IMPROVING THE TRAINING OF DOCTORAL STUDENTS IN THE MODERN EDUCATIONAL AND RESEARCH ENVIRONMENT

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ABSTRACT: *The article highlights key aspects of improving the training of third-level (educational and scientific) higher education students in the specialty A4.04 Secondary Education (Mathematics). It outlines the specific features of the educational and research environment in which doctoral students are trained under the educational and scientific programme "Theory and Methods of Teaching Mathematics" at Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University. The study is based on observations and an analysis of the effectiveness of the programme's educational components and of its research and educational events.*

KEYWORDS: *educational and scientific programme, theory and methods of teaching mathematics, doctoral training, educational and research environment.*

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1 Introduction

Since 2016, Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University (VSPU) has been training doctoral students under the educational and scientific programme (ESP) "Theory and Methods of Teaching Mathematics" in the subject specialty A4.04 Secondary Education (Mathematics). The aim of this ESP is to train highly qualified, competitive specialists integrated into the European and global academic space who are capable of solving complex specialised problems in organising the educational process that arise from the regularities and specific features of the modern theory and methods of teaching mathematics. We have set ourselves an ambitious goal: to develop an active, creative and successful personality capable of analysing existing knowledge and producing new knowledge in the methods of teaching mathematics, conducting independent research, and developing dynamically as a professional in the education of a digital society.

Over the ten years of its establishment and development, the ESP has undergone significant changes. Through active creative work and prompt responses to educational changes and challenges, the ESP development team has sought and found effective methods, techniques and tools for creating an effective educational and research environment that fosters the relevant competencies of graduates of doctoral studies in the theory and methods of teaching mathematics. These efforts and achievements were duly evaluated by the expert panel of the National Agency for Higher Education Quality Assurance (Ukraine), and the ESP "Theory and Methods of Teaching Mathematics" was successfully accredited in 2026.

The aim of this article is to highlight the specific features of the educational and research environment for training doctoral students under the ESP "Theory and Methods of Teaching Mathematics" at Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University. The study is based on observations and an analysis of the effectiveness of the programme's educational components and of its research and educational events.

2 Main Results

The basic conditions for training students at the educational and scientific level of higher education under the ESP "Theory and Methods of Teaching Mathematics" are provided by a system of educational components, including: Professional and Pedagogical Competence of a

Higher Education Lecturer; Methodology of Teaching Mathematics in Different Types of Educational Institutions; Educational Measurement; Research and Design Activities of a Lecturer (Mathematics); and Electronic Educational Resources in the Methodological Work of a Mathematics Lecturer. The content of these courses is aimed at enabling PhD candidates to gain a deep insight into and understanding of current issues in the theory and methods of teaching mathematics in general secondary and higher education institutions.

The elective component of the ESP comprises 10 elective courses in the general training cycle (students choose one of them) and 14 elective courses in the declared subject specialty A4.04 Secondary Education (Mathematics), of which students choose four. The elective components on offer include: Innovative Technologies of Teaching Mathematics in the Context of Implementing the Objectives of the New Ukrainian School; Developing Pupils'/Students' Thinking in Learning Mathematics: Current Tasks and Techniques; Professional Development and Integrity of a Mathematics Teacher/Lecturer; Methodological Glossary of a Mathematics Teacher/Lecturer; International Experience in Mathematics Education; Instructional and Methodological Support for Distance Learning of Mathematics; Preparing Educational and Methodological Works in Mathematics and Its Teaching Methods for Publication; Ukrainian Didactics of Mathematics; and Inclusive Educational Space.

PhD students in specialty A4 acquire the practical skills of a higher education lecturer during their teaching (assistantship) and research practicums.

One of the distinctive features of the educational and research environment for training doctoral students under the ESP "Theory and Methods of Teaching Mathematics" is that the Department of Mathematics Education, which provides supervision of doctoral students in this programme, is the only department in Ukraine with two permanent staff members holding the degree of Doctor of Pedagogical Sciences in the specialty Theory and Methods of Teaching (Mathematics) – O. Matiash and L. Mykhailenko. This feature has created conditions for the broad involvement of doctoral students in the Ukrainian research community of specialists in the theory and methods of teaching mathematics. In particular, all doctoral students of the programme are members of the non-governmental organisation (NGO) "International Association of Researchers in Mathematics Didactics" [1] and, since September 2022, have had the opportunity to take part in more than 30 thematic research seminars held by this NGO. Our observations allow us to assert the importance of this opportunity for the professional development of future PhDs, the growth of their research competencies, and their awareness of the value of joining the research community. The main advantage is that doctoral students can develop not only within the university's educational and scientific programme but also within a professional environment of researchers working on topical problems of the theory and methods of teaching mathematics. This contributes to shaping the young researcher's professional identity and to an awareness of their own place in the development of mathematics education. For our doctoral students, the talks given at the NGO's seminars by experienced researchers in mathematics education and the constructive discussions among specialists in the theory and methods of teaching mathematics serve as an effective mechanism for critically reflecting on the results of their own dissertation research and for identifying prospects for further research. For example, doctoral students attended talks on the following topics: "Fair Assessment of Mathematics Achievement in Inclusive Settings: Dream or Reality?" (K. Polhun, Kryvyi Rih); "Learning Losses in Mathematics: A Verdict or an Impetus for Development?" (S. Lukianova, Kyiv); "Artificial Intelligence in Teaching Mathematics: Opportunities, Risks, Prospects" (O. Panasenko, Vinnytsia); "Digital Technologies in Teaching Mathematics: An Alternative or a

Necessity?" (M. Drushliak, Sumy); "Artificial Intelligence in Mathematical Research and Mathematics Education" (S. Rakov, Kyiv), and others.

