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The arrangement of on-line training of master students, majoring in Mathematics for internship in technical universities

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Abstract. This article looks into the issue of online-training of master students, majoring in Mathematics for internship in technical universities. This study is focused on arranging students' learning activities with the help of an on-line course "Methods for teaching Mathematics to students in technical universities". The study considers the issues that students face during the internship in technical universities and debates a possibility to factor in the students' needs while designing the course content. The present study gives a description of the activities that students do while working with the course materials, requirements, and recommendations on facilitating the learning process through this course. Active participation of students and their contribution to discussing the course, its content and the facilitation of the learning process presume that introduction of the on-line course and its integration into the program of training master students enhances their readiness for internship.

1. Introduction

Would-be Mathematics teachers in universities are being trained within a master's program. Before writing a master thesis students (the qualification code of the program "014.04. Secondary Education. Mathematics") are to do assistant internship. The objective of the internship is to build the undergraduate students' readiness for teaching in colleges and universities. Among undergraduate students there are always those, who are willing to teach in a technical university, but most of them lack in adequate preparation for such kind of internship and need remote support of their pursuits. The matter is, that in ever-changing educational environment and due to academic mobility, a student who plans to teach Mathematics in a technical university must be able and ready to adapt to the environment, to upgrade and master their skills at all times. This, in turn, urges the development of a



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learning environment, aimed at those students who possess self-discipline and are able to develop their own skills.

Currently on-line courses are being launched and introduced in universities all over the world. About 65% of American universities have already introduced distant learning into their development strategies. In May 2012, Harvard and MIT representatives announced launching a joint project in on-line learning EdX (<https://www.edx.org/>). Two more successful projects of 2012 are Coursera (<https://www.coursera.org/>) and Udacity (<https://www.udacity.com>) that opened up opportunities for thousands of students.

Numerous scientific sources bring into the open certain issues of distant learning (MOOC). Gaytan and McEwen [10], Barakabitze et al. [2] look into learning and assessment strategies, considering them to be the most efficient in the on-line learning environment. Dixon [6], Verschaffel et al. [33] research motivation issues in students who are involved into taking on-line courses. Scott [28] studies a teacher's role in high quality intensive on-line courses. Holzweiss et al. [16], Austin and Gustafson [1], Vlasenko et al. [34] summarize the students' and teachers' experience in on-line learning.

The analysis of these scientific resources proves the necessity of life-long learning and expansive use of information technologies in training specialists for various lines of work. On-line courses are widely used within the system of vocational education in European countries and worldwide.

The demand for on-line platforms, which are actively used by the students, is increasing. For instance, the platform "Teachers of Tomorrow" [30] is used to train teachers who strive for being kept updated on educational processes. On-line format gives teachers an opportunity to develop professionally at their own pace. On-line courses make self-development possible and accessible.

From the experience of researchers Gardner and Gail Jones [9], Yen et al. [38], arranging the activity in any on-line course involves careful selection of content, methods and modes of learning in order to develop students' skills and abilities, required by the objectives of the course. When studying the process of training of students, who major in Mathematics, Vlasenko et al. [35] noted that while designing a course it is important to identify the types of activities specific to the work of a higher school mathematics teacher. Learning the objectives of the internship, according to researchers [35], will allow to choose the types of activities that meet the course objectives. The researchers [35] also advise learning more about the experience of teacher training courses in place.

On-line courses in French offer training for teaching on different educational levels. The course "Graduate Studies" [13] is aimed at life-long learning of teachers. "Teacher Training" [26], "MOOCs Adapted to All Actors in Education" [24] and "Training" [31] help teachers get ready for teaching on all educational levels. The course "Training to Teach in the Superior" [23] offers content for educators, working in universities.

It must be noted, that the above mentioned courses do not contain modules, which would support students in their preparation for teaching career in technical universities. That is why creating a learning platform "Higher School Mathematics Teacher" [14] was regarded as a way to effectively train would-be Mathematics teachers. Undergraduate students in teacher training universities became target audience and users of the platform. The platform concept encompasses developing courses, which might help students get on-line consulting. One of the modules of the platform contains a course "Methods for Teaching Mathematics to Students in Technical Universities" [15], aimed at the students, obtaining their master's degree and who plan to teach at technical universities.

