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Math Teacher and e-Learning Courses. Report on the Project "Modern Mathematics Teacher"

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Abstract

The article is a report on the project conducted by the author, co-financed by the National Center for Research and Development from European funds POWR.03.01.00-IP.08-00-MOC/18 entitled: A modern mathematics teacher. It was dedicated to teachers of mathematics from all over the country, teaching in primary and secondary schools, and future mathematics teachers – gaining qualifications to teach mathematics. The project aimed to improve the quality and efficiency of mathematics teachers' work through active participation in innovative e-learning courses – offered on the navoica.pl platform, concerning new teaching methods based on information technologies. A short description of the four proposed e-learning courses is presented, as well as an analysis of the choices made by the participants depending on the subject[1].

Keywords: algebra, competition tasks, e-learning, mathematical education, mathematical modeling, mathematics teacher, multimedia

Introduction

Cyberspace is remote work, cyber manager – middle and senior management. Engineering offices, tax advisers, lawyers, publishing consultants, and advertising agents are institutions that operate without offices and desks. A huge disproportion has arisen between the rate of human brain development and technological progress. In contrast, the biological, behavioral – reactions, and physiological or emotional needs remained at the same level as several thousand years ago. The enormous progress of civilization and the development of technology

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[1] The author was the project coordinator and the main contractor, so some of the wording used in the descriptions are similar to those on the WMPSNŚ UKSW website both as well as to the courses on the navoica.pl platform (Kandzia, 2019). https://wmp.uksw.edu.pl/pl/node/525 (2.01.2019).

forces a specific lifestyle. We are bombarded with an enormous amount of information at a tremendous pace. Our life can be compared to a train traveling at high speed (Kandzia, 2016, p. 124).

The rapidly changing reality forces the educational system and management to change. It also influences the methods and forms of work used by teachers. It requires them to know constructivism as a knowledge, cognition, and learning theory. Appropriate skills, acquired by educators using new technologies are: effective contact with learners, arrangement of virtual problem situations that fully meet the criterion of linking with real life and practice, and finally a reliable evaluation of the achievements of each student (Szafraniec, 2013).

The emergence of the media in human life, and thus in education, changed the privileged position of the teacher in transferring knowledge. There is no longer an impeccable expert who wields power over the students. Every teacher should be prepared to use information technology in their daily work. The computer must be a tool used by all educators. Society demands and needs a new role model of a teacher. A creative, imaginative, competent, effective teacher, looking for new constructive and unconventional solutions tinged with humanism, able to apply and use information techniques. It cannot be a person with computer phobia, (Siemieniecki, 2016), technology related anxiety, and resistance to new challenges. The teacher and educator must adapt his habits and patterns and be a conscious director of the play entitled *Teaching* (Kandzia, 2016, p. 74).

The subject matter of the study. Project description

The implemented project (2019–2021) "A modern mathematics teacher" consists of two editions of four thematic courses each (four of the same). The courses were aimed at mathematics teachers and future teachers – students of teaching specialization from all over Poland as well as mathematics enthusiasts (which happened). They were available on the navoica.pl platform. Participants could train in the following areas:

1. Multimedia in the work of a math teacher.
2. Mathematical modeling.
3. Competition and Olympic tasks.
4. School algebra in a new version.

One or more courses could be selected. Each of the subjects is 23 lessons based on didactic lectures and associated exercises for 8/9 weeks. The lectures were recorded and tagged. The materials for each module were available immediately after the beginning of the course and were active until it ended. Participants could work at their own pace. The obtained messages were verified by short tests after each module and an exam at the end of the course. Each participant had the opportunity to share his observations and impressions on the topics

proposed by the lecturer in the related forums and during discussions. Completing the course was conditional on giving 65% correct answers in all tests (including the exam) and resulted in receipt of a certificate. There was no grading applied. It was possible to attempt the individual tests twice while there was only one attempt for passing the final exam (UKSW, 2019).

Analysis of research results. Characteristics of the courses offered on navoica.pl platform

Multimedia in the work of a mathematics teacher (MPNM, 2020)

The course was created and performed by the author. The main goal of the course was to get acquainted with the methodological workshop of a mathematics teacher using digital media while encouraging the application of several information technology tools. The following issues were considered:

− using application programs to present mathematical problems, with particular emphasis on heuristic methods,

− lessons using the educational resources of websites dedicated to mathematics,

− creating math quizzes,

− geometric constructions using the interactive mathematical program GeoGebra,

− new basic skills for online learning, including teacher and student competencies.

