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EDUCATIONAL ENVIRONMENT AS A FORM FOR DEVELOPMENT OF MATH TEACHERS METHODOLOGICAL COMPETENCE

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Abstract. The problem of forming the professional competencies of a math teacher in the process of his (her) training at the pedagogical university and in the system of continuing education is extremely relevant not only in Ukraine but also abroad. This is especially true for the methodological competence of teachers, which largely determines the quality of the educational process in general and student achievements in particular. To solve this problem, we propose to create an educational environment, which, in addition to math teachers, includes specialists in mathematics teaching methods from pedagogical universities, instructors of teacher's in-service training courses, master's students in pedagogical specialties, who, in particular, are trained in dual form of education. As the results of the experiment show, such educalional environment allows to realize professional training of mathematics teachers more effectively and qualitatively compared to traditional methods.

Keyword: Professional training of math teachers; methodological competence; educational environment; dual form of education

INTRODUCTION

The problem formulation

The processes of reforms in Ukraine in the field of education directly affected the problems of training and retraining of a competent math teacher. The system of advanced training inherited from the Soviet times came into conflict with the requirements of the time and began to change to another, not yet clearly defined. Nowadays, in order to pass re-certification, a math teacher should master professionally important courses in psychology, pedagogy, mathematical disciplines, methods of teaching mathematics, etc. within 150 hours. All this he has to determine and study independently (including with the use of online learning platforms such as Ed-Era, Coursera, Prometheus, etc.) and eventually submit to the attestation commission the relevant certificates (MES of Ukraine 2018).

This approach has both positive and negative sides. The positive is that the teacher does not need to attend in-service training courses that are not always useful to him (her), but scheduled lectures and practical classes. There is an opportunity to use this time more effectively for himself (herself), i.e. to study the material that will be both interesting and necessary during working at school. The negative, obviously, is manifested in the fact that the teacher himself (herself) determines what knowledge he should acquire and where exactly to do it. At the same time, it is often difficult for a teacher to independently assess the quality of the offered courses, because he (she) is not able to get appropriate advices from a specialist. Without such advices, teacher training will be formal and ineffective.

The preparation of a math teacher starts from the time the student studies at the pedagogical university. Here, many professional teachers are concerned about the formation and development of his (her) professional competencies (in particular, methodological competence). Appropriate educational programs are created for the future teacher at the university and the educational process is built properly. After graduation, this concern, unfortunately, disappears. However, we believe that it should continue to exist, both for young and experienced teachers.

In 1998 – 1999 we conducted the experiment for math teachers, in which more than 800 respondents of different qualifications of seven regions of Ukraine (Kyiv, Donetsk, Odesa, Ivano-Frankivsk, Volyn, Poltava and Khmelnytsky) took part, showed that math teachers during studying on in-service training courses, would like to improve:

– theoretical knowledge of fundamental math disciplines (algebra, mathematical analysis, geometry, etc.) – 10% of respondents;
– psychological and pedagogical knowledge of the basics of teaching mathematics to students (pedagogy, pedagogical psychology, age psychology, etc.) – 40% of respondents;
– methods and ways of solving problems of the school course of mathematics – 42% of respondents;
– methods of teaching mathematics to students – 58% of respondents.

Young teachers whose work experience does not exceed 5 years have a special need for professional development. They want to get to the in-service courses as soon as possible in order to replenish their knowledge and skills in pedagogy, psychology, methods of teaching mathematics and get higher qualifications. The situation is more different with more experienced teachers. Most of them believe that they have already reached the peaks of pedagogical skills, and passing in-service courses is seen more as a duty than as a real need to improve the professional level.

More than 90% of respondents are in favor of the obligation to improve their skills, citing the fact that it is impossible to focus in pedagogical work only on past knowledge, skills and abilities that are rapidly «aging» in modern conditions. They want to understand the content of new programs in mathematics, requirements for

mathematical preparation of students, strategic directions of development of math education in Ukraine and abroad, theoretical and methodological features of new textbooks, the content of new learning technologies, etc. This will save them from professional burnout, promote the development of methodological competence, ensure the quality of the educational process and student's results.

Thus, there is a need to develop the methodological competence of mathematics teachers in modern conditions, on new principles and opportunities. In our opinion, the creation of an educational environment as a form of in-service training of a math teacher can be effective for the realization of this need.

