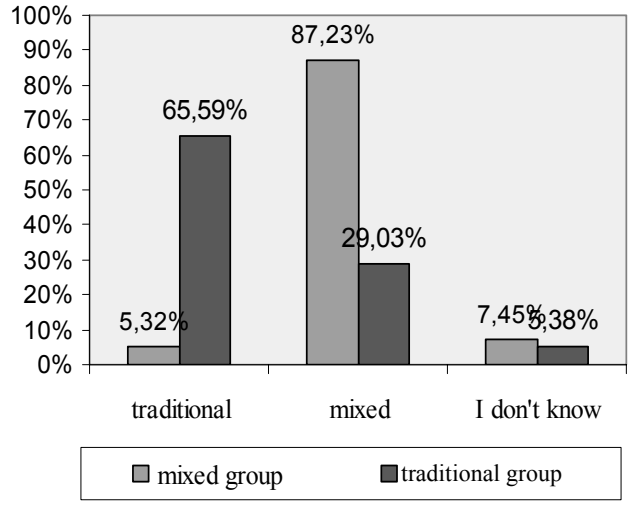

Fig. 4. Results of the survey concerning choosing the teaching method among the students in mixed and traditional group

4. Conclusions

The results of the research allow to draw the number of conclusions. Research results for two courses presented in this article confirm that an e-learning method enables the usage of the new teaching formula, which may embrace the advantages of traditional teaching and distant teaching of the Materials Science.

To the most important advantages of this educational method using the Internet we may include:

- Teaching effectiveness using the Internet is comparable to the traditional educational methods,
- Commitment and students' self-education with the using of educational materials based on a platform has an influence on final results and assures of a convenient way of current improvement control of the students,
- The Internet is a more convenient way of communication between students and teachers and students using the mixed method use this form frequently,
- A teaching method with the usage of the Internet assures the possibility of gaining new skills by the students, they are respected on the labour market, such as tele-work and work in virtual teams,
- A teaching method with the usage of the Internet assures an easy access to studying on different universities, including foreign ones,
- A teaching method with the usage of the Internet assures the possibility of reconcilement common scientific journeys with the didactic work, particularly the so-called independent research workers,

To the disadvantages, or to be more accurate, to the challenges that organizers of complementary education studies with the usage of the Internet must face we may include:

- Increased costs connected with the preparation of the teaching with the Internet conditions, investment costs of the information infrastructure and its exploitation, author's elaboration costs, software materials and didactic support costs, the costs connected with the employment of e-learning experts and finally increased costs of teaching the school by the teachers (during the training phase of the teaching method with the usage of the Internet the teachers pay much more attention to the classes' preparation than in case of traditional method),
- Smaller teacher's influence on the results achieved by the students.

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