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## **The strategy of teaching mathematics using online and the effectiveness of this education**

### **Abstract**

The article presents study results of the author's own research based on courses online at the bachelor's studies - basics of teaching mathematics, a school grade in pedagogical practice and a master thesis – mathematical didactics and neomedia in mathematical education at the Faculty of Mathematics and Natural Science (WMPSNŚ) of University of Cardinal Wyszyński (UKSW). The results reached for the same groups led by the same lecturers using the same method – online on the Moodle platform have been compared (topics related to math and mathematical teaching) but with the use of two different strategies. Strategy I involved classes conducted entirely in the form of lectures, without any exercises – verification tests. Strategy II encompassed lectures and exercises /quizzes checking the degree of students' mastery. The efficiency of teaching with the use of strategy II has been pointed out.

**Key words:** information technology, math, mathematics education, Moodle, online, online education, teaching remote

### **Introduction**

Cyberspace involves; teleworking, cyber manager – the middle and the senior management. Engineering offices, tax advisors, lawyers, public relation consultants, advertising agents, institutions operating without offices and desks. A huge disparity has emerged between the pace of the human brain development and the technological progress. The biological, behavioral level – relationships and physiological or emotional needs in fact reminded on the same level as a few thousands years ago. The enormous progress of civilization, development of technology imposes a definite lifestyle. We are bombarded with the enormous amount of

information at enormous pace. We can compare our life to the train moving at high speed. Education online has its permanent place at our schools.

### **Characteristics of the research community.**

The research was covered by students of bachelor and master degree studies. The author has been creating and conducting online courses with students of mathematics at the Mathematics and Nature Faculty of Science at University of Cardinal Wyszyński (UKSW). At bachelor studies lectures *Basic mathematics teaching and School grade in pedagogical practice*, at studies II degree lectures – *Algebra with elements of didactics. Mathematical didactics and Neomedia in mathematical education*. The contents of all the lectures and exercises relate to mathematical issues.

**Didactic and mathematics courses – DM** (students II degree studies) and **Basics of mathematical didactics - BMD** (students I degree studies) which consist of lectures on: what should a math teacher be like; the emergence and assumptions of KEN; didactic planning, learning objectives, categories of knowledge, learning cycle, stages of learning process, a visual model of class environment, models of education, teacher education system, evaluation of teaching system, different assessment systems, teaching methods, role of evaluation, activating methods, methods of projects and ways of constructing scenarios, surveys and presentations. Each subject referred to mathematics, however, adding a mathematical formula to each of the lecture elements did not seem to be purposeful. The mobilizing factor to systematic work was missing. The activity at the forums was the only requirement for admission to the exam. After completing the pedagogic course the students I degree can teach but on the level no higher than the primary school, therefore the scope of subjects related to teaching only on that level. In case of the students II degree the range of subjects involved the lower and the upper secondary schools.

At the course *Neomedia in mathematical education – NME*, there were tackled such subjects as: cyber society and the process of globalization of education; development and importance of media; nature and characteristics of multimedia education; mathematical education in relation to the Internet; constructivism in mathematical education and new information technologies; competences ( mathematical competence); impact of new technologies on the change of teaching methods, learning mathematics, relationship between the use of online sources and creativity in mathematics, shaping creative attitudes, distance education in terms of cognitive approach; good and bad sides of digital media.

**School grade in pedagogical practice - SGPP**, there are first of all subjects concerning evaluation of mathematical practice: effects occurring at checking the assignments, accuracy and reliability of the tools, role of destructors, preparation of tests, quality analysis of answers, issues concerning statistics and statistical analysis; analysis of difficulties and failures in learning mathematics; evaluating student's assignment, school assessment and evaluation of school education. After each lecture in NME or SGPP the students took the assessment test. Each test could be taken three times. The final result consisted of the average of the approaches. The condition to pass the exercises and enter the exam was to obtain at least 75,0% scores for home assignments – quizzes<sup>1</sup>.

The above were conducted online; therefore, the precise communication between the lecturer and student was important. Table 1 summarizes the types of activities, the number of didactic hours implemented in individual modules and the number of students.