We define the concept of educational environment as postgraduate continuing education of math teachers within the interested community of specialists – teachers of pedagogical universities, instructors of in-service training institutes, working mathematics teachers (young and experienced), master's students and senior bachelor's students who have connected their future activities with teaching mathematics to students. Such a voluntary and informal association will benefit all its members. For scientists it is a platform for scientific research and methodological developments, for teachers it is an opportunity to develop their professional competencies (in particular, methodological competence), and for students it is an opportunity to join the real educational process at school. Experienced specialists in the field of methods of teaching mathematics have to manage the work of such educational environment.

Analysis of recent research and publications

Ukrainian scientists have an opportunity to discuss different ways of solving the problem of methodical competence formation for future math teachers and development of methodical competence of working math teachers at the traditional conference "Problems and prospects of professional training of math teachers" (Vinnytsia, Ukraine). All materials of these conferences are presented in Matiash 2021. It was during the discussions at these conferences on the partnership between the pedagogical university and the school that the idea of creating an educational environment arose, which was joined by the Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University and the National Pedagogical Drahomanov University, teachers of which are the authors of this article.

Not only Ukrainian Methodists were concerned with such problems. For example, in the United States, the Mathematics Teachers Association established a consortium, the MTE-Partnership (Mathematics Teacher Education Partnership 2020), in 2012. This consortium consists of more than 90 universities and more than 100 school systems. This Association has prepared a fundamental document "Guidelines for the training of primary school mathematics teachers." The guiding principle "Partnership as a foundation" emphasizes the importance of partnership for qualitative prepation of math teachers. We believe that the provisions of the

document "Guidelines for the training of primary school mathematics teachers" may be relevant and interesting for the Ukrainian and European realities of math teacher training.

From the analysis of various modern publications on teacher training in European countries (Daemen 2020, Tatto et. al. 2012, Wang 2003, Shvets et. al. 2020, Matiash & Mykhailenko 2020), we can conclude that the problems of methodological training of future math teachers are almost similar in European countries and in Ukraine. In particular, most European scholars in the field of mathematics teaching methods determine the need for close cooperation between teachers of pedagogical universities who train mathematics teachers and practicing math teachers.

As a result of a certain generalization of foreign practice of methodical preparation of future teachers of mathematics (Mykhailenko 2021) we can say that it is important:

– to diversify the forms of training of math teachers (in particular, introduce a dual form of their preparation);
– to improve the content of educational programs for the training of math teachers; to establish cooperation between teachers of pedagogical universities and working teachers to improve the methodological training of future mathematics teachers;
– to analyze the idea of training coaches to teach math teachers (selection of highly professional teachers who will be able to perform the role of coach, determining the content of coaching and the content of teacher's retraining, highlighting the main forms of cooperation).

In general, the analysis of recent Ukrainian and foreign publications suggests that with the increase in various forms of cooperation between schools and universities, there is a growing interest in empirical research on the diversity and value of these initiatives. In this article, we mostly focused on the problem of developing the methodological competence of mathematics teachers in terms of partnership between the pedagogical university and the school, ie in the educational environment.

The purpose of the article is to determine the essence of a new form of postgraduate continuing education – an educational environment for the development of methodological competence of math teachers and justification of the feasibility of creating such an environment.

THEORETICAL BASIS OF RESEARCH

In the process of many years of research, we came to the following definitions of key concepts for this article:

Methodological competence of a future math teacher is a dynamic combination of methodological knowledge, skills, abilities, certain methodological experience of a student who acquires the profession of math teacher and which he (she) needs

for effective methodological activity on formation of mathematical competence of students.

Methodological competence of a working math teacher is a dynamic combination of his (her) awareness and ability to recognize and solve current methodological problems and analyze the feasibility and critically evaluate the effectiveness of techniques and tools used in the process of methodological activities to form mathematical competence of students.

Methodological competence of a teacher of math methodology is a dynamic combination of his (her) methodological knowledge, skills, methodological beliefs and methodical experience of teaching mathematics students, which are enriched by research experience and which are necessary for him (her) to effectively form methodological competence of future math teachers.

The development of methodological competence in teaching mathematics to students is the acquisition of new and improvement of acquired components of methodological competence in teaching mathematics to students, enrichment of experience in methodological activities.

The educational environment for the development of methodological competence in teaching mathematics to students is a system of partnership between the pedagogical university and schools, which covers the purpose and objectives, content, methods, tools and forms of development of methodological competence of math teachers, future math teachers and pedagogical university teachers that accomplish a preparation of future teachers of mathematics.