The author coordinated the remaining courses and conducted the second edition.

Mathematical modeling (MM, 2020)

The main goal of the course was to discuss the basic tools needed for mathematical modeling of linear problems. Mathematical modeling is a very extensive topic. Hence, the focus during the course relied on discussion of linear problems. The participants gained the ability to calculate the maximization of profits in production plants and the ability to solve further basic mathematical problems such as backpack problem, and transport problem. In addition they learned how the Google search engine sorts results and how to measure popularity on social networks.

The presented issues are:

− introduction to linear programming, presentation of necessary tools,

− discussion of the graphic method,

− discussion of the simplex method with solutions,

− application of the simplex method in Excel, introduction to the Solver add-in,

− using vectors and eigenvalues, using the Google.com search engine.

Competition and Olympic tasks (ZKO, 2020)

The main goal of the course was to get acquainted with the mathematical competition/Olympic tasks of various categories at the level of primary and secondary schools. The presented material in each of the sections provides basic information on a given scope of the material and the analysis of selected tasks that appeared at provincial competitions, Olympic tasks, or more difficult tasks from textbooks. The issues discussed are:
- equations and systems of equations,
- in-plane geometry,
- combinatorics,
- finite probability of events and independent events,
- sequences, arithmetic, and geometric sequence,
- polynomials and algebraic expressions.

School algebra in a new version (ASNO, 2020)

The main goal of this course was to acquire the skills needed to solve tasks in this field and to consolidate the knowledge of school algebra and the content slightly beyond the degree of difficulty applied by current curriculum. Evidence for the claims could be found. The course covered topics such as:
- arithmetic of polynomials,
- Bézout theorem,
- numerical sets and equations, number field,
- complex numbers and operations on complex numbers,
- vectors, operations on vectors, dot product and vector norm, basis vectors,
- numerical sets and equations – operations on matrices, matrix determinants, inverse matrix,
- matrices and systems of equations – matrix form of a system of equations, solving matrix equations.

Analysis of the research results

The study used reports on logins into the platform and a register of issued course completion certificates. The analysis was made based on four courses for two editions. This allowed us to verify the research problems posed:

1. What is the relation between the number of math teachers enrolled in e-learning courses and the number of those completing this form of self-study?

2. Are female math teachers more consistent in achieving goals than male teachers?

Tables 1 and 2 compare the number of participants with the number of certificates issued, split by women and men, and the ratio of obtained certificates to the number of participants, for two editions.

I edition

Table 1. Comparison of the number of participants with the number of obtained certificates, divided into female and male participants

Name of the course	Number of participants		Together	Number of obtained certificates		Total	Percentage of certificates
	F	**M**	**%**	**F**	**M**		**%**
Multimedia in the work of a math teacher	59	8	**67**	44	4	**48**	71.6
Mathematical modeling	62	20	**82**	35	8	**43**	52.4
Competition and Olympic tasks	86	21	**107**	50	15	**65**	60.7
School algebra in a new version	55	8	**63**	43	4	**47**	74.6
Total	262	57	**319**	172	31	**203**	63.6

By analyzing Table 1 it can be stated that most people were interested in the course – Competition and Olympic tasks – as many as 107 participants, whereas 82 people chose mathematical modeling. The other two courses had the smaller number of participants – 67 and 63. The percentage ratio of obtained certificates to the number of participants is slightly different. The most persistent and consistent were Students of school algebra in a new version – 74.6% and multimedia in the work of a math teacher – 71.6% of the obtained certificates in relation to registered persons. Participants of the course – Competition and Olympic tasks obtained fewer certificates, which constitutes – 60.7%; the fewest certificates – 54.2% were completed in the course mathematical modeling. It is worth paying attention to the ratio of the participants' genders: 262 women and 57 men were enrolled. Overall, 172 women – 84.7% and 31 men – 15.3% passed the course.