Table 1. Juxtaposition of activities and the total number of participants

Characteristics	Number of didactic hours/semester	Number of respondents	Sex	
			Female	Male
<b>Subjects - I degree studies</b>				
Basics of mathematical didactics	30/winter	54	46	8
School grade in pedagogical practice <sup>2</sup>	60/summer	61	54	7
<b>Subjects - II degree studies</b>				
Mathematical didactics	30/winter	22	18	4
Neomedia in mathematical education	60/summer	22	18	4
Total		159	136	23

Information on teacher's skills and student's abilities could be found in each of the online courses on the platform. There were also discussion forums. The forum – *Let's know each other* started the course. The participants presented their image with a brief description and a photograph. It was followed by: *My readiness to test*, *My e-learning*, *My experience with*

<sup>1</sup> The scale of grades: 50% - 65% satisfactory, 66% - 75% satisfactory+, 76% - 82% good, 83% - 90% good+, 91% - 100% very good.

<sup>2</sup> The lecture concerned mathematical pedagogical practice.

*evaluation, To read and discuss*<sup>3</sup>. Apart from the exam, there was a forum summarizing the subject of the course, the way of conduct, the degree of satisfaction (or dissatisfaction). The student's opinion on this method of teaching did not influence the final grade. The most important for the lecturer were the "customer's" opinions for whom the lecture was addressed. All the comments (particularly the critical ones) allow to introduce adjustments to improve the teacher's skills. The same students took part in DM and NME courses. The same situation was in case of BMD and SGPP where in the latter course only seven new students participated. Therefore, it can be assumed that the groups were identical in terms of students and their interests. The only change was the strategy of teaching with the use of online method<sup>4</sup>. The gender of respondents was not important. However, the vast majority constituted women. Out of 237 students taking part in the experiment 136 were women and 23 men.

The author carried out the research and worked out the results based on the online courses because she wanted to find an answer to the question – *What is the relation between the choice of teaching strategies with the use of online method and its effectiveness?*

## **The research results**

**The tools used:** the Moodle platform, reports of examination carried out on the Moodle platform, reports of the students' ability on the Moodle platform – home assignments on forums, reports of the exam results on the platform, reports of the tests qualifying exercises, diagnosing survey questionnaire designed for students and summary of the examine grades and tests. In order to clarify the formulated application a statistical test U Mann – Whitney was used. The test is an equivalent to the non-parametric student's test.

Four courses of distance learning were subjected to the analysis: **Didactics of mathematics (DM), Basics of didactics of mathematics (BDM), Neomedia in mathematical education (NME) and School grade in pedagogical practice (SGPP)**<sup>5</sup>. Each course was analyzed separately. The grading scale was the same for all the courses. The exams were carried out with the use of online method in the computer room under the lecturer's supervision.

The main **tool** was the Moodle platform and depending on the course, relevant reports. In case of DM and BMD the reports of exams on the platform were used as well as reports on the

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<sup>3</sup> The lecture concerned mathematical pedagogical practice.

<sup>4</sup> Online courses conducted by the author, <http://www.e.uksw.edu.pl/my> [22.08.2014].

<sup>5</sup> The above abbreviations will be used in the further part of the study in order to achieve the greater transparency.

students' activity during the classes on the Moodle platform – home assignments and a diagnosing survey questionnaire designed for NME and SGPP students. Additionally, there were also reports on qualifying tests results.

Strategy I – courses with DM and BMD were conducted exclusively in the form of lectures on the e - platform without qualifying exercises and tests. Within the framework of DM and BMD courses, three discussing forums were held on the platform: *Why do I want to be a teacher? My teacher's education system and Didactic systems, which one would you choose?*

The discussion forums were the only factor enabling the lecturer to control the students' activity. The scope of words and the number of points available for each statement were specified i.e. maximum 17 points.

Strategy II – courses **NME** and **SGPP** lectures, together with workshops were held online on the Moodle platform. Each lecture was supplemented with exercises /quizzes checking the degree of the acquired knowledge. The pass mark, which was simultaneously the admission to the exam, amounted to 75 scores. In each course there were discussion forums and such workshops as: *The most important mathematical achievements in XX and XXI century, Mathematical programs online*. In both cases the same students, who took part in DM and BDM, participated in the classes. Respectively: NME and DM – students of the I degree studies, SGPP and BMD – students of the II degree studies.

