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TRIGGERS FOR THE FORMATION OF PROFESSIONAL COMPETENCE OF FUTURE TEACHERS OF MATHEMATICS

Summary

This paper introduces part of the study of the effectiveness of tools that generate a professionally competent teacher of Mathematics. Design research with focus on learning processes was used as a research model, which have lasted more than 10 years. The methodology of teaching mathematics as an obligatory educational component for future teachers of Mathematics produces means of the professional development in terms of integration and the development of mathematical and methodological competence. First, this is the meaningful filling of classes of all forms with professionally significant material with the systematic use of ICT in the classroom. The means of organizing work in the discipline (laboratory and practical classes) in general and the forms of organization in practical classes (independent work, work in pairs) are important. Among the activities in practical classes, it is worth highlighting the implementation of hands-on training, business games, solving methodological problems.

Keywords: professional competence, methodological competence, future teacher of Mathematics, methodology of Mathematics teaching, laboratory practical, business game, hands-on training, methodological problem

Introduction

The education is a key priority in every country. Thus, the teacher's role is of great importance in the society. John Adams underlined that "teacher is a maker of man. He is foundation of all Education, and thus of the whole civilization of mankind, present and future. No nation reconstruction is possible without the active cooperation of the teacher." In fact, the

achievement of educational goals set by the country depends on the professional competence of teachers. This is noted in many works related to research on teacher competence, for example [1], [2], [3].

Nowadays the competence-based approach is used, and consequently, new concepts in relation to education (for example, professional competence, methodological competence, etc.), began to be used as early as the 60-70s of the XX century. The professional competence is the ability for a specialist to perform his activity, which implies deep knowledge of the phenomena and objects that he transforms, fluency in the content of his own work, as well as the compliance of professionally important qualities of a person with the requirements of a certain type of activity [4]. The professional competence of a teacher of Mathematics is formed throughout the entire study at the University in the process of learning all disciplines of general and professional training. However, the level of formation of the professional foundations primarily depends on the motivational factor, that is, the desire of the student himself to become a professional in the chosen field [5]. The basic factor and significant component of the professional competence is the methodological competence of the teacher [6]. When clarifying the aspects of methodological competence in this research, a specific subject orientation is clearly traced. In our case, this is Mathematics. Let us name the essential properties of the concept of "methodological competence" of a teacher of Mathematics, which were identified by Zatsarynna V. [7]: 1) implements basic and key competencies in accordance with the characteristics of the professional pedagogical activity of a teacher of Mathematics; 2) characterizes the teacher of mathematics at the stage of his professional pedagogical education; 3) manifests itself in his professional methodological activity; 4) the result of the methodological preparation of the teacher, the result of his methodological experience; 5) the axiological component of the professional competence of a teacher of Mathematics, his professional and personal characteristics.

It should be noted that there are different approaches to the interpretation of the concepts of "competence-based approach", "competence", "professional competence", and various models of the professional competence of a teacher of Mathematics have been created [8]. This can be explained by the peculiarities of the socio-economic development of every country, national traditions, and the peculiarities of the formation and the development of the education system [9]. According to the chosen model of the professional competence, each country has established educational systems for teacher training. These systems have both distinct and similar elements and trends.

Kugai N.V. analyzed and compared the training of teachers in Poland and Ukraine. The researcher found out that the volume of hours allocated for general training of a teacher of Mathematics differs most of all, and almost the same amount of hours is allocated for mathematical and methodological training. Besides, she noticed that the significant attention is paid to the study of a foreign language and information technology training of future teachers of Mathematics in Polish Universities [10]. Hodovaniuk T. analyzed and compared the training of teachers of Mathematics in Norway and the USA. This allowed her to determine the basic trends in the development of methodological training for future teachers of Mathematics: improving the content of methodological training in the context of latest achievements and innovative technologies; strengthening the integration component of methodological and mathematical training; increasing the level of independent and research activities; strengthening the connection between theory and practice [11]. Koroliuk O.M. researched the professional training of future teachers of Mathematics at German Universities. She noted that there is a predominance of individual-group, tutor classes, trainings, classes in small groups (3-6 people), the emphasis is made on problem-based, research, situational training, discussions; such methods as modeling, game method, microteaching, project method, case methods are actively used in the classroom [12].

Purpose, subject and research methods

The purpose of this study is to present the part of the research on the use of means for the formation of professional competence of a teacher of Mathematics and their effectiveness.

The subject of the study is the means that launch and form the professional competence of a future teacher of Mathematics.

