

Mathematics Teacher's Methodical Competence Development in the Conditions of the University and School Partnership

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The leading idea of our study is that in the conditions of purposeful cooperation between a pedagogical university and a school, the system of methodical competence development of mathematics teachers can be more effective. In the process of research and experimental work, we tested several scientific, practical, and methodological activities with the active involvement of mathematics teachers. The main goal is to find effective ways to establish and expand university-school and teacher-professor cooperation to create an environment based on the university for the mathematics school teachers' methodological development. We emphasize that each form of cooperation involves friendliness and a positive attitude, mutual understanding, responsibility, equality of all participants, shared interests and aspirations, discussion, communication, and mutual learning, which focuses on professional dialogue.

Keywords: mathematics teacher's methodical competence, partnership of the university and the school

INTRODUCTION

The current state of mathematics education at school encourages rethinking and improving mathematics teachers' professional development system. The professional activity of a mathematics teacher is, first of all, pedagogical activity related to the diverse development of pupils in the process of learning mathematics. Modern pupils are a new generation growing in the rapid development of technology, including information. Today it is essential to provide conditions for motivation and increase the ability of modern mathematics teachers to improve and develop professional competence under new challenges. In our study,

we single out the concept of “mathematics teacher’s methodological competence” as a dynamic combination of the abilities of a mathematics teacher to recognize and solve current methodological problems; analyze the feasibility and critically evaluate the effectiveness of the methods used to form the mathematical competence of pupils, their diverse development. Among the current methodological tasks that are now competently solved by mathematics teachers, we include, in particular, the preparation and conduct of mathematics lessons at school based on a deep understanding of modern goals and objectives of teaching mathematics; selection of effective modern means of teaching mathematics; methodically competent and balanced use of various learning technologies, including a computer; ensuring the development of methods of mental activity of pupils in the process of learning mathematics, etc.

We explain our position on the content of a mathematics teacher’s concept and structure of methodological competence as follows. According to the project “Education & Training 2010” Work program, 2004 professional competencies of European teachers are divided into three groups (2004):

- key competencies (necessary for any professional activity);
- basic competencies (that reflect the specific level of pedagogical activity and are based on abilities, knowledge, and skills);
- specialized / subject competencies (that demonstrate the level of mastery of the subject being taught; the teacher’s ability to implement their basic and key competencies in the process of teaching their subject).

Following this approach, in the professional competence of a mathematics teacher, we distinguish

- key competencies (educational, cultural, civic, social, entrepreneurial);
- basic competencies (mathematical, pedagogical, methodological, informational, communicative);
- specialized subject competencies (methodological competence in teaching algebra, methodological competence in teaching geometry, competence in preparing for mathematical competitions, etc.).

This interpretation is consistent with both international trends and leading Ukrainian approaches, which are disclosed in the collective monograph “Competence approach in modern education: world experience and Ukrainian perspectives” (Bibik et al., 2004). Thereby, we can state that the methodological competence of a mathematics teacher is his basic competence, manifested in the conscious ability and willingness to perform quality methodological work (didactic, educational, organizational, and managerial) and a conscious and responsible attitude to professional results.

The Law of Ukraine on Education defines professional development as a continuous process of learning and improving the professional competencies of professionals after higher and/or postgraduate education, which allows a specialist to maintain or improve professional standards and lasts throughout his professional career (Law of Ukraine, n.d.). We consider the development of a mathematics teacher’s methodological competence as a process of transition of a mathematics teacher from one qualitative state to another - higher, from a sufficient level of methodological competence of a pedagogical university graduate to a high level of methodological competence of a teacher, and later, possibly, to the creative level of methodological competence in teaching mathematics to pupils (Matiash, 2014, p.250). Thus, the development of methodological competence of a mathematics teacher is the acquisition of new and improvement of previously acquired abilities of methodical activity. The main idea of our study is that in the conditions of purposeful cooperation between a pedagogical university and a school, the system of development of methodical competence of mathematics teachers can be more effective.

The State of the Research Analysis

The traditional type of professional development of teachers in Ukraine is training in educational institutions that have a license for advanced training or conduct educational activities under accredited educational programs. There are the following types of mathematics teachers’ professional development in Ukraine: internship, participation in certification programs, training, seminars, workshops, seminars-meetings, seminars-trainings, webinars, master classes, etc. Also, an internship with the best pedagogical

workers is recognized in recent Ukrainian educational documents as one of the types of teachers' professional development aimed at disseminating effective practice (Order of the Ministry of Education and Science of Ukraine, 2018; 2019). Diversified, prolonged, personality-oriented, intersectoral models of teachers' professional development have also begun to be more widely introduced in Ukraine.

Our research prompted us to analyze foreign teachers' professional development systems. The international pedagogical community is actively discussing opportunities for cooperation in the professional development of teachers (Robutti et al., 2016; Erens et al., 2019; Matiash et al., 2021; Vanblaere et al., 2021; Mykhailenko, 2021), the possibility of introducing new collaboration technologies that can contribute to the more effective formation and development of methodological competence of mathematics teachers (Daemen et al., 2020; Jackson et al., 2018; Martin et al., 2018; Matiash et al., 2020; Zelkowski et al., 2020; Kolomiiets et al., 2017; Kolomiiets et al., 2020).

Analysis of the literature suggests that social and cultural factors of different countries, such as different philosophical paradigms, pedagogical education traditions, and traditions of teaching mathematics, are essential factors influencing the teachers' professional development, including methodological development (Thurm & Barzel, 2020).

