USE OF PORTFOLIO TECHNOLOGY IN THE TRAINING OF FUTURE TEACHERS OF MATHEMATICS*

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ABSTRACT: *The article examines the problem of finding new ways of forming a competent and proactive young mathematics teacher. New approaches to conducting lectures and practical classes during the master's study of the educational discipline "Theory and methods of teaching mathematics in a specialized school" were considered. New approaches to conducting lectures and practical classes during the master's study of the academic discipline "Theory and methodology of teaching mathematics in a specialized school" have been determined. The comprehensive use of portfolio technology is proposed to increase the level of formation of methodological competence of future mathematics teachers, development of their creative abilities and formation of readiness to use the knowledge and skills acquired during master's studies in their professional activities. Examples of methodical tasks are given.*

KEYWORDS: *training of future mathematics teachers, methodical competence, portfolio technology, portfolio of achievements*

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1 Introduction.

The current stage of reforming school mathematics education in Ukraine requires the search for new ways of forming a competent and proactive teacher, who is able not only to persistently and creatively perform the tasks set before him in order to put into practice the conceptual ideas of the project "New Ukrainian School", but also to be ready independently identify possible problems and propose own solutions.

The restructuring of the educational process in secondary general education institutions in general and specialized educational secondary institutions in particular became the impetus for revising the goals and updating the traditional content of the course "Theory and methods of teaching mathematics in a specialized school" in the master's degree of Dragomanov Ukrainian State University. In addition, the introduction of new curricula in 2023 in accordance with the updated editions of the educational and professional program Secondary education (Mathematics) [1] and the educational and scientific program Theory and teaching methods of mathematics [2] specialty 014 Secondary education (Mathematics) led to a review of methods, means and organizational forms of education.

According to the new curriculum of 2023 to study the academic discipline, from the "Professional training" cycle for students of the 1 year 4 months, "Theory and teaching methods of mathematics" 6 ECTS credits are planned (total volume 180 hours), of which 24 hours are lectures, 37 hours are practical classes, and 119 hours are independent work [1]. And for students studying for 1 year 9 months: 9 ECTS credits are planned (a total of 270 hours), of which 44 hours are lectures, 46 hours are practical classes, and 180 hours are independent work [2]. It can be seen that in both curricula, twice as much time is allocated for independent work as for classroom classes. Note that the number of classroom classes has decreased by almost 50% compared to the previous curriculum.

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These factors lead to a comprehensive solution to the problem of updating the goals, content and technologies (methods, means and organizational forms) of teaching the academic discipline Theory and methods of teaching mathematics in the master's degree.

In view of the fact that for many years during the organization of practical classes in the educational disciplines "Methodology of teaching mathematics" and "Theory and methodology of teaching mathematics in a specialized school" the portfolio technology was successfully used, a decision was made to comprehensively apply the mentioned technology to practical, as well as to lectures.

2 Research results.

Portfolio technology in a broad sense is an educational technology for working with the information of the subjects of the educational process. The use of portfolios in the educational and cognitive activities of students contributes to: their mastering of ways of working with normative, educational and methodical literature; systematization of professional knowledge; development of professional reflection; development of creative abilities in creating own didactic materials; formation of master's readiness to responsibly and creatively use the knowledge received at the institution of higher education in their professional activities.

Final thematic portfolios of achievements (we mean personal portfolios with creative developments on a specific topic and final works) can be used to demonstrate, analyze and evaluate educational results, develop reflection, increase the level of awareness, understanding and self-evaluation of the results of educational activities.

The use of this technology helps masters to successfully master the information offered by the teacher-lecturer (learn knowledge) during the lecture. In addition, it also enables each master to organize his own educational activities, develop self-study skills, assess the prospects of professional growth, identify difficulties during his own assimilation of theoretical material of educational topics, and perform methodical tasks of constructive and creative types.