Design research with a focus on learning processes was used as a research model. According to this methodology, the researcher works out learning paths through the creation and the development of thinking experiments and learning experiments directly in the learning process. This implies a cumulative process of reviewing and testing. The typical aspect for design research are iterative cycles of invention and review; when the assumption is refined during the experiment or between experiments [13]. The most important data, which were carefully analyzed, consisted of observations in the classrooms, mini-interviews with students, discussions with teachers, student questionnaires, written work of students.

Research results

The study started in 2010 at the Ivan Franko Zhytomyr State University (Ukraine). It covered students who planned to become teachers of Mathematics in the secondary and high schools. Questioning of students was conducted periodically, in 2010-2011, 2014-2015, 2017-2018 and 2022-2023 academic years. Accordingly, 195, 79, 46, 32 students participated in the surveys. The decrease in the number of respondents is a decrease in the number of students entering the Faculty of Physics and Mathematics. Falling interest in the profession of a teacher, a teacher of Mathematics in particular is a general trend in Ukrainian Universities.

Based on our own experience in the formation of a professional orientation, the analysis of related studies, discussions with teachers and students, tools that launch the process of forming professional competence and support this process were identified. These means are as follows.

1. A balanced educational program: a judicious mix of the number of hours 1) between educational components that form general competencies and educational components that form professional competencies; 2) between theoretical and practical training (education and internship) of future teachers of Mathematics; 3) between the forms of organization of training within each individual educational component; 4) between the number of hours allocated for classroom work and independent work.
2. Deep interdisciplinary connections 1) at the level of concepts; 2) at the level of methods of activity; 3) at the application level.
3. Appropriate organizational forms of education: 1) forms of organization of education in the discipline in general; 2) forms of educational work in a separate lesson.
4. A professional direction of all studied educational components.
5. Systematic implementation of ICT.
6. The position of the discipline “Methods of Teaching Mathematics” (MTM) as the basis for the methodological training of a future teacher of Mathematics with its local triggers for the formation of professional competence.
7. Scientific and methodological activities of students (research in schools; writing papers, term papers, etc.).

The part of the study that concerned the methodology of teaching Mathematics and its means for the formation of the professional competence of a future teacher of Mathematics is focused in this paper.

The organizational model of the MTM was based on three forms of lessons: 1) lectures; 2) practical classes; 3) laboratory practical. The comparison results of the students' survey on the forms of MTM lessons are shown in Figure 1.

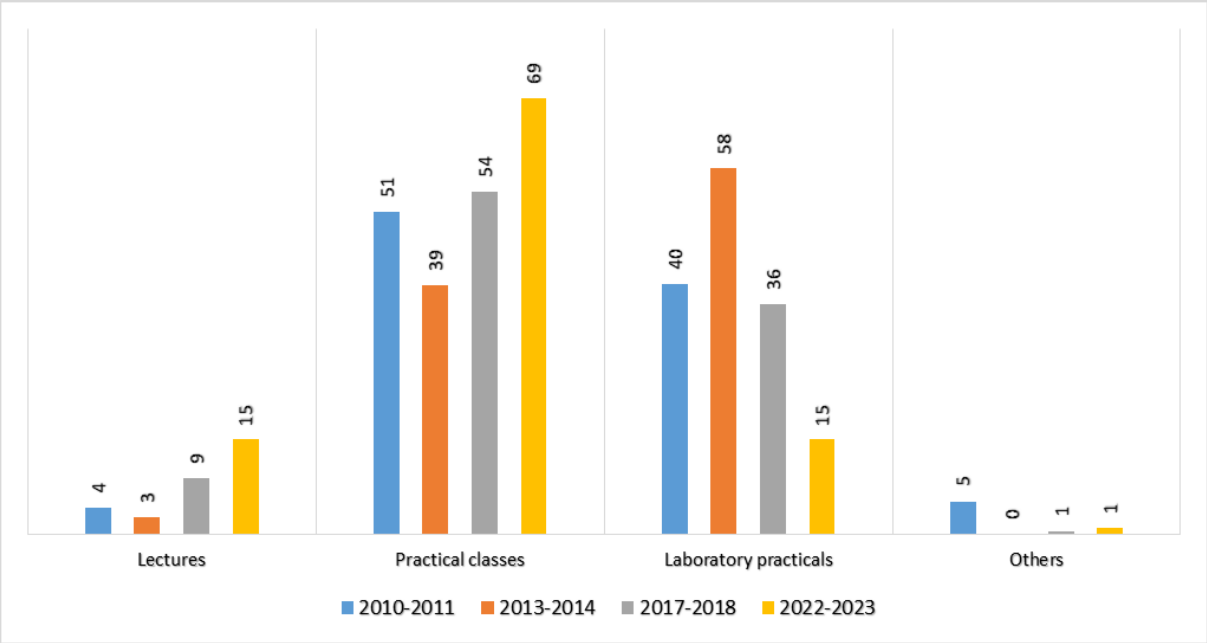

Figure 1. Forms of organizing academic studies in the methodology of teaching mathematics, which are the most useful and effective for acquiring the necessary professional skills and abilities (%)
Source: Own survey on the basis of conducted research