We found that in many countries, the teachers' professional development is provided through teaching and methodical work and learning mathematics lessons, mentoring and coaching programs, cooperation between teachers who work in the school and teachers-leaders or mentors or facilitators, etc., in the process of mentoring during the future teachers' pedagogical practice, etc.

In NCTM (USA), cooperation with colleagues is one of the teachers' primary forms of professional development. The NCTM website states that there is an urgent and growing need for math teacher specialists who can help school math teachers improve their teaching skills. They can organize joint research or discussion groups on the school website, encourage teachers to participate in seminars at the school or district level, facilitate teachers' attendance at professional conferences, and organize the study of professional resources. Leading teachers should possess the appropriate knowledge and experience to advise teachers on the organization of mathematics teaching and the choice of teaching materials. The NCTM website has a separate professional development resources page (see <https://www.nctm.org/Conferences-and-Professional-Development/Professional-Development-Resources/>). The NCTM Academy of Professional Development offers two- and five-day courses throughout the United States that are practical and designed to provide an understanding and application of teaching principles and standards. The illuminations.nctm.org website offers lesson plans based on standards, including interactive applets for pupils to learn and apply math.

Many math teachers worldwide use the free online resource CK-12 to develop their professional competence. There is a separate entrance for teachers (see <https://www.ck12.org/teacher/>). The purpose of CK-12 is to provide tools that will help teachers improve the level of teaching math to pupils. The CK-12 platform offers a comprehensive "Certified Teacher Program." This program is an online, flexible and accessible resource of SC-12. Certificates of professional development are issued with specific hours and topics.

The PRIMAS project (<https://primas-project.eu/>) has developed seven Bowland Math Professional Development modules, which cover the main pedagogical challenges in classroom management, which are involved in research, and unscheduled problem-solving. Bowland's professional development modules are activity-based and built around the specific problems described in the examples. The activity is designed for teachers who work in groups. Self-employed teachers can watch additional videos of teachers discussing issues and trying to conduct their classes with their classes. Each of the seven modules consists of three parts. Introductory session: teachers get together, work on some problems, discuss pedagogical problems, watch videos of other teachers covering one of the problems, and then choose a problem and plan a lesson based on it. Classroom work: each teacher conducts a lesson on a planned topic, guided by the reviewed lessons, instructions, etc. Next session: Teachers meet again to describe and reflect on what happened in the classroom, discuss videos that show teachers' interventions and their pedagogical implications, and plan strategies for future lessons.

Wake, G., Swan, M. & Foster, C. (Wake et al., 2016) described models of professional training for secondary school teachers based on the lessons study. Lesson learning is a form of professional development of a teacher, built around “research lessons,” which are specially developed. The research lesson identifies various ways to improve pupils’ learning. Invited teachers and experts closely monitor the work of pupils in the classroom. After the lesson, there is a discussion in which the lesson planners and observers discuss their observations of pupils’ learning and explore ways in which lessons should be planned to improve pupils’ learning.

Scientists’ pedagogical researches testify that the mathematics teachers’ methodical competence development is effective under the conditions -increase in the teacher’s mathematical and methodical knowledge level, direct practice of the received knowledge and skills application, ability to quickly understand another person, hear, interact, and communicate, improvement of critical thinking and analytical abilities of teachers, development of creativity, ability to implement modern methods, forms of teaching mathematics to pupils, creation of collegial relations and structures that support the continuing education of teachers. In addition, for the mathematics teachers’ methodological competence development, the following elements are necessary - motivation for creative pedagogical activity and teachers’ psychological readiness formation for professional self-development; significant time investment for professional growth; creation of comfortable and favorable conditions for active self-improvement and constant professional development; systematic support of the teacher by the school management; the possibility of receiving financial assistance in the form of grants, awards, prizes.

Thus, the study of the teachers’ professional development at the international level is a multifaceted problem with the possibility of using many different approaches at the empirical, theoretical, and methodological levels.

METHODOLOGY

In our opinion, a modern mathematics teacher should be motivated to develop his methodological competence and independently design his program of personal methodological growth. Mathematics teachers’ involvement in designing their personal methodological development is a necessary condition for the effectiveness of their professional development.

In the process of research and experimental work, we tested several scientific, practical, and methodological activities with the active involvement of mathematics teachers. The main goal is to find effective ways to establish and expand university-school and teacher-professor cooperation to create an environment based on the university for the mathematics school teachers’ methodological development. We emphasize that each form of cooperation involves friendliness and a positive attitude, mutual understanding, responsibility, equality of all participants, shared interests and aspirations, discussion, communication, and mutual learning, which focuses on professional dialogue.

Let us consider the forms of cooperation between a pedagogical university and a school we investigated and tested for the increase of efficiency working mathematics teachers’ methodical competence development.

Olympiad of Geometric Creativity

General Characteristics of the Problem

The readiness and ability of mathematics teachers to solve methodological activities problems in teaching geometry to pupils depend on the formation of relevant methodological skills. Our analysis of the practice of teaching geometry to pupils and the practice of training future mathematics teachers to teach geometry to pupils in pedagogical universities of Ukraine shows that there are problems in providing conditions for the formation of the necessary methodological skills for teaching geometry to pupils. In our opinion, there is a contradiction between the vital place and role of geometry in the formation and development of a pupil’s personality in school and those simple ideas about the methods of teaching geometry, which future mathematics teachers can get in the methodological training in traditional educational organizations. The quality of methodical activity of mathematics teachers in teaching geometry

to pupils at the present stage of development of educational processes in Ukraine does not sufficiently correspond to the social order of society and the state.