## Summary

The obtained data as well as the exploration of the results, achieved by the students participating in the courses, enabled to verify the hypothesis generated by the certain problem (*What is the relation between the choice of mathematics teaching strategies with the use of online method and its effectiveness?*) They revealed that there is a close correlation between the choice of teaching strategies and its effectiveness. The better choice of mathematics teaching strategy with the online method, the better effectiveness of learning:

- Strategy I - online lectures without systematic checking of knowledge – poor exam results.
- Strategy II - lectures and exercises online. Systematic mobilization through solving home assignments and qualifying tests every week. They enable to obtain the pass results, thus to reach admission to the exam – very good exam scores.

Using the appropriate strategy in teaching online, in this case the lectures and testing exercises on e-learning platform, very good results can be obtained, that are confirmed by the final grades at the exams

The studies were carried out on identical groups of students, taught by the same teacher. The only change was the strategy.

**Strategy I** – only lectures online without systematic testing of knowledge for subjects DM and BMD with some work in the form of comments on forums which were evaluated and simultaneously accounted for a pass to take the exam. In case of such courses there were not any reasons to be proud of. The lack of external, mobilizing element – a certain form of coercion. Nevertheless, the most important should be willingness to acquire the knowledge. The results of (anonymous) students’ survey should satisfy the teacher. The exam results ought to be sensational taking into account the intensity of the students’ work. 36,0% of respondents admitted to have systematically prepared to the classes and 40,8% rather systematically. It means 76,8% did it consistently. 69,7% entered the platform once a week to be acquainted with the content of the lecture and 22,0 % once in 2-4 weeks. As many as 27,6% out of them devoted more than 10 hours to implement the course and 35,6% up to 10 hours.

Comparing the results of the examinations for both subjects with scores for activity during the entire course, it should be stated that the home assignments were not too spectacular a factor in mobilizing the students. The answers, in the survey concerning the big involvement, did not affect the grades either. Although in DM (students II degree studies) we mainly observe the maximum values of the home assignments in which there is a huge dispersion in BDM (students II degree studies). However, it does not significantly affect good grades at the subjects. In DM there is a greater percentage rating for good grades – 22,7% and satisfactory plus – 54,6% where BDS for the same grades only 7,4% and 25,9%. In DM there are not any unsatisfactory grades whereas in BDM there are up to 4, table 2.

Table 2. Juxtaposition of the exam results for DM and BDS courses

Subject	Number admittet to the exam	Grades					
		unsat	sat	sat+	good	good+	v. good
<b>DM</b>	22	0	4	1	5	1	0
<b>%</b>		0	18,2	54,6	22,7	4,5	0
<b>BDM</b>	54	4	28	14	4	4	0
<b>%</b>		7,4	51,9	25,9	7,4	7,4	0

**Strategy II** involves lectures and exercises online. Systematic mobilization through solving home assignments every week as well as tests determining the pass results and the possibility to take the exam. The strategy was used in NME.

(students II degree studies) and SGPP (students I degree studies). In both cases the exercises and examination results were very promising. Apart from a few exceptions the students worked systematically. It can be concluded that motivation to action during the whole term resulted in a great number of good grades at the exam. Not only was the information transmitted and read but also brought effects in the form of acquired knowledge, table 3.

Table 3. Juxtaposition of exam results for courses NME and SGPP

Subject	Number admittet to the exam	Grades					
		unsat	sat	sat+	good	good+	v. good
<b>NEM</b>	22	0	0	2	0	7	13
<b>%</b>		0	0	9,1	0	31,8	59,1
<b>SGPP</b>	60	0	1	1	7	16	35
<b>%</b>		0	1,7	1,7	11,(6)	26,7	58,(3)

Strategy **I (S\_I)** for courses - DM for N = 22 and BMD for N = 54.

Strategy **II (S\_II)** was used for courses – NME for N = 22 and SGPP for N = 60.