It should be noted that the teacher acted as the main speaker in lectures, he acted as a moderator in practical classes, and the role of the teacher was limited to providing advice to students if necessary in laboratory practical. It should also be mentioned that laboratory practical for the MTM discipline were a new organizational form; before that, students had laboratory practical only in certain disciplines, for example, in Physics, ICT.

The lectures primarily was developed as a presentation of the foundations of theory according to a general methodology, a special methodology with a constant dialogue on the practical (active or passive) pedagogical experience of the participants in the learning process. There was also a discussion with students about the ways of solving, ways of explaining to students the ways to find solutions and solve problems of a particular program topic of a school Mathematics course (MTM). Each lecture had a specific topic and the following headings: 1) motivational aspects; 2) content filling; 3) propaedeutics of study; 4) the basic concepts of the topic and their definition according to the current textbooks; features of the formation of individual concepts; 5) the main statements of the topic, their formulation according to the

current textbooks; features of proving individual theorems, properties, etc.; 6) basic tasks; 7) a list of recommended references.

During the study a chilly relationship of students to the importance of lectures was observed. Therefore, the content of the lectures was changed, and, from our point of view, were filled with contemporary professionally important, content. The vision of the teacher as a specialist who not only has to be able to solve problems in Mathematics and explain to students the necessary program material was the main argument. The teacher of Mathematics must understand the theoretical foundations of the concepts formation, the proof of mathematical statements, finding solutions to problems; know the basic thinking activities and specific mathematical mental activities (summing under the concept and deducing the consequences). However, to convince students of this failed. The students did not see the need for this knowledge for them in the future, they talked about their role in lectures as rather passive listeners. Discussions with them showed that this is especially evident in online learning. Starting from the 2021-2022 academic year, the traditional form of lectures was changed to "flipped learning." Lectures were worked out and sent to students. Then, the control testing was provided according to the theory (using Google forms, Classtime, etc.). And, the practical issues of the basic tasks of the MTM were paid attention directly at the lectures. However, the students did not change their minds, although in the 2022-2023 academic year the percentage of students who appreciated the role of lectures in shaping their professional competence was increased.

Scenarios of practical classes were developed by the teacher with detailed timing. Students conducted practical classes (each stage of the lesson was for a separate student). At the end of each stage, an introspective element was the self-analysis of the presenters and the analysis of each presentation. The analysis was carried out by both the students of the group and a teacher. The following activities were planned for partial classes.

1. Conducting educational games. Such activities included the holding by students of fragments of different types of lessons on certain topics, the role of students in the class was played by classmates.

2. Solving methodological problems. It should be noted that there are not enough problems in the scientific and methodological literature, and a significant part of them required updating. Therefore, in the course of the study, a number of methodological tasks were specially developed [14].

3. Microteaching. Students conducted a survey; prepared historical references, reports on the methodology for the formation of a certain concept, methods for solving a certain type of equations (inequations), etc.

4. Organization and conducting training workshops. The activity was worked out in the following way: 1) students selected basic tasks on a certain topic from existing school textbooks in advance; 2) developed their solution with classmates or the whole group, or in pairs or small groups of 3-5 people (as per instructions, these groups were either heterogeneous, that is, students had different levels of educational achievements, or homogeneous, that is, students had approximately the same level of educational achievements).

Practical classes as a means of their professional growth were rated as the highest by students. At the same time, their relations differ regarding the types of educational activities in the practical classes themselves (Figure 2) and the forms of organization of work in practical classes (Figure 3).