Form of Cooperation

Olympiad of geometric creativity in three areas: Tournament of methodical discoveries (for geometry teachers); Competitions for solving geometric problems (for pupils); Competition of creative works in geometry (for groups of pupils under the guidance of a teacher).

Participants of the Experimental Research

University teachers, graduate students majoring in “Secondary education. Mathematics”, mathematics teachers, students - future mathematics teachers, and pupils of 7-11 grades.

Research Organization

The Tournament of methodical discoveries in teaching geometry, for Ukrainian mathematics teachers, is a form of approbation, in the conditions of interactive competition, the pedagogical experience of mathematics teachers in solving problems of forming pupils’ geometric competencies. Methodical findings in geometry teaching to pupils within this Tournament are: original methodological developments aimed at overcoming the problems of teaching geometry to pupils; original development of geometry lessons; original thematic compositions of geometric problems; etc. The Tournament aims to identify the level of methodological and communicative competence of mathematics teachers in teaching geometry to pupils and to create conditions for celebrating, generalizing, and disseminating the best achievements in the experience of teaching geometry to Ukrainian teachers-practitioners. The tasks of the Tournament of methodical discoveries in teaching geometry to pupils: boost mathematics teachers’ methodical literacy in teaching geometry to pupils; identifying and providing conditions for qualifying examination of the author’s methodological developments of mathematics teachers in teaching geometry to pupils; expanding opportunities for mathematics teachers to recognize the positive qualities of their methodological activities for successful certification, reports on implementing plans for self-education, self-improvement, etc.; support and creation of conditions favorable for the development of initiative and active professional position of creative mathematics teachers and students of physics and mathematics faculties of pedagogical universities; establishing professionally significant relationships between mathematics teachers of the city, region, Ukraine, and the faculties of pedagogical universities that train future mathematics teachers; identification of the creative community of mathematics teachers for the experimental base of scientific research for future mathematics teachers.

Mathematics teachers from all over Ukraine are invited to participate in the tournament. After registration, each participant must submit a contest work. Requirements for the contest work are the author’s idea of solving one of the problems of teaching geometry to pupils; description or video recording of the relevant fragment of pedagogical experience. The work must be new, submitted to the competition for the first time, and must not have been previously published in paper or electronic form.

Each registered contest work participates in the correspondence stage of the Tournament, and at least three members of the Tournament jury should write a review. Based on the review results, the number of participants in the face-to-face competition of the Tournament is determined. In 2017, 18 participants were selected; in 2018 and 2019, 12 participants each. These are the examples of competition topics “Using an interactive whiteboard in math lessons”; “Geometry lesson: Circumference and area of a circle. Problem-solving”; “Non-standard (story) lessons in geometry and math classes”; “Methods of preparing high school pupils for external evaluation”; “Motivation in pupils’ learning activities in geometry lessons”; “Geometry lesson of learning new material: A rectangular coordinate system on the plane. Coordinates of the middle of the segment”; “Solids of revolution”; “Pupils’ graphic literacy formation in geometry lessons, technical drawing”; “Elements of geometry in 5th grade”; “Motivation in pupils’ learning activities in the process of studying geometry”; “Geometry of a cube”; “Cartesian coordinates and vectors in space help to solve problems in geometry”; “A prism. Construction of sections by the method of traces”; “Moments of educational and research activities of pupils in the aspect of studying geometry”; “Aspects of preparing

pupils to prove theorems”; “Basic problems in planimetry”; “Geometry lesson of systematization and generalization of knowledge and skills: Geometric and algebraic methods for solving planimetric problems”; “Workshops on geometry for 7th grade.”

Participants of the correspondence stage of the Tournament can receive an invitation from the organizing committee to participate in the discussion of the Tournament face-to-face stage of methodical discoveries in teaching geometry to pupils. Doctors of pedagogical sciences in the specialty 13.00.02 (Theory and methods of teaching mathematics) and mathematics teachers with a high title “Honored Teacher of Ukraine” are invited to work on the jury of the face-to-face stage of the Tournament. The face-to-face stage of the Tournament takes place in the form of a discussion based on the winners’ presentations of the correspondence stage of the Tournament of methodical discoveries in teaching geometry to pupils.

Competition of creative works in geometry (for groups of pupils) under the guidance of a teacher is a form of Competition for educational and research projects of pupils (or groups of pupils) in grades 7-11 of general secondary schools. The purpose of the Competition of creative works in geometry is to identify pupils who are capable of learning geometry, to involve them in research activities, to inculcate the skills of scientific and research work, and to stimulate the pupils’ creative self-improvement. The main task of the Competition is to identify and support intellectually and creatively gifted pupils in geometry, to involve them in research and experimental work, to form an active educational and cognitive position, to cultivate perseverance and the ability to work in a team, the ability to formulate, present and defend own ideas.

Pupils of grades 7-11 of Ukrainian general secondary schools and their teachers can participate in the Competition. The Competition takes place in two rounds - extramural and intramural. During the Competition extramural round, the jury checks and evaluates the participants’ works and determines the winners. The winners of the extramural round are invited to participate in the intramural round. Based on the review results, 6, 12, or 18 participants of the Competition intramural round are determined. The greater the participants’ activity and the competitive work quality at the Competition extramural round, the greater the number of participants in the intramural round.