II edition

Table 2. Comparison of the number of participants and the number of obtained certificates
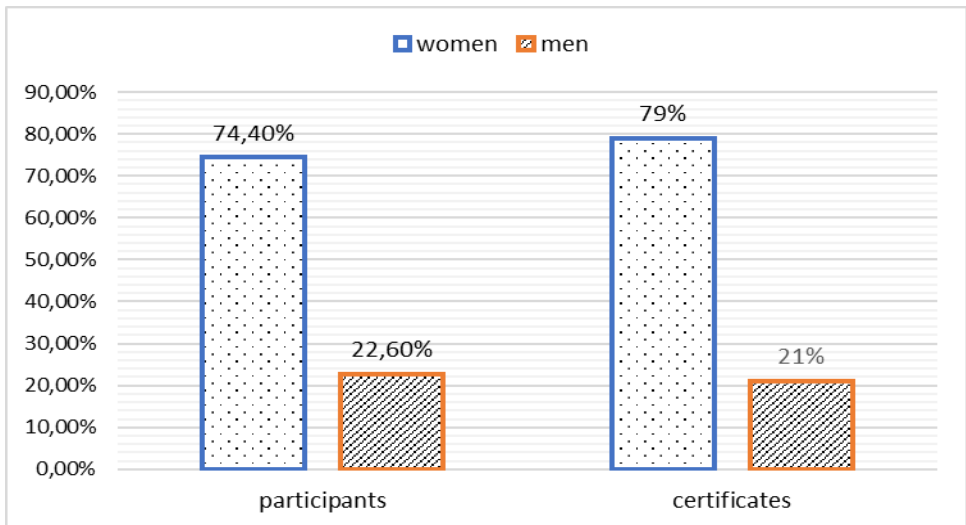
Name of the course	Number of participants		Total	Number of certificates obtained		Total	Percentage of certificates
	F	**M**		**F**	**M**		
Multimedia in the work of a math teacher	33	8	**41**	19	5	**24**	58.5
Mathematical modeling	41	20	**61**	23	12	**35**	55.6
Competition and Olympic tasks	59	22	**81**	23	9	**32**	39.5
School algebra in a new version	39	20	**59**	23	12	**35**	59.3
Total	172	70	**242**	88	38	**126**	52.1

In the second edition, the interest in the courses was much lower, although the course – Competition and Olympic tasks attracted the greatest number of students, as many as 81. In the remaining three courses, the number of students enrolled was comparable. Also, the number of obtained certificates was similar. The highest percentage of obtained certificates was in the course – School Algebra in the new version – 59.3%; Multimedia in the work of a mathematics teacher – 58.5%; Mathematical modeling – 55.6% and Competition and Olympic tasks only 39.5%. In this edition, the training was completed by 88 women, which constitutes 69.8%, and 38 men, which constitutes 30.2% of the total number of participants.

Table 3. Comparison of participation in the courses with the obtained certificates, divided into women and men in the 1st and 2nd editions

Edition	Number of participants				Number of certificates obtained			
	F	%	M	%	F	%	M	%
I	262	82.1	57	17.9	172	84.7	31	15.3
II	172	71.1	70	28.9	88	69.8	38	30.2
Total	434	77.4	127	22.6	260	79.0	69	21.0

Definitely more women continued their self-education compared to men – 434 (74.4%) women and 127 (22.6%) men. 260 (79%) women and 69 (21%) men finished the courses and obtained certificates. The teaching profession is extremely feminized, therefore it is a pleasingfact that so many men have faced the courses. However, the differences between the number of participants and the number of obtained certificates for both women and men are similar and hence comparable.


Graph 1. Percentage comparison of participation in the courses with the obtained certificates, divided into women and men in the 1st and 2nd editions