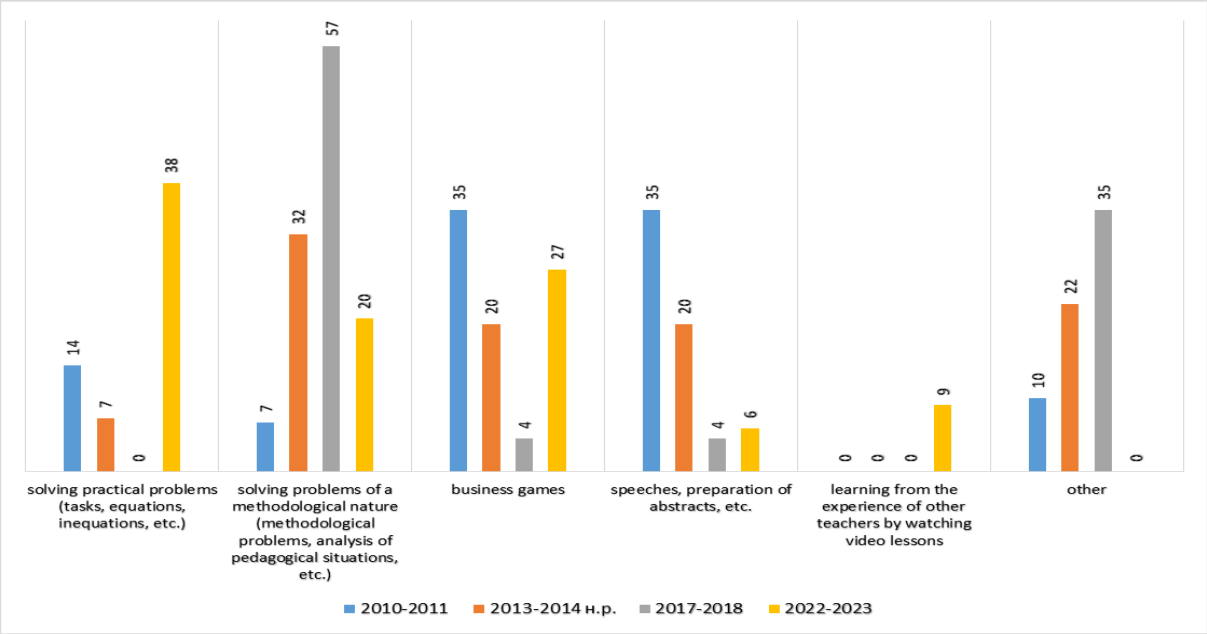

Figure 2. What activity in the practical classes in the main specialty has the best effect on the growth of your professional competence? (%)

Source: Own survey on the basis of conducted research

It should be noted that the students concluded the importance of working in pairs, and individual work. Although a significant percentage of students continued to choose the traditional (frontal) form of work. It is obvious that this is due to their experience in school, where this form of work dominates. In the 2022-2023 academic year, a high level of students' interest in organizing and conducting school workshops was noted during practical classes. In particular, students strived forward to learn how to solve problems of different levels of complexity from school textbooks in the most rational way.

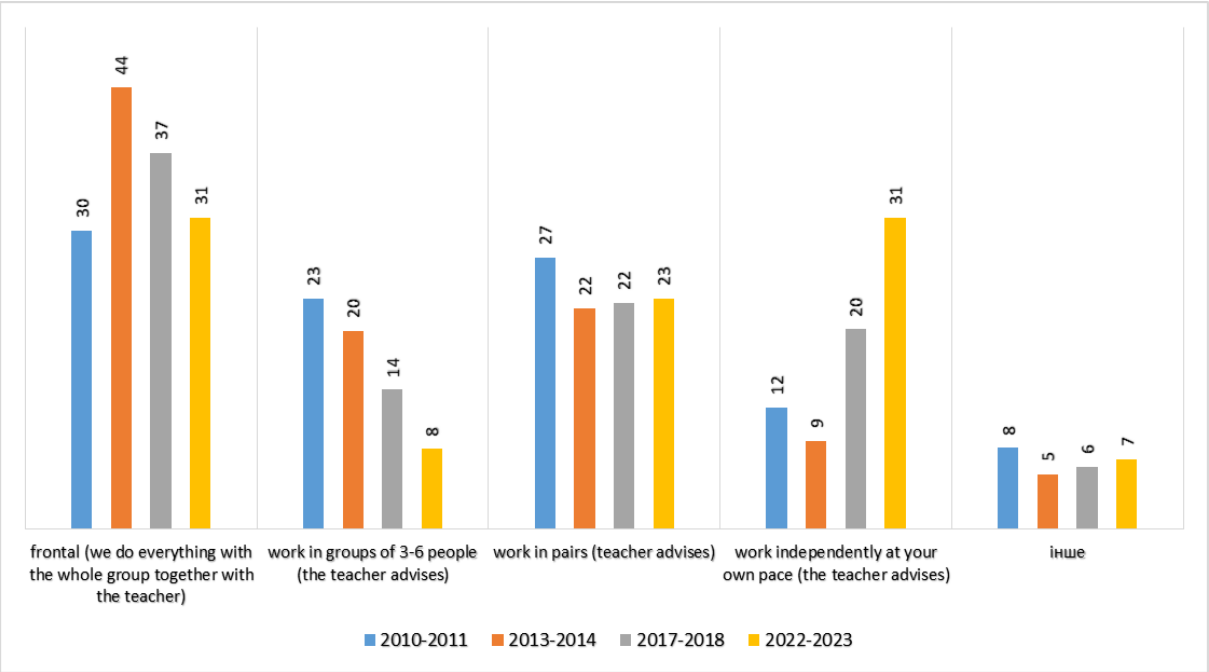

Figure 3. What forms of organization in cma classes are most useful for professional growth? (%)