Necessity and timeliness of developing and introducing such a course was discussed at the International Conference on Sustainable Future: Environmental, Technological, Social and Economic Matters (ICSF 2020) [36]. As a conclusion, ultimate need for providing distant support in professional education of students, obtaining the master's degree in Mathematics (the qualification code of the program "014.04 Secondary Educational. Mathematics").

The objective of this research is to look into the description of the activity arrangement in the on-line course "Methods for teaching mathematics to students in technical universities" [15], designed for students who are trained to be Mathematics teacher. Added to that, the present paper displays the outcomes of the process of developing educational content for the on-line course, that is, the selection

of the content, effective forms of developing the learning material, with reference to a preliminary survey of master students and further discussions on the forum.

2. Materials and methods

Prior to drafting the course, the developers found out the problems and difficulties in training would-be Mathematics teachers, which undergraduate students most frequently encounter. For this purpose, questionnaires and pedagogical observation methods were used.

57 master students, in Mathematics (the qualification code of the program “014.04 Secondary Education. Mathematics”) took part in the survey. The respondents are the students of the following universities: Kryvyi Rih State Pedagogical University, Sumy State Pedagogical University named after A. Makarenko, National Pedagogical Dragomanov University, Berdyansk State Pedagogical University, Vinnytsia Mikhailo Kotsiubinskyi State Pedagogical University.

To deal with the issues, which students face during assistant internship, the course developers devised a questionnaire using a free-to-access on-line resource and uploaded it to the platform “Higher School Mathematics Teacher”. The questions were aimed at defining the most typical problems that students encounter while having their internship. Taking account of the students’ willingness to actively and directly participate in selecting and adapting the course topics and materials, the developers engaged undergraduate students into discussion of the course content on the platform “Higher School Mathematics Teacher”. Analysis of the survey and active students' participation in the forum discussion, which contributed to improving the learning materials and choosing topics for the course, is to be presented in the research findings.

Launching the on-line course also means defining the learning activities of its users. For this purpose, Inductive Content Analysis Method of the Internship Programme for master students, majoring in Mathematics (“014.04 Secondary Education. Mathematics”) in Ukrainian Universities was applied. The findings of the analysis are presented in table 1.

Table 1. Analysis of the objectives of the Internship Programme for master students.

Assistant Internship Program in Kryvyi Rih State Pedagogical University [20]
To learn about the basic principles, modes and methods of teaching special disciplines at University; to develop the ability to plan and manage educational and methodological activity of a teacher; to master the methods of designing educational materials in order to use them in the process of training students, who obtain a Bachelor’s degree; to master the methods of running various types of classes at University and managing students’ self-study work; to develop professional teacher competencies; to develop personal qualities, necessary for the job.
Scientific and Pedagogical (assistant) Internship Program in the Bohdan Khmelnytsky National University of Cherkasy [32]
To prepare and run seminars, tutorials and to draft their plans; to do methodological analysis of the educational material in order to anticipate possible difficulties in its acquisition by students; to draft educational materials for seminars, tutorials and self-study work of students.
Scientific and Pedagogical Internship Program in National Pedagogical Dragomanov University [25]
To develop own skills and abilities in future scientific pedagogical activity: to draft plans of lectures, to give the lectures in Mathematics; to draft notes and run tutorials, seminars or laboratory works according to the notes
Internship Program for master students in Berdyansk State Pedagogical University [3]
To develop relevant professional teaching competencies in University teachers; to develop the ability to manage the basic modes of arranging the learning process at University, using modern technologies and teaching methods; to refine the teaching experience, ethical qualities in a University teacher, to develop individual creative teaching style as well as willingness to pursue life-long learning.

The analysis of internship programs at the above-mentioned universities allowed the authors to highlight the types of activities that will ensure the arrangement of the learning process of users of online course.

The course is aimed at giving students an opportunity to learn better various teaching methods, used by Mathematics teachers in technical universities.

The course program consists of three modules.

I. Didactical basics of Mathematics teacher training in technical universities.

II. Basic content of the course “Mathematics” for students of technical universities.

III. Modern technologies for teaching higher Mathematics to students in technical universities.

The duration of the course program is three weeks, the total number of hours – 30. Each week students spend up to 10 hours, allocating 2-4 hours for covering all the activities and exercises. The timeframe is a rough estimate and can be adapted to the students’ needs and capacity. The weekly material is considered to be fully covered, if a student has done all the activities and exercises, allocated for this week and the results are presented on the week’s forum. Video is used to introduce the course and to assess the students’ plans.