The differences in the exam results indicate significant imbalance in favor of strategy II (with exercises evaluating the increase of knowledge). In **DM (S\_I)** there were 54,6% (12 people) satisfactory plus in **NME (S\_II)** only 9,1%. (2 people). In NME (S\_II) the grades good plus and very good prevailed 90, 9% (20) and there were no unsatisfactory grades. In the course DM (S\_I) there was not a single good grade whereas in NME (S\_II) good grades constituted up to 59,1% (13). Watchful hand of the lecturer conducting the classes? A detailed juxtaposition of the results has been presented in table 4.

Table 4. A list of the examination results for courses: DM and NME

Subject	Number of students	Grades					
		unsat	sat	sat+	good	good+	v. good
<b>DM (S_I)</b>	22	0	4	12	5	1	0
<b>%</b>		0	18,2	54,6	22,7	4,5	0

<b>NEM (S_II)</b>	22	0	0	2	0	7	13
<b>%</b>		0	0	9,1	0	31,8	59,1

There is a similar situation for **(BMD (S\_I) and SGPP (S\_II))**.

In table 5, the quantitative and percentage juxtaposition of grades at BDM and SGPP exams has been presented. There are substantial differences used for strategy I and II. In **BMD (S\_I)** very good grades are missing in **SGPP (S\_II)** there are as many as 39, in BMD - 28 satisfactory in SGPP as many as 65,0%(39). There were 12 (20,0%) good grades plus in SGPP and in BMD only 4 (7,4%). The number of satisfactory and satisfactory plus grades in both cases was the same, only one student.

Most students believe that according to analysis of the survey, the strategy II was effective. 76,3% said that the evaluation tests after each lecture were an inspiring factor for systematic learning and becoming familiar with the lecture.

67,1% expressed the view that the verification tests, after each lecture enabled to be better prepared for the exam.

The significance of the method, Strategy II has been confirmed with the use of statistical U Mann-Whitney test ( $Z = - 10,26$ ,  $p < 0,001$ ). Therefore, it seems to be appropriate to accept the hypothesis.

Comparison of the results obtained **for the same students' groups led by the same lecturer with the same method** (subjects related to mathematics and teaching math) but with the use of two different strategies generates undeniable conclusions. Strategy II both in the younger group (bachelor) as well as the older (master degree) has brought much better results. Here you can argue whether it is just the strategy or other factors e.g. connected with students' age, previous experience or skills in knowledge acquisition that had an impact on the success of strategy II. Undoubtedly such elements affect an individual in some way. However, as the research has revealed the way of teaching and the role of a lecturer is very important. Constant vigil, systematic monitoring and stimulating to activity the participants of distance learning, passing off interesting topics upon students to provoke their thoughts. The great assignments placed by a lecturer on the platform it is not enough. Classes must live, must be interactive, students must feel and be responsible for them, they must also contribute to the process of learning, exchanging the ideas, have the possibility to correct their own mistakes as well as their colleagues and their teacher's mistakes<sup>6</sup>.

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<sup>6</sup> Ibidem, p.284.

## Conclusion

Distance education, which is in students' demand and has been implemented successfully in many countries, is inevitable. The problem is that we should be well prepared to it not only technically but also intellectually. The awareness of student's different feelings, at the successive stages of participation in distance learning, can help organizers to match the form of material presentation, the content of messages and the frequency of contacts with the participants of the course to their needs, thus enhancing their level of knowledge and satisfaction. The distance learning is successful in teams which have preconceived habits of self-education as a complement to the traditional teaching forms. The verification of self-education online should be done in the traditional way or as the author has done, in a controlled manner (J. Kandzia, 2013, p. 284)<sup>7</sup>.

[The article uses fragments of material contained in the monograph J. Kandzia, 2016, p. 216-235].

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## About the author

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Dr Joanna Kandzia has graduated in mathematics and computer study from the Warsaw University. She has received PhD degree in Education from the Educational Research Institute. An assistant professor at the University of Cardinal Stefan Wyszyński in Warsaw and practicing (certified) teacher of mathematics and computer studies. She conducts workshops and mathematical circles of interests for talented students in secondary schools. The initiator and coordinator of the all-Polish mathematical on-line competition - The Internet Adventure with

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Mathematics. Her research and mathematics interest include various uses of digital media in teaching mathematics. The research and teaching resulted in many publications concerning this sphere of her activity.