Another feature of the educational and research environment for training doctoral students under the ESP "Theory and Methods of Teaching Mathematics" is the practice of guest lectures by international experts. In particular, doctoral students attended a lecture entitled "Desmos: Basic Principles of Lesson Design" by L. Bukalova, a lecturer at Touro University (USA), winner of the 2023 Math for America Muller Award for Professional Influence in mathematics education and recipient of the 2024 Sliffe Award. Doctoral students also attended a guest lecture by A. Karp, Professor in the Mathematics Department of Teachers College, Columbia University (New York, USA), entitled "The History of Mathematical Education: Why and How to Study It". In addition, they heard presentations by international experts at the NGO's research seminar: "Selected Aspects of PhD Training in Mathematics Education in the USA" (Zelbo Shen, PhD in Mathematics Education, Teachers College, Columbia University, New York, USA) and "Methods of Organising and Conducting STEM Learning in Grades 5–7" (K. Harizanov, Konstantin Preslavsky University of Shumen, Bulgaria).

A further distinctive feature of the ESP "Theory and Methods of Teaching Mathematics" is that doctoral students are actively involved in organising the International Scientific and Practical Conference "Problems and Prospects of Professional Training of Mathematics Teachers" (2018, 2021, 2024), hosted by the Department of Mathematics Education. All doctoral students of the programme are members of the organising committee of the annual All-Ukrainian Conference "Methodological Search of a Mathematics Teacher". Fourth-year doctoral students give presentations at the plenary session of this conference, which traditionally brings together more than 100 mathematics teachers from all over Ukraine. Doctoral students have the opportunity to publish in the collection of papers "Methodological Search", and since 2018 they have served as managing editors of this annual collection of students' research papers [2]. In 2024, VSPU launched the scientific journal "Didactics of Mathematics: Theory, Experience, Innovations" [3]. All doctoral students of the programme have published papers in Issues 1–5 of this journal. The organisational forms through which teaching and research are integrated within the programme include the Consultative and Educational Online Centre for Mathematics Education of the Vinnytsia Region [4], established by the department, and the All-Ukrainian Olympiad of Geometric Creativity named after V. A. Yasinskyi [5].

Participation in research conferences and other research and educational events of the Department of Mathematics Education enables doctoral students to practise public speaking and discussion skills in front of unfamiliar audiences. Involvement in organising and running a number of the department's traditional events (the Olympiad of Geometric Creativity, the teaching skills competition, webinars, training sessions for mathematics teachers, mathematical battles for university and school students, etc. [6]) fosters responsibility, initiative, creativity and motivation in future PhDs.

One more feature of the ESP "Theory and Methods of Teaching Mathematics" is that our doctoral students are active in international research internships. In particular, doctoral students of the programme took part in Pre-YESS13: Buddy Program, an event for doctoral students in mathematics education planning to attend the YERME Summer School (Spain, 2024). The doctoral students received invitations to participate in the 13th YERME Summer School (YESS13) at the University of Cantabria (Spain). Almost all doctoral students of the programme have completed international internships on topical issues of mathematics education in Lublin (Poland, 2023) and Oslo (Norway, 2024).

We also regard as a feature of the educational and research environment for training doctoral students under the ESP "Theory and Methods of Teaching Mathematics" the rating system for evaluating the research activity of third- and fourth-year doctoral students, which we have developed and introduced. The corresponding Regulations define the procedure, criteria and processes for assessing doctoral students' research activity within the research component of the ESP. The objectives of the rating system are to increase doctoral students' motivation for systematic research work; to ensure objective assessment of research outcomes; to stimulate publication, project and innovation activity; and to foster a culture of academic integrity. The main tasks of rating doctoral students' research activity are monitoring their individual research achievements; creating conditions for healthy academic competition; and using the rating results for incentives, selection for academic mobility, and recommendations for participation in competitions, grant programmes, etc.

3 Conclusions

The ESP ensures the comprehensive development of the general and professional competencies of future PhDs in the theory and methods of teaching mathematics in an active and creative educational and research environment. We identify a number of features of this environment:

- specially created conditions for partnership with the NGO "International Association of Researchers in Mathematics Didactics", which enables doctoral students to join the research community in the theory and methods of teaching mathematics;
- a successful practice of providing opportunities to study international experience in addressing problems of mathematics education;
- learning about the specifics of research, innovation and teaching activities in the theory and methods of teaching mathematics takes place in the active scientific and methodological environment of the Department of Mathematics Education, which has well-established traditions recognised in Ukraine (olympiads, conferences, training sessions, etc.).

In the near future, we plan to improve doctoral training under the ESP "Theory and Methods of Teaching Mathematics" in the following directions: intensifying doctoral students' participation in international mobility and developing virtual international mobility; integrating research into the European Research Area by actively involving doctoral students in working groups that prepare research projects for international grant programmes and competitions; expanding the list of courses taught in English; and encouraging doctoral students to write articles and monograph chapters in English.

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