The use of this technology in the educational process has changed approaches to conducting lectures and practical classes. Let's look at examples of new ideas in action.

First of all, we note that the traditional reading of lectures began to be conducted according to the technology of flipped learning. For this purpose, a new textbook on "Theory and methods of teaching mathematics" was developed, which contains lectures on general methods of teaching mathematics in high school (three lectures), lectures on theory and methods of teaching algebra and the beginnings of analysis (thirteen lectures) and lectures on stereometry (thirteen lectures) [4]. Each of the proposed lectures contains a plan, theoretical information on mathematics, methodological recommendations for the study of the corresponding topic from the school course of mathematics of a senior specialized school, methodological problems for independent solution, some of which may be chosen by students as topics for coursework or master's theses.

Before the class, students study the selected lecture, study it, and during the class they discuss, deepen their knowledge, get answers to unclear questions, express their own opinion and suggestions regarding the proposed educational material. Special attention in each lesson is paid to teaching students how to solve applied problems. A certain number of lectures are studied by masters completely independently. A consultation is provided for clarification of problematic issues that arose for students during the elaboration of the lecture outline. We offer several applied problems that the lecturer offers students to solve during lectures.

Problem 1 of applied content. A mine is fired from a mortar with a speed $\mathbf{v_0}$ at an angle $\propto$ to the horizon. Determine the maximum height h_{max} of raising the mine and how far the mine

will fly at this speed. At what angle to the horizon should the mine be launched so that the flight range is maximum? Calculate the named values of the M120-15 MOLOT army mortar (Ukrainian production), knowing that its muzzle velocity is 325 m/s, and the shot is fired at an angle of 60°, air resistance is neglected.

The solution

1) Construction of a mathematical model for solving problems.

Let's make an illustrative drawing (Figure 1), on which we will note the position of the mine and the direction of its movement speed. Students can find the above considerations in the school textbook on physics for the 10th grade.

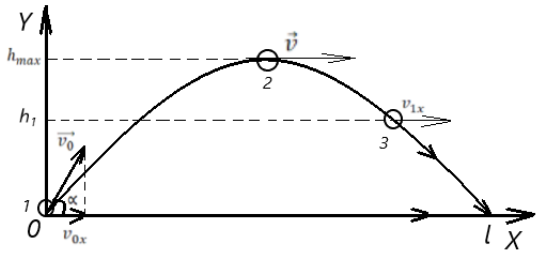

Figure 1. Illustrative drawing of the task

Since there is no air resistance, the law of conservation of energy can be used. Recall that during the movement of a body under the influence of gravity, the projection of the velocity onto the horizontal axis OX does not change $v_x = v_{0x} = v_0 cosa$. At the upper point of the trajectory, the body's speed is directed horizontally, therefore $v_x = v$.

For each position of the mine, write down the expression for calculating the total mechanical energy:

1. $W = \frac{mv_0^2}{2} + mgh_0 = \frac{mv_0^2}{2}$;
2. $W = \frac{mv_0^2}{2} + mgh_{max} = \frac{mv_0^2 cos^2 \propto}{2} + mgh_{max}$;
3. $W = \frac{mv_1^2}{2} + mgh_1$.

Since the total mechanical energy is conserved, we have two equalities:

$$\frac{mv_0^2}{2} = \frac{mv_0^2 cos^2 \propto}{2} + mgh_{max}; \quad \frac{mv_0^2}{2} = \frac{mv_1^2}{2} + mgh_1.$$

After simplification, we will find the unknown value:

$$h_{max} : v_0^2 = v_0^2 cos^2 \propto + 2gh_{max} \Rightarrow 2gh_{max} = v_0^2 - v_0^2 cos^2 \propto \Rightarrow$$

$$h_{max} = \frac{v_0^2 sin^2 \propto}{2q} \qquad (1)$$

Then $l = v_0 cos \propto \cdot 2t$, where t is the time of ascent to the height h_{max}, that is, the time during which the vertical component of the speed will decrease to 0.