It should be noted at once that the organization of an effective environment for the development of methodological competence in teaching mathematics to students is not an easy task, but it is important and interesting. A key factor in such a special educational environment is the creative atmosphere of mutually beneficial cooperation of working mathematics teachers, future math teachers and teachers of pedagogical universities, which provide methodological training for future math teachers. Each of these participants has its own goals, objectives, has its necessary value to enrich the experience of methodological activities of other participants in such a professionally creative environment.

A working teacher of mathematics is a carrier of relevant data on real modern methodological problems of teaching mathematics to students, the current state of affairs with the implementation of modern school reforms, the level of motivation and academic achievement of students. The working teacher of mathematics has real methodical experience in real conditions of students preparation in mathematics. The teacher of the pedagogical university, which provides methodological training for future teachers of mathematics, is a carrier of relevant information about innovations in methods of teaching mathematics in Ukraine and abroad, is a researcher of methodological problems, is a connoisseur of modern scientific findings in pedagogy. Future math teachers are a generation of young people who have

grown up in the age of computer technology, they are closer to students in age, they are not carriers of methodological stereotypes.

We consider active professional communication, mutual trust, joint work on projects in the atmosphere of friendliness and mutual support should be the basis of effective cooperation for the development of methodological competence in teaching mathematics students, for future and working teachers of mathematics, for teachers of methodological disciplines. Our research suggests that such relationships can be a mutually beneficial opportunity to learn together and develop methodological competence in teaching mathematics to students.

METHODOLOGY OF THE RESEARCH

The effectiveness of the formation of methodological competence of a mathematics teacher depends on many factors, each of which plays a specific role determined by its content and direction of influence. The process of development of methodological competence of math teachers requires special organization with strengthening of practical, interdisciplinary and applied aspects. To confirm the correctness of the ideas we held a number of events: tournament of methodological discoveries, competition of methodological talent, master classes of honored teachers of math, scientific and methodical seminars, lectures by experienced teachers of mathematics, scientific and methodological support, publication of the collection of teacher's and student's works "Methodological search", approbation of methodological manuals, scientific-practical conference "Methodological search of math teacher", etc. We just will briefly describe some of the above activities that had a positive impact on the development of methodological competence of all participants in our educational environment.

Since 2017, the All-Ukrainian Olympiad of Geometric Creativity named after Vyacheslav Yasinskyi has been held annually on the basis of the Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University. Well-known in Ukraine specialists in the methods of teaching mathematics of the National Pedagogical Dragomanov University, in particular, the authors of this article, are actively involved in this Olympiad. One of the directions of this Olympiad is the Tournament of methodological discoveries in teaching students of geometry for teachers of mathematics. Teachers of mathematics in the Tournament of methodological discoveries were able to wider professional communication, to exchange of acquired methodological experience, to present their own original ideas and achievements in the field of methodological activities in teaching students of geometry.

The survey of teachers after their participation in the Tournament showed their satisfaction with the opportunity to hear the assessment of their methodological ideas from specialists in the field of methods of teaching mathematics. At the same time, university teachers who teach methodological disciplines for future math teachers, in the preparation and holding of the Tournament of methodical discov-

eries had the opportunity to analyze a significant number of competitive works performed by creative math teachers, to participate in discussions during the presentation of teachers' methodical discoveries, to enrich yourself experience by interesting ideas and techniques.

Since both in the preparation and providing of the Tournament of methodological discoveries took an active part students who qualify as a teacher of mathematics, they were able to observe a competition of the best methodological ideas and beliefs, to compare different methodological approaches to solving typical methodological problems, to participate in the discussion on methodological topics, to gain some experience of immersion in a special educational environment for the development of methodological competence in teaching mathematics to students.

The experience of holding joint methodological meetings of math teachers of different schools and university teachers turned out to be successful. We tested the technologies of collective-group methodological activity, situational learning and technologies of methodological development in the discussions. We also included successful senior master students who performed qualification research in such joint methodological meetings. To ensure parity, we discussed with school administrations the desired topics of speeches by university teachers to mathematics teachers. Thus, it was found that these could be topics of a methodological nature, as well as lectures on elementary mathematics, or the history of mathematics. For example, teachers of mathematics have a significant interest in the issues of deeped mathematics, in the specifics of preparing students for external examinations in mathematics, and so on.