Table 4. Comparison of the number of participants in relation to the number of certificates obtained during the entire project
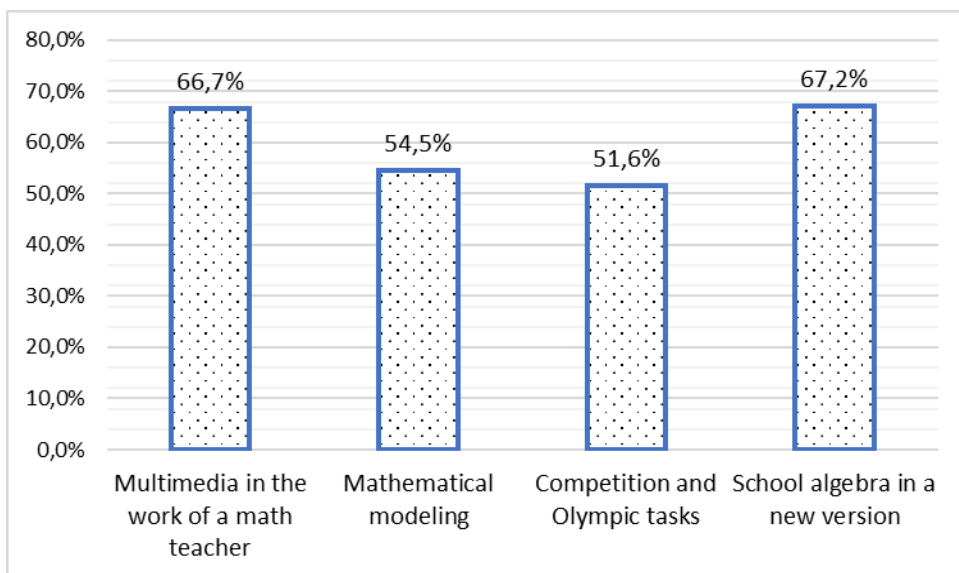
Name of the course	Number of participants	Number of certificates obtained	Percentage of certificates
Multimedia in the work of a math teacher	108	72	66.7
Mathematical modeling	143	78	54.5
Competition and Olympic tasks	188	97	51.6
School algebra in a new version	122	82	67.2
Total	**561**	**329**	56.9

The most popular course was Competition and Olympic tasks which gathered 188 people and graduated 97. Next: Mathematical modeling – 143 people, 78 graduated; The new version of school algebra – 122 people, 82 graduated and Multimedia in the work of a mathematics teacher – 108 people, 72 graduated. 561 people participated in the entire project, and 329 certificates were obtained, which is a ratio of 56.9% graduates.
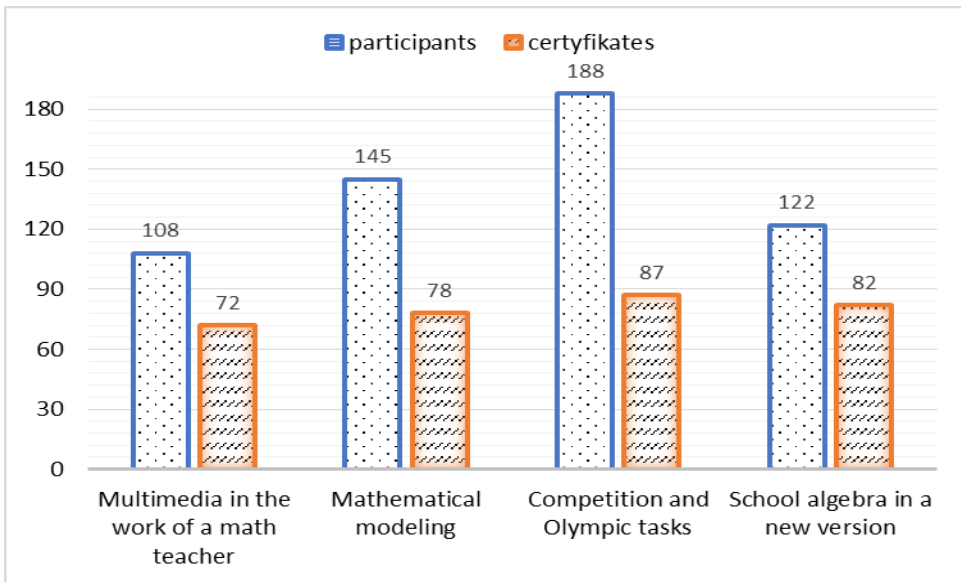
Graph 2. Quantitative comparison of the number of participants and the number of obtained certificates in the entire project

When comparing the number of students enrolled in the course to the number of obtained certificates, the order is opposite to that in the case of participation. The lowest percentage is: Competition and Olympic tasks only 51.6%; Mathematical modeling – 54.5%; Multimedia in the work of a mathematics teacher – 66.7%; The new version of school algebra was in the first position – 67.2%.