Therefore, $l = v_0 cos \propto \cdot 2 \cdot \frac{v_0 sin \propto}{q} = \frac{v_0^2 sin 2 \propto}{q} \Rightarrow$

$$l = \frac{v_0^2 sin 2 \propto}{q} \qquad (2)$$

Formulas (1) and (2) are mathematical models by which this physical problem is solved.

The flight range of the mine for a given speed v_0 will be maximum in the case when v_0 will be maximal in the case if $sin 2 \propto = 1$. That is if $\propto = 45^0$. Therefore, the mine will fly the longest distance when the shot is fired at an angle of 45^0 to the horizon.

Let's calculate for the M120-15 "MOLOT" mortar, provided if $v_0 = 325$ м/с, $q = 9{,}8$ м/с, $\propto = 60^0$.

Therefore

$$h_{max} = \frac{325^2\ sin^2 60^0}{2 \cdot 9{,}8} = \frac{105\,625 \cdot 0{,}75}{19{,}6} = 4041{,}7726 \approx 4042 \text{ м},$$

$$l = \frac{325^2\ sin\ \ 120^0}{2 \cdot 9{,}8} \approx \frac{105\,625 \cdot 0{,}866}{9{,}8} \approx 9334 \text{ м}.$$

Answer. $h_{max} = \frac{v_0^2 sin^2 \propto}{2 \cdot q}$, $l = \frac{v_0^2 sin\ \ 2\propto}{q}$, $h_{max} \approx 4042$ м, $l = 9334$ м.

Problem 2 of applied content. Cheese makers believe that with equal volume, ball-shaped cheeses retain their taste better than cylinder- or cube-shaped cheeses. Why?

Note that the text of the problem can be presented as shown in the figure.

Figure 2. Original text of the task with an illustration

It is advisable for the teacher to analyze this problem, for example, like this. Initially, the taste of cheese does not depend on its shape. There is a hypothesis that the taste changes as a result of evaporation and oxidation. And the intensity of these processes depends on the surface area of the body: the smaller it is, the slower the evaporation and oxidation. So, to answer the question of the problem, you should compare the surface areas of a cube, a cylinder and a sphere, which have equal volumes.

Solving the problem within the constructed model (the solution can be collective). The problem remains underspecified, because the height of the cylinder is unknown. We will assume it to be equal to $2R$, R – radius of the base of the cylinder.

Then its volume will be:$V = V_{cylinder.} = 2\pi R^3$, then

$$R = \sqrt[3]{\frac{V}{2\pi}},\ \ S_{cylinder} = 2\pi R^2 + 2\pi R \cdot 2R = 6\pi R^2 = 6\pi\ \sqrt[3]{\left(\frac{V}{2\pi}\right)^2}.$$

$V_{cube} = a^3$ (a – side of the cube), therefore $a = \sqrt[3]{V}$, $S_{cube} = 6a^2 = 6\sqrt[3]{V^2}$.

$V_{ball} = \frac{4}{4}\pi r^3$ (r – radius of the ball), therefore $r = \sqrt[3]{\frac{V}{4\pi}}$.

Therefore

$$S_{ball} = 4\pi r^2 = 4\pi\sqrt[3]{\left(\frac{V}{4\pi}\right)}\ .$$

We need to compare the surface areas. All of their values are positive, so we can move on to comparing x cubes.:

$$S^3_{cylinder} = 6^3\pi^3\frac{V^2}{4\pi^2} = 54V^2\pi,$$

$$S^3_{cube} = 54 \cdot 4V^2,$$

$$S^3_{ball} = 36\pi V^2.$$

$$36\pi < 54\pi < 54 \cdot 4$$

that is, we have the following:$S_{ball}^3 < S_{cylinder}^3 < S_{cube}^3$, then $S_{ball} < S_{cylinder} < S_{cube}$.

Answer: The smallest surface area of a sphere.