During the Competition intramural round, the presented works are protected in the form of debates (discussion of works’ problematic aspects). The following types of works are considered in the Competition: problem-referential: an analytical comparison of data from various literary sources to elucidate current issues of geometry or teaching geometry and design options for solving them; creative and rationalizing: improvement of existing, design and creation of new means for teaching geometry. Creative works on geometry should: contain their observations, their analysis and generalization; correspond to the pupils’ age interests and cognitive abilities; be conducted by pupils independently or under the teacher’s guidance.

Advantages of the Proposed Form

Mathematics teachers working in schools, under the Olympiad of geometric creativity, had the opportunity to: wider professional communication, exchange of acquired experience, presentation and recognition of their original ideas and achievements of methodological activity in teaching geometry to pupils. The survey of teachers after their participation in the Tournament proved their satisfaction with the opportunity to take part in the discussion on the actual problems of teaching geometry to pupils, as well as the satisfaction with the opportunity to hear the assessment of their ideas from experts-scientists in mathematics teaching methods. One of our tasks was to create special conditions for mathematics teachers to understand and assimilate a specific environment and models of highly professional behaviour of a mathematics teacher. Mathematics teachers had the opportunity to see the best examples of the methodical activity of creative mathematics teachers. Discussions between mathematics teachers and university lecturers on the actual problems of teaching geometry to pupils allow working teachers to develop their own methodical beliefs.

In particular, evidence of the effectiveness of our proposed form of organizing the cooperation between school teachers and university teachers is that 243 students and 27 teachers from 8 regions of Ukraine, from 14 districts and cities of the Vinnytsia region, took part in our Olympiad in 2018. One hundred forty-eight students and 21 teachers from 6 regions of Ukraine, 14 districts and cities of the region, including 69

students from specialized educational institutions, were invited to the full-time stage of the Olympiad in 2018. Such a creative environment became a training center and a motivator for the mathematics teachers' methodical development.

Scientific and Methodological Seminars

General Characteristics of the Problem

Scientific and methodological seminars are a traditional form of discussion of the scientific research results by university teachers. However, in pedagogical universities, such seminars lack the presentation of points of view on the discussed problem from practising teachers.

Form of Cooperation

Thematic scientific and methodological seminar.

Participants of the Experimental Research

Department teachers, graduate students and students majoring in "Secondary education. Mathematics", mathematics teachers of different schools.

Research Organization

The team department that provides mathematics teachers methodical training ensures the scientific and methodical seminars on the problems of the teaching mathematics methodology. Seminars are held periodically - once per academic semester. The scientific and methodological seminar on the problems of the teaching mathematics methodology involves the presentation of experienced mathematics teachers who have significant achievements in teaching mathematics to pupils. During our experimental research, six such scientific and methodical seminars were prepared and analyzed. In particular, the leading Ukrainian teachers in their speeches focused on: aspects of the mathematics teacher's creative methodical activity; methodical features of working with gifted mathematics pupils; original method of solving geometric problems; specifics of developing and solving test tasks in mathematics; peculiarities of the formation of pupils' logical thinking in extracurricular work in mathematics; interesting techniques for solving logical problems offered at international championships for solving logical-mathematical problems.

According to the program of experimental research, scientific and methodological seminars were investigated by us not only at our university. In order to find effective forms and means of a partnership between the university and the school for the formation and development of the mathematics teachers' methodological competence, the teachers of the department took an active part in the work of mathematics teachers' district methodological seminars. The scientific level of such seminars was provided by the presentations of teachers of methodical disciplines who conduct active scientific research on the problems of effective mathematics teaching to pupils.

Advantages of the Proposed Form

Scientific and methodological seminars proved to be an effective form of stimulating motivation for methodical development for all participants of partnership interaction. Experienced mathematics teachers were able to systematize, generalize and enrich their own experience of methodical activity in teaching mathematics to pupils. Beginning teachers had good conditions for improving their own methodical knowledge and skills in teaching mathematics to pupils effectively. Teachers of methodical disciplines got acquainted with the best pedagogical experience of teaching mathematics to pupils in the process of direct communication with honoured Ukrainian teachers, joined a scientific discussion with recognized practicing teachers, discussion of modern means of effective teaching of mathematics to pupils. We have noticed that participation in such seminars contributes to the acquisition of interest and motivation in pedagogical activity and contributes to the development of methodological competence of mathematics teachers.

Master Classes of Mathematics Teachers

General Characteristics of the Problem

Modern Ukrainian schools, despite the low teachers' salaries, have many creative, highly qualified mathematics teachers. Such teachers need recognition of their achievements, and therefore they are happy to communicate with colleagues and future mathematics teachers. The form of a master class is a good opportunity to present one's own methodological findings.

Form of Cooperation

Master class of a teacher who has significant achievements in teaching mathematics to pupils.

Participants of the Experimental Research

Teachers who are winners of various levels of methodological competitions, graduate students and students majoring in "Secondary education. Mathematics", mathematics teachers, and department teachers.

Research Organization

According to the experimental research program, namely, with the aim of finding effective forms and means of a partnership between the university and the school for the formation and development of the mathematics teacher's methodological competence, the methodological department organized a number of master classes for mathematics teachers who became winners of various levels of methodological competitions.

During master classes, mathematics teachers demonstrate their own methodical ideas for an interesting lesson and the rules for a successful lesson. Teachers share their own methodological developments, present their own websites and share their e-library of methodological findings and videos of their own mathematics lessons.