The main basis for conducting master classes by experienced math teachers in our experimental research was the pedagogical university. In the course of the master class the participants get acquainted with new methodological ideas on the topic of the master class, participate in the discussion of the obtained results, ask questions to the master, receive consultations, can offer for discussion their own problems, questions, developments on a subject of a master class, express their proposals for solving the problems under discussion. Our observations in the course of master classes of honored teachers of mathematics of Ukraine (O.V. Kostenko, T.S. Zbozhynska, I.M. Krivosheya, I.A. Kushnir) and surveys of participants of master classes after their holding allow to state a significant increase in interest of future math teachers, as well as teachers of methods of teaching mathematics, to creative methodological activities, to the search for non-standard methods, techniques and means of activating the educational and cognitive activities of students in the process of teaching mathematics.

The authors of this article also systematically hold seminars and workshops for teachers in Ukraine. In a pandemic, these activities are mostly held remotely. In the last 2 years alone, more than 10 author's seminars and master classes have been held for teachers in Vinnytsia, Zhytomyr, Odesa, Uzhhorod, Kharkiv, Cherkasy, Chernivtsi and Chernihiv.

RESULTS OF THE RESEARCH

Let us consider the results of the investigation of indicators of methodological competence in the experimental group of mathematics teachers that work at the school. The experimental group EG-1 included 21 math teachers who took an active part each year in the decribed above forms of partnership between the university and the school. In this experimental group we found out the formation of the following indicators of methodological competence: willingness and ability to present their own methodological experience; readiness and ability to prepare teaching materials; ability to independently and impartially perceive new methodological knowledge or problems through the prism of their own methodological beliefs; knowledge of innovative pedagogical technologies of teaching mathematics at school.

Mathematics teachers were asked to evaluate the statements concerning the development of their methodological competence before immersion in our educational environment, and as a result of participation in the methodological activities of the department in 2017 – 2018 and 2018 – 2019 school years. It was necessary to evaluate each characteristic separately, using a scale from 0 to 3, where the answer is 3 – yes, 2 – more yes than no, 1 – more no than yes, 0 – no. As the result of the survey for each indicator, a maximum of 15 points could be scored. The obtained results were translated into an average score and displayed in the form of a diagram (Fig.1).

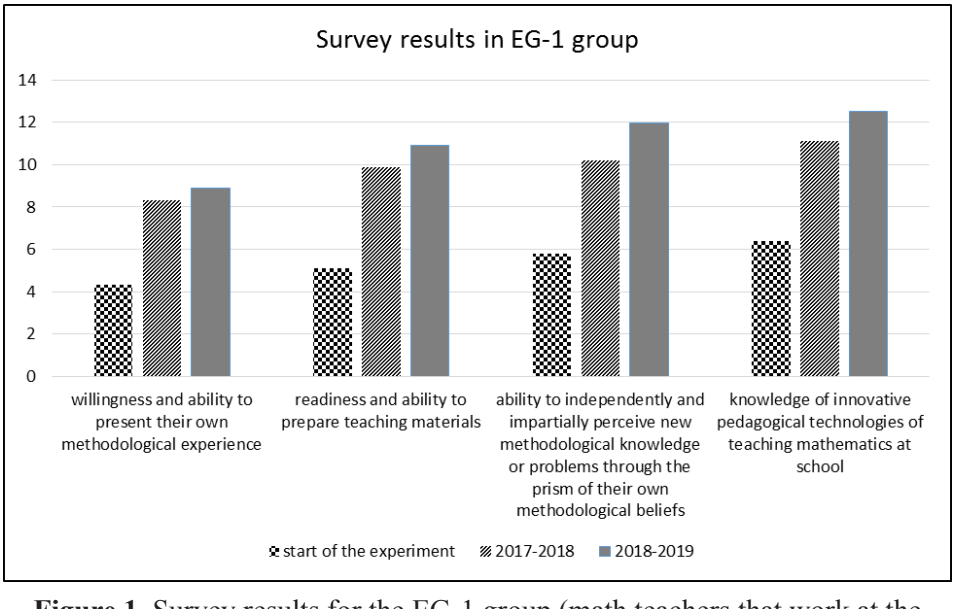

Figure 1. Survey results for the EG-1 group (math teachers that work at the school)

Let us consider the procedure and results of the study of indicators of methodological competence in the experimental group of university teachers who provide methodological training for future teachers (EG 2). The experimental group included 8 teachers of the Department of Algebra and Methods of Teaching Mathematics of Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University, who took part every year in the special educational environment we studied. In this group we found out the impact of our tools for the development of methodological competence on the following indicators: willingness and ability to work with stakeholders to achieve goals in teaching mathematics to students; ability to generate new ideas aimed at improving the process of learning mathematics; awareness of the need for self-education, self-development, self-improvement in teaching mathematics to students; willingness and ability to communicate with colleagues on the problems of effective teaching of mathematics to students.