Students create a selection of the above problems independently, discuss them in a practical session, and exchange them with each other.

Practical classes are a continuation of lectures on creating a thematic portfolio by each student individually. In addition to discussing the solution of methodological tasks proposed by the lecturer, the following issues are considered in the practical class.

1) Analysis of alternative school textbooks and mathematics programs regarding the content of the selected topic of the school mathematics course, requirements for students' knowledge and skills.

2) Methodological recommendations for forming basic concepts of the topic, proving theorems, and solving practical and applied problems.

3) Discussion of materials on the history of mathematics that can be used for motivation or for student projects.

4) Creation of collections of motivational applied problems and problems of increased complexity

5) Discussion of fragments of lessons of different types on this topic: school lecture, practical lesson, test, school project, final test.

6) Search for ways to solve current problems of school mathematics education.

Let us consider, for example, a variant of the task for point 6).

Currently, Ukraine is facing the problem of “educational losses”. This problem arose during the pandemic and continues to accumulate due to military operations. Prolonged exposure of students to stress during military operations creates emotional instability in them (anxiety, fear, uncertainty about the future, apathy) and deepens the problem of motivation. Distance learning, slowing down or interruption of the academic process due to air alarms, Internet outages, and lack of electricity affect the quality of students’ assimilation of program material. There is an accumulation of under-obtained and "forgotten" knowledge. As a result, according to the results of PISA-22, the educational losses of Ukrainian schoolchildren are 1.5-2 years.

One of the ways to solve the problem of educational losses, which is available to every mathematics teacher and can be used by him in his work, is the activity of identifying and establishing connections between different content lines of the school mathematics course: between the characteristic features of one concept; between concepts; between algorithms for solving reference problems. In order for masters to be able to perform work on compensating for "educational losses" by means of mathematics in practical classes, they are offered tasks of this type [3].

Problem 3 of “educational losses”. In order to establish connections between the content lines “Equations and inequalities” and “Functions and their properties”, the teacher suggested that students solve three tasks.

Task A) Solve the equation$x^2 + 5x + 6 = 0$. (*Answer:* $x_1 = -3 x_2 = -2$).

Task B) Find the coordinates of the intersection points of the graph of the function $f(x) = x^2 + 5x + 6$ with the Ox. (*Answer:* $(-3; 0),\ (-2;\ 0)$).

Task C) Find the domain of the function $y = \frac{x-5}{x^2+5x+6}$

(*Answer:* $(-\infty; -3) \cup (-3;\ -2) \cup (-2; +\infty)$)

Tasks for students. Solve the tasks and compare the steps of their solution and the features of recording the answers; determine the didactic purpose of these tasks; suggest additional questions to increase student activity when solving each task; create your own

similar tasks; suggest interesting forms and tools that can be used in lessons or during homework to solve them.

3 Conclusions and prospects for further research.

Modern Ukrainian school mathematics education needs teachers who will quickly and effectively respond to all the challenges of today. That is why, even during their studies at higher pedagogical educational institutions, young specialists should be prepared for future challenges in their professional activities.

A comprehensive study conducted over several years in the master's program of the Faculty of Mathematics, Informatics and Physics of the Dragomanov Ukrainian State University during the study of the course Theory and Methods of Teaching Mathematics made it possible to verify the effectiveness and necessity of the widespread use of portfolio technology in the professional training of future mathematics teachers.

In particular, it was found that, unlike the traditional approach, which separates teaching, learning and assessment, portfolio technology organically integrates these three components of the learning process of future mathematics teachers. Portfolio makes it possible to combine quantitative and qualitative assessment of educational achievements through the analysis of various “products” of the student’s educational activity and the system of continuous assessment and self-assessment. Due to the implementation of diverse methodological tasks of the constructive and creative levels, portfolio technology provides the opportunity for the early formation of professionally significant skills of students and contributes to the development of their methodological competence.

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