Graph 3. Percentage of the number of participants in particular courses which obtained certificates

Conclusions

The presented analysis allows us to answer the research problems provided:

1. What is the relation between the number of math teachers enrolled in e-learning courses and the number of those completing this type of self-study?

2. Are female math teachers more consistent in achieving goals than male teachers?

Ad. 1

Math teachers prepare students for competitions. Therefore it is not surprising that 188 people signed up for the course on competition and Olympic tasks. Unfortunately, only 96 of them completed the course and obtained certificates, which is 51.6%. The situation was similar during the mathematical modeling course – 143 participants and only 73 exams passed (54.5%). In the other two courses the discrepancy is smaller, but the tendency is similar. A relatively large number of enrolled participants certificates. In the first edition, there is observation made of 319 registered participants resulting in only 103 certificates. In edition II – 242 participants but only 126 certificates. Was it fatigue and aversion to taking tests and exams? Was it discouragement and reluctance to take tests and exams? It can be assumed that there were only people who wanted to check what remote teaching looks like in the university edition or compare it to their actual work and what how they potentially could improve. As a result, even without finishing the course by passing the exam, they got acquainted with the materials and this can be regarded as a positive aspect.

Ad. 2

The analysis of the collected data shows that the majority of participants of all courses, both in the 1st and 2nd edition, were women, which also translates into the number of certificates obtained. Furthermore it can be unequivocally stated that both teachers and mathematics teachers were determined to a similar degree when it comes to achieving goals. There were 77.4% of women enrolled, 79% completed it; there were 22.6% of enrolled men, and 21% completed it. The definite difference between the first and second edition shows that there is less interest in the topic in each of the groups.

Summary

The learning comfort obtained by participants of e-learning courses is very useful in self-education. The main advantages are:
 − work at your own pace,
 − refill in the gaps of your knowledge,
 − expand knowledge with new content,
 − meet your own cognitive needs,
 − better prepare for classes, credits, exams, self-education, systematics and creativity,
 − independence in acquiring knowledge,
 − self-responsibility of your education process,
 − learn to respect the opinions and views of other participants in distance learning.

Remote learning, despite many advantages, requires self-discipline, motivation (although it was here – obtaining a certificate), consistency, concentration, good organization, and creativity.

The courses and certification were completely voluntary. They were not a ticket to further stages of education. The obtained results are not surprising. When preparing the project application, the author assumed that the course would be completed by at least 50% of the participants. Initial euphoria and then work. Successful participation in e-learning courses requires appropriate competencies on the part of the students. Not everyone can participate in this form of education.

In online learning, an e-tutor takes a very important, if not the most important role. The quality of the didactic process and who the student will become in adulthood depend on his or her competencies and knowledge. Information and communication competencies constitute an inseparable link in remote education. Basic skills in this area are necessary for obtaining, evaluating, storing, creating, presenting, and exchanging information as well as for communication and participation in networks, and cooperation via the Internet (Kandzia, 2016, p. 72).

When talking about e-mathematics teachers and e-learners in mathematics education, one should remember about mathematical competencies necessary in mathematics education. Teaching mathematics is not only substantive and pedagogical knowledge. It is based on: concept formation, motivations, emotions (psychology); communication, language in learning and teaching mathematics, creating symbols, and understanding them (linguistics); equality and diversity (socio-cultural theories); development of mathematical concepts, historical obstacles to understanding mathematical concepts (history and epistemology); the use of technology in mathematics, the use of computers in teaching mathematics (technology) (Kandzia, 2016, p. 136).

It is not enough to place computers "next to" the student or recommend their use in textbooks. It is necessary to link curricula, teaching aids (textbooks, computers and software) and the methods of their use in teaching mathematics. The condition for achieving success resulting from the use of computers in education is full interdisciplinary integration, i.e., the link of information technology considering every sphere of learning and teaching related to mathematics, in combination with the ability to work with information.

Among the general tasks of the school in the core curriculum, the following statement was included: "Teachers create conditions for students to acquire the following skills: (…) search, organize and use information from various sources, and use information technology effectively" (Fundamental Program, 2014).

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