The rating scale for each of the characteristics for the participants of the EG-2 group was the same as for the EG-1 group. The results of the survey of university teachers, who provide methodological training for future teachers of mathematics, were translated into the average score and displayed in the form of a diagram (Fig. 2).

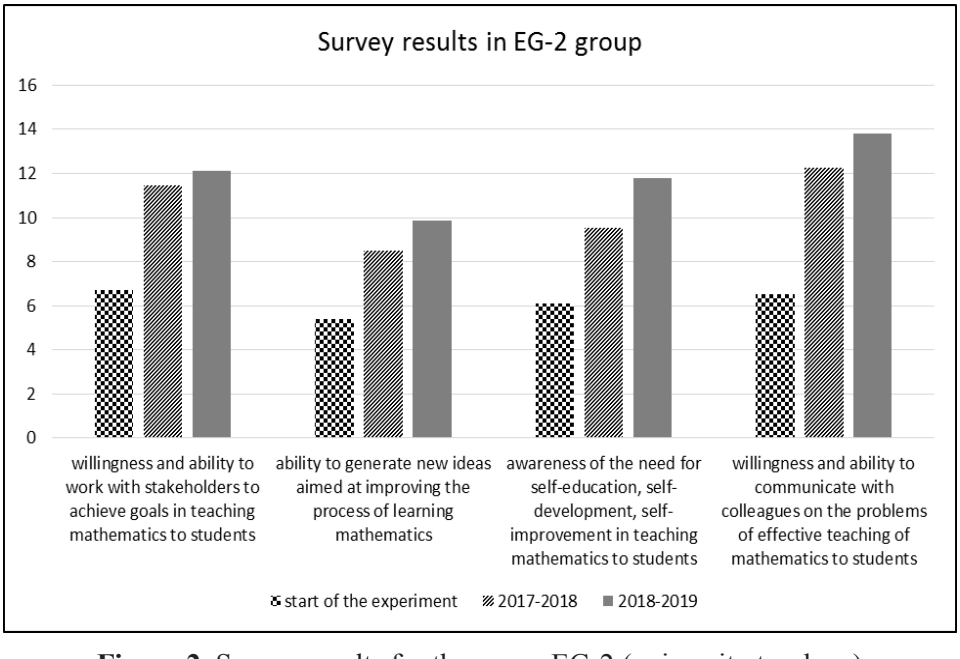

Figure 2. Survey results for the group EG-2 (university teachers)

Statistical analysis of the results of experimental data using Wilcoxon's T-test allows us to conclude that the level of formation of the studied indicators of methodological competence for all experimental groups increased after using experimental tools to influence the development of methodological competence in teaching mathematics to students.

CONCLUSIONS

In the process of observations, during our activities, we saw that reducing the "distance" between school teachers and university teachers, between school teachers and future teachers opens up significant opportunities for the development of methodological competence in teaching mathematics to students, as each learns from another. The process of such joint learning is a valuable result for the methodological growth of mathematics teachers and improves the conditions and strategies for teaching methods of teaching mathematics at the pedagogical university. In this context, the creation of an educational environment that unites all professionals involved in the formation of professional competencies of math teachers is a natural and logical step.

Indeed, mathematics teachers who join the educational environment, summarize their own methodological experience, develop creatively, increase readiness and ability for professional discussion, find professional expertise and recognition of their own methodological ideas and beliefs; future teachers gain invaluable experience of active communication with many creative teachers of mathematics who have different methodological experience and methodological beliefs; teachers of methodical disciplines receive excellent conditions for their own research on methods of teaching mathematics and a creative platform to improve the conditions for the formation of methodological competence of future teachers of mathematics.

A promising direction for the implementation of the educational environment is the dual form of education by future teachers of mathematics. It allows students to acquire methodological competence directly in the process of working at the school under the guidance of both teachers of pedagogical university and experienced teachers-mentors at the school. In our subsequent publications, we will dwell on this aspect of the problem in more detail.

According to the results of our research, the educational environment aimed at the development of methodological competence in teaching mathematics to students is characterized by: regular, well-planned activities; comfortable conditions of cooperation for the exchange of ideas and experience of methodical activity in teaching mathematics to students; variety of forms and means of cooperation; system of incentives to increase motivation for partnership.

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