Advantages of the Proposed Form

A master class is one of the forms of effective professional active learning. It differs from a seminar in that during a master class the teacher tells and, more importantly, shows how to apply a new technology or method in practice. During the master class participants get acquainted with new methodical ideas on the topic of the master class; take part in the discussion of the obtained results; ask questions and receive consultations; can offer to discuss their own problems, questions, and developments on the topic of the master class; express their proposals for solving the discussed problems.

Approbation of Methodical Manuals

General Characteristics of the Problem

The most common ways of proving the practical significance of the dissertation work materials are the participation of the recipient in scientific and methodical conferences, speeches at department meetings, publications of books, articles, reports at conferences, etc. However, if we consider the dissertation materials in the direction of the theory and methods of teaching mathematics at school, then the most desirable is the approbation of teaching and methodical manuals prepared within the dissertation by practising teachers. Studying and researching the methodological content of the proposed manuals by mathematics teachers working in the school and evaluating the quality of these manuals can be an important means of establishing cooperation between teachers and teachers of methodological disciplines.

Form of Cooperation

The approbation of teaching and methodical manuals prepared at a pedagogical university for mathematics teachers, or review by university teachers of mathematics teachers' methodological developments.

Participants of the Experimental Research

Mathematics teachers of partner schools, graduate students and students majoring in “Secondary education. Mathematics”, department teachers.

Research Organization

In the conditions of our study, the approbation of manuals for mathematics teachers were tested at the department per the Regulations on the Approbation of Educational and Methodical Manuals on Mathematics Teaching Methods that were developed by us. To research the partnership forms between a pedagogical university and a school suitable for increasing the effectiveness of the mathematics teachers’ methodological competence development, we proposed to the mathematics teachers methodological association of Nemyriv, Kozyatyn and Vinnytsia districts during the academic year to implement methodological recommendations for the mathematics teaching to pupils. They are substantiated in the dissertations of the department’s graduate students. Teachers received appropriate sets of methodological developments for conducting experimental research. Based on the results of testing the materials proposed by the department, mathematics teachers prepared detailed reviews.

Advantages of the Proposed Form

The advantage of this form of partnership is the familiarization of teachers (future and working ones) with the latest developments in the field of mathematics teaching methods, the opportunity to implement these new ideas in the educational process; the opportunity to improve and expand one’s methodological knowledge and skills. We will also point out the possibility for teachers to develop experience in conducting approbation and monitoring studies of methodical literature. The department’s teachers actively use methodological developments of graduate students during practical exercises on mathematics teaching methods, which motivate future mathematics teachers to monitor the results of scientific research in the field of mathematics teaching methods. The department is forming a bank of original methodological developments, tested in the actual conditions of the school educational process.

Scientific and Practical Conferences

General Characteristics of the Problem

The main purpose of scientific and practical conferences on the methodology of teaching mathematics is to increase the participants’ interest in active scientific research of the actual problems of teaching mathematics to pupils; to promote the formation of scientific connections between educational and scientific institutions.

Form of Cooperation

Discussion of the mathematics education problems in Ukraine; discussion of possible ways to overcome the school mathematics education problems; effective methodical experience exchange in teaching mathematics to pupils.

Participants of the Experimental Research

Experienced university teachers of mathematics teaching methods, students majoring in “Secondary education. Mathematics”, and mathematics teachers of partner schools.

Research Organization

Since 2009, once every three years, the department’s faculty has organized and held an International Scientific and Practical Conference on «Problems and prospects of professional training of mathematics teachers. Our experimental studies in the conditions of this conference concerned the means of partnership interaction between teacher-researchers and lecturer-scientists. The international scientific and practical conference gathers a broad representation of people concerned with the mathematics education problems in Ukraine every time. We actively invited mathematics teachers from Vinnytsia and Vinnytsia region to the conference as listeners and speakers in all directions of the conference. In the context of the International

Scientific and Practical Conference, mathematics teachers had the opportunity to communicate directly with the authors of school mathematics textbooks in Ukraine (N.A. Tarasenkova, V.O. Shvets, O.V. Kryzhanovskiy, H.I. Bilianin, S.O. Skvortsova, V.H. Bevz); with the authors of the test tasks of the external vocational training in mathematics (O.V. Shkolnyi); to hear first-hand advice on their practical use in the educational process. The scientific and practical conference participants discuss possible ways to overcome the problems of mathematics teachers' professional training.

According to our experimental research program, since 2018, we have held the annual All-Ukrainian scientific and practical conference "Methodical search for mathematics teacher". The thematic directions of the conference change annually: "Modern innovative technologies for teaching mathematics to pupils"; "Actual tasks of implementing the concept of the New Ukrainian School"; "Strategies of school - pedagogical higher education partnership"; "Monitoring of mathematical competences as a pedagogical problem"; "Pupils' mathematical modelling skills formation"; "Formation and development of students' logical competence"; "Creating mathematical problems"; "Different methods of solving the same mathematical problem"; "Construction of mathematical problem systems in the mathematics teacher methodical activity."

Advantages of the Proposed Form

Mathematics teachers can receive first-hand up-to-date, scientifically-based information about innovative approaches to organise pupils' educational and cognitive activities in mathematics lessons. Future mathematics teachers at such conferences can present their developments to the professional community for the first time and get the first experience presenting the scientific research results. University teachers develop their organisational and methodical communication skills with highly qualified colleagues and creative mathematics teachers and become motivated to intensify scientific research.