The learning process is arranged in the following way: a tutor-presenter outlines tasks for the week, sets timeframes. The start of the first week on the course is chosen by students individually, from the moment of registering for it. Each participant has their own deadlines for the week.

Various resources and activities make the individual work more efficient. Short videos accompany all the documents, which are in a text format and used in order to present the main theoretical points through graphs and tables. The videos show examples of teaching mathematical concepts and notions, giving lectures and tutorials to the students of technical universities.

Covering theoretical material during each week finishes with assessment and taking a test. All the tests in the course are aimed to train the skill, so the number of tries is not limited. A test is passed, when a student gives 60 % of correct answers.

To get prepared for a tutorial, a student has an opportunity to watch a video with guidelines on taking lecture notes, or preparing a set of exercises to be done in class. After watching the video students choose a part of Mathematics they would like to cover and create their own product in line with the weekly task, uploading it to the weekly forum. One of the tasks is checking their course-mates’ tasks and peer assessment, along with discussing it on the forum. Students are provided with assessment criteria to complete this task.

The course also contains resources that can help students to familiarize themselves with examples of using modern technologies in teaching Mathematics in technical universities. Participation in a weekly forum is the main criterion of mastering the course.

3. Results

Master students in their first year of studying made up 35.7%, students in their second year made up 48.2% and students, who recently obtained their master’s degree made up 16.1% of the survey respondents. The question posed was “What are you plans career-wise?” and 41.1% of the respondents answered they would like to pursue a teaching career in a technical university. Most of them are considering obtaining a PhD in this sphere.

The respondents were offered to assess their level of qualification and readiness to teach Mathematics and related subjects in a technical university. The results showed that 10.7% of the respondents consider their level of qualification to be insufficient, 30.4 % of the undergraduates have doubts as to own qualification and readiness to teach Mathematics-related subjects, 25% lack in confidence as to their professional skills for teaching Mathematics.

The findings prove that master students in the final year, willing to work in technical universities, assess own level of qualification as inadequate. 58.9% of the survey respondents have a need to improve their level of professional qualification for future work, which urged developing the on-line course.

The survey respondents joined in a discussion on the course content and materials (see figure 1), as 45.6 % of the respondents consider their theoretical background insufficient to pursue a teaching career in a technical university; 68.4% confirmed their willingness to know more about the concept of computer-aided tutorials and laboratory work classes in Mathematics; 40.4% want to familiarise themselves with a possibility to manage individual work; 59.6% of the respondents see it as a central need to know more about activities and methods, used by a Mathematics teacher, such as preparing lecture notes, exercises and activities for tutorials, etc.

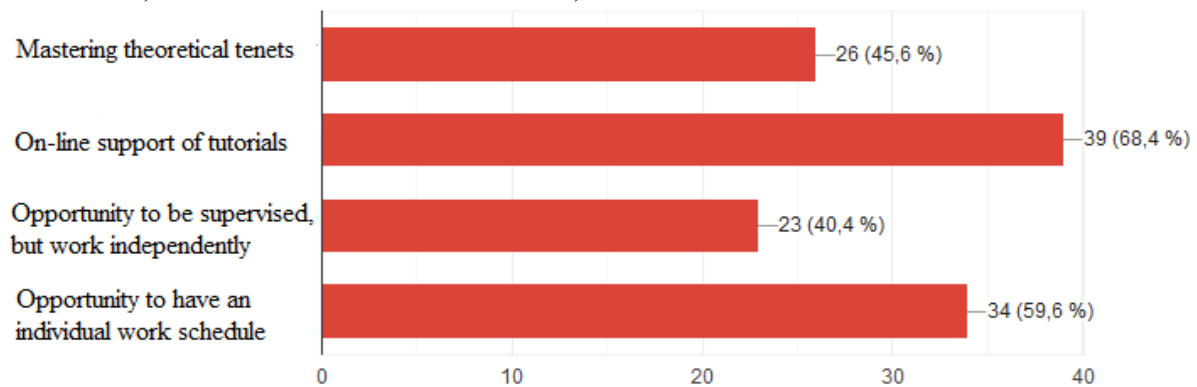


Figure 1. Allocation of the students’ preferences who enrolled in the on-line course.