Source: Own survey on the basis of conducted research

Throughout the study a gradual increase in the professional interest in solving methodological problems was observed.

Table 1. An example of a methodological problem for finding a mistake.

Source: Self-composed methodological problem

Problem. The student solved a homogeneous exponential inequation $36^x - 2\cdot 18^x - 8\cdot 9^x > 0$. Find the *mistake* in the solution and give the correct solution.

Solution. $36^x - 2\cdot 18^x - 8\cdot 9^x > 0$, $6^{2x} - 2\cdot 6^x \cdot 3^x - 8\cdot 3^{2x} > 0 \mid \div 3^{2x} > 0$, $\frac{6^{2x}}{3^{2x}} - 2\cdot\frac{6^x\cdot 3^x}{3^{2x}} - 8\cdot\frac{3^{2x}}{3^{2x}} > 0$, $2^{2x} - 2\cdot 2^x - 8 > 0$. Replacement: $2^x = t$ $(t>0)$, the received inequation is $t^2 - 2t - 8 > 0$. Finding the root: $t_1 = -2$ (extraneous root), $t_2 = 4$, return to the replacement:: $2^x = 4$, $x = 2$.

However, in the 2022-2023 academic year, that was unexpectedly, some of the respondents estimated the importance of their decision for their professional development much lower.

Students rated the importance of microteaching quite low. During the mini-interview, the respondents told that they consider this form of work irrelevant. In particular, they noted that they can find theoretical information such as historical excursions, methodological advice on their own quickly, if such a need arises.

It should be mentioned that in the 2022-2023 academic year, for the first time during all the years of the study, students paid attention to the importance of studying the experience of other teachers of Mathematics. Students responded positively to reviewing and further analysis of fragments of online lessons in Algebra and Geometry taught by Ukrainian teachers (the lessons are posted on the "All-Ukrainian School Online" platform for distance and blended learning, which was created during the pandemic), and they also communicated with the guests - real professionals, teachers of Mathematics of our city - with the great interest.

Instructions for laboratory practical were developed by the teacher. Each lesson had the following components: 1) purpose; 2) tasks; 3) reference book for laboratory practical; 4) requirements for the laboratory report; 5) list of recommended references. The result of the students' activities in each laboratory practical was necessarily a certain result. In particular, it can be the following: scribing presentation; virtual workbook; video lesson, model for a stereometric problem (material), etc. It should be highlighted that each student in the group developed, as a rule, his own separate topic during the lesson. Students considered laboratory practical as a form of conducting MTM classes important. The decrease in the role of laboratory practical in the formation of the professional competence turned out to be unexpected in this academic year. Basically, the students considered completing tasks in laboratory pratical as an expedient activity for them as future teachers. However, in their opinion, they spent too much time doing this. Thus, it was found out that students quite pragmatically evaluate the balance of their efforts to perform certain educational tasks and the result obtained as a contribution to their system of professional competence.

Conclusions

The local MTM triggers for the formation of the professional competence of a teacher of Mathematics were studied. The expectations about lectures as a local CSM trigger for the professional competence were not confirmed. Therefore, the number of hours allocated for lectures has been reduced. Besides, more research is needed on practical activities such as microteaching. It should be pointed out that the study in the 2022-2023 academic years is continuing despite the backdrop of the war (the possibility of shelling, the necessity for students to stay in a civil defense shelter). In our opinion, this stressful situation may have influenced the results of this year-long study.

Thus, after the correction, the above-described MTM model can be considered as a means of the professional development of students. This was proved by: 1) the results of writing

papers after completing the study of the MTM course; 2) approving feedback from teachers during the students' active teaching practice in schools; 3) mini-interviews of students who switched to a personal plan and started working as teachers of Mathematics in a secondary school. Because of the study, new ideas of means for the professional development of future teachers of Mathematics have appeared: 1) the introduction of virtual pedagogical excursions in practical classes on MTM; 2) to practice activities for the creation of methodological and mathematical projects by students.

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