We understand that effective cooperation between the university and the school for the methodological competence development of mathematics teachers is possible under the following organizational and pedagogical conditions:

- 1) positive motivation creation for cooperation among all participants from the university and school with awareness of the goal of cooperation - improving the conditions for the formation and development of mathematics teachers' methodological competence;
- 2) adjustment of all cooperation participants to parity and to the intense activity of each participant in achieving jointly set goals;
- 3) creation of a unique educational environment aimed at enriching the experience of methodological activities in teaching mathematics pupils;
- 4) ensuring reflexivity of all participants of cooperation.

RESULTS

To identify the mathematics teachers' motivation for the cooperation in Vinnytsia and Vinnytsia region, we developed a questionnaire in which 12 statements need to be evaluated by choosing only one of the answers - *yes, rather yes, rather no, no*. The proposed series of statements allows us to conclude about understanding the partnership's essence, the partnership's purpose, attitude to cooperation, and teachers' expectations from the cooperation of the pedagogical university and the school.

The first survey of mathematics teachers of the Vinnytsia region who took advanced training courses at the regional institute of postgraduate education of teachers according to this questionnaire took place in 2014 (19 people). The vast majority of mathematics teachers answering the questionnaire showed a lack of understanding of the partnership's goals and their own unwillingness to cooperate with the pedagogical university and the school. In particular, 83% of mathematics teachers chose the answer "no" or "rather no" in response to the statement I understand the purpose and content of the partnership between the pedagogical university and the school; I plan to take an active part in various forms of cooperation; I have a positive attitude to the cooperation between the pedagogical university and the school; I know the principal regulations, which indicate my rights and requirements for my professional development; I need self-

education. A thorough analysis of teachers' answers to various questions in our questionnaire allows us to state: that none of the respondents identified a high level of motivation to cooperate; 4 teachers (21%) showed an average level of motivation to cooperate; 10 teachers (53%) found a below-average level of motivation to cooperate; 5 teachers (26%) showed a low level of motivation to cooperate.

The reasons for this situation, in our opinion, can be

- a lack of positive experience of cooperation between the pedagogical university and the school;
- high workload of teachers in the school and, as a consequence, a low level of opportunities to clarify the partnership's essence between the pedagogical university and the school;
- a formal system of professional development of mathematics teachers and, consequently, the lack of desire for methodological development.

In 2017, 2018, and 2019, teachers of mathematics in Vinnytsia, who participated in the Olympiad of geometric creativity (one of the forms of our experimental research), were offered a questionnaire to diagnose motivation to cooperate with awareness of the purpose of partnership - improving conditions for forming and developing mathematics teachers' competence. It should be noted that the questionnaire was offered in the afternoon, closer to the Olympiad closing. At that time, the mathematics teachers who participated in the Competition jury work for solving geometric problems had already completed the examination of pupils' work; it means that at the time of the survey, they had the opportunity to get acquainted with:

- conditions and solutions of geometric problems offered to pupils; pupils' ways to solve the problems (all this allows us to conclude the level of geometric competence of pupils of other schools);
- features of work in cooperation with teachers from other schools, university teachers, and students (future teachers).

Teachers who participated in the Competition of creative works in geometry (as a jury or pupils' works supervisor) at the time of the survey:

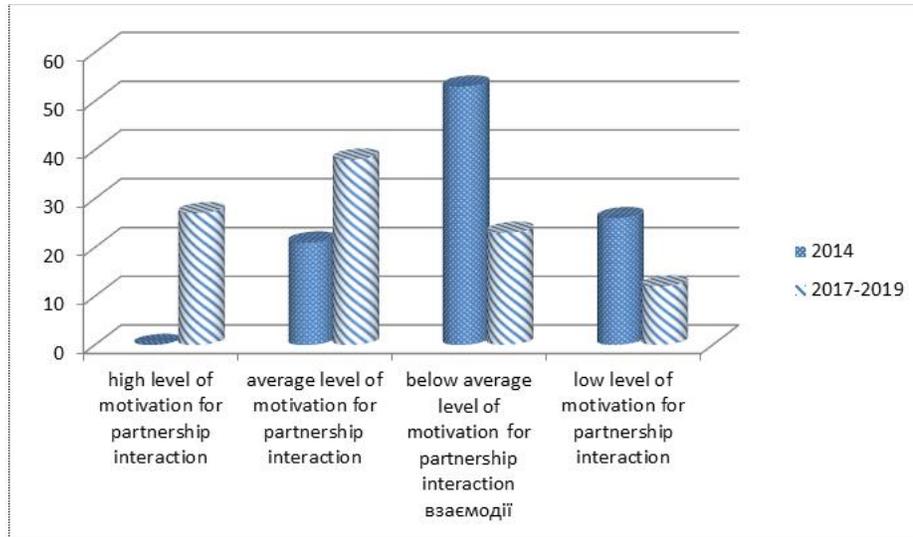
- reviewed the speeches of all pupils, listened to their answers to additional questions (it allows us to estimate the level of geometric competence of pupils of other schools);
- got acquainted with the peculiarities of work in cooperation with teachers from other schools, university teachers, and students (future teachers).

Teachers who participated in the Tournament of Methodological Finds (as a jury or a Tournament participant) at the time of the survey:

- got acquainted with the speeches of their colleagues;
- had the opportunity to speak in the discussion of the speeches of colleagues;
- presented their methodological ideas;
- had the opportunity to hear the evaluation of their ideas from scientists in the field of methods of teaching mathematics;
- had the opportunity to participate in a discussion on topical issues of teaching geometry to pupils.