The respondents’ preferences as to the choice of the forms of learning are allocated as follows (see figure 2): 78.9% of the students emphasize the necessity to have an individual, flexible work schedule; 80.7% of the respondents would like to enjoy the tutor’s support throughout the learning process; 10.5% need support only while mastering theoretical tenets of the course and for 30.4% of the respondents doing internship in a technical university, the tutor’s support becomes a motivator to learn.

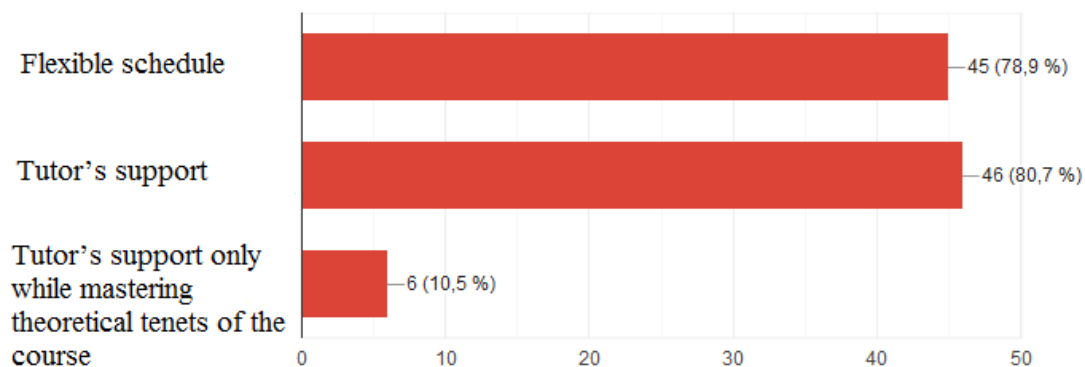


Figure 2. Allocation of the students’ preferences as to the choice of the learning forms.

The students’ responses also helped make corrections to the list of topics (table 2). The students were asked to look into the content of the course “Methods for teaching Mathematics to students in technical universities” and rank these topics according to their relevance: 1 – “The topic is not of relevance for my methodological competence”, 2 – “The topic does not require any special theoretical course”, 3 – “The topic is not relevant in terms of modern requirements for a university teacher”, 4 – “The topic is a must for a would-be teacher”, 5 – “The topic is crucial for my methodological competence as a university teacher”, 6 – “Lack of this topic makes the teacher’s qualification inadequate”.

Table 2. Results of students’ ranking of the topics of the course “Methods of teaching Mathematics in technical universities”.

No.	List of topics for the course	Selection of topics, done by students					
		1	2	3	4	5	6
1.	Course definition and content	12	8	9	16	2	10
2.	Basics of the design of methodological framework	3	5	1	19	20	9
3.	Implementation of the project of a methodological framework	1	2	2	8	19	25
4.	Psychological and pedagogical basics of teaching higher Mathematics to university students	1	4	3	12	15	22
5.	Didactical basics of training Mathematics teachers in the system of higher education	0	2	3	13	15	24
6.	Arrangement of the educational process in the system of training Mathematics teachers	0	3	2	8	22	22
7.	Methodological basics of teaching Mathematics in tertiary educational level.	0	1	1	5	22	28
8.	Teaching methods to give a lecture in Mathematics	1	1	2	13	13	27
9.	Methodology for running tutorials, seminars, laboratory work classes.	1	0	1	9	13	33
10.	Methodology for using Systems of Computer Mathematics when teaching higher Mathematics to students.	0	2	1	14	14	26
11.	Methodology for arranging individual work of students	2	5	3	10	24	13
12.	Methodology for designing a Mathematical project	10	12	12	6	8	9
13.	Cloud technologies in teaching Mathematics	1	3	4	15	16	18
14.	Methods of monitoring and evaluation of the students’ qualification level	15	22	1	10	1	8
15.	Methodology for creating a teacher’s portfolio with the help of cloud services tools.	2	5	4	13	20	13

If, according to the results of the ranking, a topic scored 4, 5, 6 points in most respondents, it became a part of the course program. Thus, master students selected topics 2, 3, 4, 5, 6, 11, 15 as central to enhancing their methodological competence. Topics 7, 8, 9, 10, 14 were also embedded into the course, being selected as important. This allowed the developers to identify 3 modules, aimed at covering methodological, content and technical constituents of training would-be Mathematics teachers in technical universities.