Summarizing the above, we can say that all surveyed teachers during 2017-2019 (123 people) participated in professional communication, exchange of experiences, presentation, and recognition of original ideas and achievements of methodological activities in teaching geometry to pupils, in discussions on current issues of teaching geometry to pupils, in partnership with colleagues, university professors, and future teachers, etc. The results of the survey show that 33 teachers (27%) showed a high level of motivation to cooperate; 47 teachers (38%) - an average level of motivation to cooperate; 28 teachers (23%) - a below-average level of motivation to cooperate; 15 teachers (12%) showed a low level of motivation for cooperation between the pedagogical university and the school (Fig. 1). It should be noted that among the total number of surveyed teachers participating in the Olympiad of Geometric Creativity, 21 teachers participated in various events each year. Since participation in these activities is voluntary and unpaid, the repeated participation of teachers also indicates a positive attitude to the forms and methods of cooperation and the desire to develop and improve methodological competence.

FIGURE 1
DIAGRAM OF LEVELS OF MATHEMATICS TEACHERS' MOTIVATION TO COOPERATE WITH THE PEDAGOGICAL UNIVERSITY AND SCHOOL



In our study, the basis of cooperation between the pedagogical university and the school for the formation and development of mathematics teachers' methodological competence, we indicate mutual trust and joint work on projects in an atmosphere of friendliness and mutual support. The basic ideas, namely: enrichment of forms and methods of cooperation of pedagogical university and school, were put in a basis of realization of adjustment of all participants of cooperation on parity; creating a parity relationship between all participants in the partnership.

Several measures were taken to confirm the correctness of the presented ideas: joint methodological associations (representatives of secondary schools and pedagogical universities); master classes; launch of the Pan-Ukrainian scientific-practical conference "Methodical search for a mathematics teacher."

We have identified the objectives of joint methodological associations (Table 1.):

TABLE 1
JOINT METHODOLOGICAL ASSOCIATIONS GOALS

The goal of partnership for a teacher	The goal of partnership for a university teacher/lecturer
Discussion of problems of pupils' mathematical competence formation	
Development of motivation for creative methodical activity	
Improving own technologies of teaching mathematics to pupils or students	
Obtaining information about new research results in the methodology of teaching mathematics	Acquisition of relevant practical knowledge and skills for effective methodological training of students
Creating conditions for professional development of mathematics teachers	Conditions for the formation and development of the need for methodological growth of a teacher
Advisory assistance in solving topical problems of a methodological nature	Ability to test their methodological findings based on the results of a teacher's research work

According to the results of our observations, we can say that the joint methodological associations should meet the methodological needs of both a school and a pedagogical university. Therefore, it is

necessary to plan the topics of meetings of methodological associations in different aspects. The experience of holding joint methodical meetings of mathematics teachers of different schools and university teachers in the form of interactive technologies was successful. We tested the technologies of collective-group methodical activity, situational learning and technologies of methodical development in the discussion. The most desired effect for the methodological development of the partnership participants was achieved by using the following technologies - brainstorming, microphone, circle of ideas, work in small groups, position loans, press method, aquarium, etc. It is the interactive technologies of establishing communication between the participants of methodical meetings that allowed to create parity relations between the participants.

We state that the representatives of the school administration, understanding the applicants and students' need for pedagogical institutions of higher education, within such associations offer to conduct career guidance activities for school graduates and their parents. In our experimental research, we involved in career guidance activities not only teachers of pedagogical universities but also successful undergraduates who spoke about their beliefs about why one should be a mathematics teacher. 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 can be topics of both methodological nature and lectures on elementary mathematics or the history of mathematics. For example, mathematics teachers have a special interest in the issues of Olympiad mathematics, in the specifics of preparing pupils for external assessment in mathematics, and so on. According to the results of our research, we can say that participation in joint methodological seminars helps to stimulate the desire for methodological development in all participants of the partnership.

In the process of preparing and conducting master classes, we identified the following goals (Table 2.):

TABLE 2
GOALS OF MASTER CLASSES

The purpose of partnership for a teacher	The purpose of partnership for a future teacher	The purpose of partnership for a university teacher
Support for the mathematics teachers' methodological identity		
Formation of substantiated beliefs in methodical activity		
Personal pedagogical experience generalization	Methodical knowledge expansion acquired in the process of methodical training in Institutions of higher education	Possibility of comparison, comparison of different styles of methodical activity in teaching mathematics
Conditions for the formation and development of the need for methodological growth of the teacher	Improving personal methodological knowledge and skills for effective teaching of mathematics to pupils	Obtaining information about typical methodological problems in teaching mathematics to pupils in modern conditions
Creating conditions for professional development of mathematics teachers	Study of the teacher's practical experience of methodical activity in teaching mathematics to pupils	Opportunity to get acquainted with the effective experience of mathematics teachers

A Pedagogical University was the primary basis for conducting master classes by experienced mathematics teachers in our experimental research. The teacher who conducts the master class tells and shows how to apply a new technology or method in practice. In the process 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 personal problems, questions, researches on a subject of a master class; express their ideas for solving the problems.

Our observations during master classes of experienced mathematics teachers and surveys of master class participants allow us to state a significant increase in the interest of future mathematics teachers, as well as teachers of mathematics teaching methodology, in creative methodical activity, in search of non-standard methods, techniques, and means of educational and cognitive activities activation of pupils in the process of learning mathematics.