The students’ offers as to the outcome of the training helped choose a certification procedure option (see figure 3). Thus, 38.6% of the respondents offered issuing a certificate of participation according to academic achievements; 19.3% were in favour of pitching a creative project and receiving a certificate of participation; 40.4% of the respondents chose doing internship in a technical university and receiving a certificate of participation.

The course development was accompanied by the comments of the forum participants on the platform “Higher School Mathematics Teacher” [14]. The forum contributed to establishing a two-way connection with the students, who were willing to participate in drafting the course. Upon uploading the course program and materials to the platform, a discussion started on the forum, which played a significant role in making changes and adapting the program and materials in line with the users’ needs. The insights from students helped the course developers select proper forms of learning

and assessment. Moreover, the respondents’ comments on the content of the units to be studied by the Mathematics students in technical universities were taken into account as well.



Figure 3. Allocation of answers to a question “What should be an outcome of training?”

Feedbacks on the methods of assessment, given by the users of the platform also proved to be of use (see figure 4).

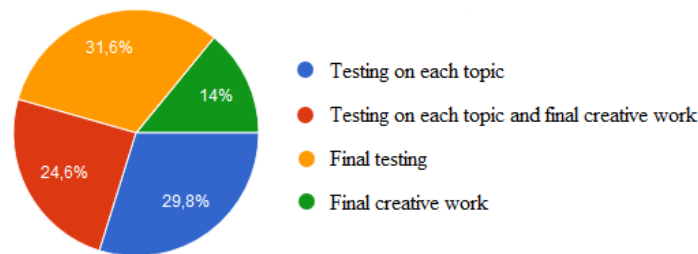


Figure 4. Allocation of respondents to estimation methods of their training at the course.

The study of the impact of the designed course on the efficiency of the arrangement of the students’ learning activities during their assistant internship in technical universities took place over 2019-2020 academic years. The study involved the master students of the second year of study in the above mentioned universities, who had the assistant internship during that period. The experimental group (EG) of students was invited to sign up for the course “Methods of teaching Mathematics in technical universities” [15] while doing their internship. Students of the control group (CG) did the assistant internship without involving the course. The assessment of the internship was done by the same tutors. The internship in technical universities was assessed by the type of activities in accordance with the scoring system developed in the provision ([3], [20], [25], [32]).

The 1st type – to prepare and hold a tutorial on topics “Matrices. Actions with Matrices” (20 points), “Derivative of Function. Physical Content of the Derivative” (20 points);

The 2nd type – to draft a plan of consulting students on the topics of tutorials, to draft assignments for individual work of students on the topic “Derivative of Function. Geometrical Content of Derivative” (20 points);

The 3rd type – to select and prepare learning materials on the topic “Matrices. Actions with Matrices” (20 points);

The 4th type – to make a list of topics for a special course or a workshop “Applied Problems of Linear Algebra”, using systems of computer Mathematics (20 points).

The average score for a definite activity in the control and the experimental groups was calculated as an average of scores of each student in this group.

A student-intern scored 20 points for:

- showing Mathematical literacy in presenting the content of a tutorial, maintaining students’ motivation in class;
- showing applied aspects of studying a topic, interdisciplinary connections between Mathematics and other professionally-orientated subjects of the cycle;

- striking the balance between scientific rigour of teaching abstract mathematical content and its practical applicability;
- managing the audience, skills in using cutting-edge learning technologies.

Figure 5 presents the average score of the selected activities of students of the control and experimental groups.

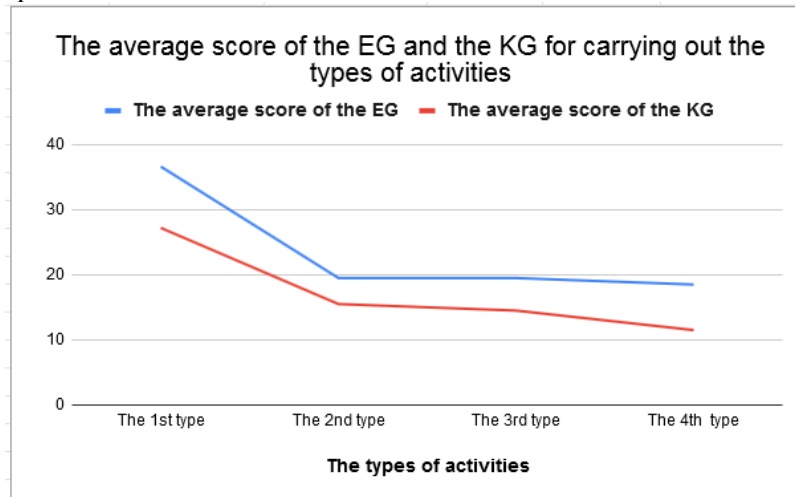


Figure 5. Comparison of average scores of students in the experimental and control group by types of activities during the assistant internship.

Percentage of the indicators in the experimental group and the control group according to the abovementioned types of activities is 34.6%, 25.8%, 34.5% and 60.9% respectively in favour of the experimental group. This fact proves the efficiency of engaging students into enrolling for the on-line course when doing the internship.

4. Discussion

Analysis of the blogs and on-line platforms, such as Inclusive Education [17], Job Test Prep [18], Teacher Certification Degrees [29], and Mathematical Association of America [22] proved our assumption concerning the necessity to consult master students majoring in Mathematics (the qualification code of the program “014.04 Secondary Education. Mathematics”) to be correct. The scientists, looking into the issue of providing the students with support through on-line courses, prove that students tend to learn on-line ([8], [9], [12], [19]).

Before designing the on-line course “Methods of Teaching Mathematics in Technical Universities” [15], the authors of this article studied the guidelines on preparation, structuring and design of on-line materials for courses, the developers studied the guidelines on preparation, structuring and development of on-line materials for courses, devised by FAO [11], DIGICOMP [5] and Leicester Learning Institute [21]. Based on these recommendations (Burgess et al. [4], Donnelly and Agius [7], Vlasenko et al. [37]), we looked at the development of the teaching material for the course from a different perspective. We had to take into account all the demands and desires of the students as users of training. A survey was conducted with the students, who obtain their master’s degree majoring in Mathematics (the qualification code of the program “014.04 Secondary Education. Mathematics”) in order to find out the problems or difficulties they encounter during their assistant internship. Upon receiving the students’ agreement to work with on-line courses and analyzing the Internship Programme for master students, majoring in Mathematics (“014.04 Secondary Education. Mathematics”) in Ukrainian Universities, the developers defined the content, structure, modalities, and materials in order to organize the students’ activities on the course.

The works of researchers, who define the quality benchmarks for on-line courses (Yen et al. [38], Peters et al. [27]), the developers engaged into drafting the high-quality content some educators-experts on Mathematics.

The importance of using imagery (graphs, schemes) and animation was taken account of and helped combine different formats of presenting the materials. To select relevant resources, only verified sources of information, approved by the Ministry for Education and Science of Ukraine were used. Students' comments and feedbacks on the course materials, which were uploaded to the platform, proved the course to be popular with the undergraduate students.

5. Conclusions

Absence of a special program for training master's students to prepare them for assistant internship was one of the decisive factors to develop the on-line course "Methods for teaching Mathematics to students in technical universities" [15]. Students' willingness to get on-line support while doing internship added significantly to its value.

The types of learning activities of the master students majoring in Mathematics were designed based upon the analysis of resources of Ukrainian Universities that provide with objectives of the internship for master students. The content of the course and the learning process are based around the principles of personal orientation, practical implementation, flexibility, independence and voluntariness. It can be easily adapted to the learners' needs. Learners' forum helped improve the course, as through questions, posed on the forum, we found out its flaws. Discussing and taking into consideration the learners' comments and offers helped adapt the course to the learners' needs. Analysis of the feedbacks from the forum participants and their willingness to work with the course shows that the course can be used by the master students to get prepared for assistant internship in a technical university. The effectiveness of involving students in the course during their assistant internship in technical universities was confirmed experimentally. Master students, engaged in the course, showed mathematical literacy and a better understanding of how to motivate learners. They also showed better results in applying active learning tools and techniques to present the applied aspects of the topics and interdisciplinary connections between Mathematics and professionally-orientated subjects of the cycle. The master students in the experimental group exceeded the students in the control group in terms of managing the audience with the help of information technologies and communication strategies.

The findings also make it possible to outline certain lines of work in future research, such as the implementation of the on-line course "Methods for Teaching Mathematics to Students in Technical Universities" [15] into practical training of the 2nd year Master students in teacher training Universities.

6. Data Availability

The [RESULTS OF SURVEY] data used to support the findings of this study have been deposited in the repository https://docs.google.com/forms/d/106_BvuExmTBg6u-QhxzV-RglMIe2K8ZZmBVQc_02iLA/edit?usp=sharing

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