According to our experimental research program, since 2017, the annual Pan-Ukrainian scientific-practical conference “Methodical search for a mathematics teacher” has been started. At this conference, the main participants are practicing and future mathematics teachers. Participants of the scientific-practical conference discuss possible ways to overcome the problems of school mathematics education, exchange practical methodical experience in teaching mathematics to pupils, and discuss methodical findings. At the plenary session of the Pan-Ukrainian scientific-practical conference, “Methodical search for a mathematics teacher,” teachers of methodology, experienced mathematics teachers, beginner teachers, and students are invited to address the conference.

We define the purpose of holding the Pan-Ukrainian scientific-practical conference “Methodical search for a mathematics teacher,” taking into account the parity of the participants of partnership interaction (Table 3.)

TABLE 3
THE PURPOSE OF THE PAN-UKRAINIAN SCIENTIFIC-PRACTICAL CONFERENCE
“METHODICAL SEARCH FOR A MATHEMATICS TEACHER”

The purpose of partnership for a teacher	The purpose of partnership for a future teacher	The purpose of partnership for a university teacher
Obtaining up-to-date scientifically-based information about innovative approaches in the organization of educational and cognitive pupils’ activities during mathematics lessons	Creation of conditions for the presentation of own developments for the professional community	Development of own organizational and methodical abilities in communication with highly qualified colleagues and creative mathematics teachers
Own methodical competencies development during communication with highly qualified colleagues and creative mathematics teachers	Conditions for obtaining the first experience of presenting the scientific research results	Motivation to intensify scientific research

According to the experimental research program, intending to determine the content of improving the methodological qualifications of mathematics teachers in the conditions of the partnership between the university and the school, we have determined the most exciting topics for teachers. We processed the questionnaire content for the positive motivation diagnosis for partnership interaction of mathematics teachers regarding the teachers’ expectations. The topics were singled out, and the teachers were asked to rank them according to their importance. The results are presented in the table.

The teachers’ survey results regarding the definition of the content of improving the mathematics teachers’ methodical qualification in the conditions of cooperation between the university and the school (Table 4.):

TABLE 4
THE RESULTS OF A TEACHER'S SURVEY

The response options	Rank
Pedagogy of partnership in the context of the New Ukrainian School	6
A safe and inclusive educational environment creation, features of inclusive mathematics education	7
Preparation for the certification of teaching staff	1
Peculiarities in preparing pupils for independent external assessment in mathematics	4
Technologies for critical thinking development in mathematics lessons	5
Teaching mathematical modelling to pupils	
Innovative pedagogical experience in teaching mathematics (domestic and foreign)	2
Technology for content and structure development of remote support for a school mathematics course	3

During observations of the organized events, we were convinced that reducing the “distance” between school and university teachers opens up significant partnership opportunities, as each learns from the other. The process of such joint learning is a valuable result for the mathematics teacher’s methodical growth. It improves professional knowledge and teaching strategies at the university.

We can say that effective partnerships are based on the fact that each partner reveals their strengths. That is, each partnership participant must justify that he is the one who can cope best with his area of work because otherwise, the question of participation in the partnership arises. A pedagogical university and a school partnership should be built based on parity. It is crucial to ensure that the partners do not “increase their importance”.

In our opinion, a unique educational environment aimed at enriching the experience of methodological activities in teaching mathematics to pupils is characterized by: regular, clearly planned activities; comfortable conditions of cooperation for the exchange of ideas and experience of methodological activity in teaching mathematics to pupils; a variety of forms and means of cooperation; a system of incentives to increase motivation for partnership interaction.

The methodical development of mathematics teachers working in schools will be more effective in the conditions of a unique educational environment conducive to the awareness of the need for self-education, participation in professional development programs, and other types and forms of methodical growth.

We understand the reflective activity of all cooperation participants as an activity aimed at analyzing and realizing their methodological abilities, self-regulation and adjustment of one’s methodological activity. It is essential to find out the answer to the question: what did the participants of partnership interaction receive for the formation and development of their methodological competence. We consider examining the results of cooperation as a process of gathering arguments and reflections, which will help to understand the dynamics and effect of partnership work. In particular, it can be a survey, questionnaire, or exchange of impressions. We believe there is not, and perhaps should not be, a single way to document achievement. The main thing is that the obtained data are reliable and systematized regarding the prospects of partnership interaction.

CONCLUSION

Successful professional activity of a mathematics teacher requires continuous professional development in dynamic changes and the ability to adapt to them. This activity should be constant and systematic, inextricably linked with professional growth and increasing the level of methodological competence.

Presenting the content of activities for the mathematics teachers' development of methodological competence in a partnership between university and school, we believe that the mathematics teachers' development of methodological competence contributes to the individual trajectories of methodological development; coordination of cooperation between institutions of higher pedagogical education and institutions of general secondary education in terms of development of methodological competence of mathematics teachers.

According to the results of our research, we indicate the main modern problems in the mathematics teachers' development of methodological competence are the lack of appropriate conditions for motivating the methodological development of teachers; the need to create a creative environment for methodological development of teachers; the need to use relevant technologies in the context of gaining new methodological experience.

Typical problems of development of mathematics teachers' methodical competence in the cooperation of university and school include the need to motivate mathematics teachers to interact with both students of pedagogical universities and teachers; to establish a partnership, it is necessary to prepare all participants in such activities and achieve their understanding of the content, purpose, and features of the organization of joint activities; to establish a high level of mutual understanding, the participants of the partnership must be ready and able to overcome persistent stereotypes of perception, thinking, behavior; the cooperation of university teachers who train future mathematics teachers with school mathematics teachers at the school should take into account the andragogical principles of teaching.

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