METHOD OF THE PROJECT FOR INTERACTIVE TRAINING IN MATHAMATICAL DIDACTICS

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ABSTRACT

The paper deals with the nature and role of the method of the project for encouragement of students' methodological expertise by interactive "training in action" in mathematical didactics. A model of a project technology of "Methodological approaches to teaching identities and equalities in the eighth form" is presented.

The traditional technology of university training (from knowledge to skills), based on the logic of science should be supplemented with new technologies for "*training in action"* based on the laws of students' cognitive activity. The theoretical foundations of the 'training in action' are Lev Vygotsky's cultural and historical theory of reflection and action, Kolb's Cycle theory and Schon's Principles of Reflexive practice. Efficient training is based on participants' shared experience. According to Robert Glacier, the methodology of interactive training is about teaching the individual to think within the range of the subject's context. Training should be experience and contextually relevant. Modern didactics offers base definitions of training and a theory of learning as a cyclical process. (David Kolb, The Experiential Learning Model, 1976-84): the act of learning starts with the trial 'here and now', reflexive observation (data collection and trial observation) abstract conceptualisation (conclusions of analysis), active experimenting (data is integrated into the individual's experience of using behaviour and new concrete trial to be used with the aim of modification) [8].

In theory, interactive training targeted at the trainee and the result, is actively recommended, but in reality these practices are not applied in higher education. The theoretical analysis shows that only the project's method can help shorten the distance between 'real life', while all other interactive methods always remain in fact *simulation [7]*. In recent times, project training has become a topical issue in high school education (literature, physics, chemistry, etc.), whereas at universities the methodologies of economic, political and information sciences are focused on it [7]. In spite of the numerous publications in the pedagogical literature [4,5,6,8], no studies have been done in Bulgaria about the use of the method of the

projects in students' training in mathematical didactics in higher pedagogical education. Mathematics and Information Technology curricula encompass a large amount of special mathematics training and inadequate professional pedagogical training. It is a set of complex methodological expertise (mathematical and methodological, professional and communication, social and psychological, informational, etc.), which is why it requires time and approaches to its development. These and other reasons emphasise the importance of students' self-training and independent activity.

- **The project's method as an interactive training method**

John Dewey, William Kilpatrick and Thorndike's ideas underlie project training. They maintain that trainees fulfil a certain academic activity more whole-heartedly when they choose it themselves, and that real training is never unilateral, locked within the scope of the subject. The development of training projects and project tasks is associated with modern approaches in education, based on training that is project-based, practice, project and problem-oriented. The projects' method makes it possible to encourage and assess the potential of the professional and methodological development of future mathematics teachers. American educator and philosopher John Dewey (1859-1952) defines this method in education as 'a method of reflective experience'. "*The basis of a given project is always the real focus on experienced reality when, with common efforts, one or several solutions to a certain problem are achieved, which ultimately merge in one product, in a concrete result respectively"* [6]. The project method involves the use of the environment as a laboratory in which the cognitive process takes place. In his book 'The Project Method' Karl Frey (1997) for the first time understands the method as a way along which both trainer and trainee walk in developing the project. The author distinguishes 17 features of the project method with participants in the project taking the initiative from a real-life situation, agreeing on the form of training, developing a project initiative and demonstrating it to all, organizing themselves for independent work, participating in a discussion, etc. The project method is carried out by a system of team actions which go through four basic stages (planning, conducting, presentation, evaluation).

N. G. Chernilov regards project training as a developing training based on successive fulfilment of complex training projects with information pauses in order for theoretical knowledge to be mastered (1997).

The modern dimensions of using project technologies in mathematical didactics training go hand in hand with the traditional university training methods, supplemented with project-based and problem technologies which do not contradict the subject field. Our motives behind the use of the project method in university training are:

1). After 2005, the training of the students of Information Technology at Veliko Tarnovo University is regulated by new curricula (ESTK – credit system) and curricula in methodology of mathematics training – 5 credits for part I and part II. The credit hours for extracurricular activity (90 hrs) are higher than for

contact classes (60 hrs). This requires new forms and content of students' private study, as well as forms of control and evaluation.

2). The project method allows encouragement of students' research and self-dependent practical studies with a view to the professional prospects for their development as mathematics teachers.

3). The project method involves individual and team solution of project problems, encourages individual elements of methodological expertise (communications and leader capabilities, skills to teach others, etc.).

4). The main motivator is the synergic effect of the project's result.

A training project technology in the subject of Methodology of mathematics training was experimented in the 2006/2008 period. The theoretical and practical significance of the problem under study oriented us towards the aim, the object and subject of the study.

The aims of the study targeted:

- Classification and round-up of the students' methodological knowledge in solving applied methodological problems related to teaching specific mathematical content.
- Deep insight of the mastered basic methodological knowledge in its use in various situations.
- Placing the student in the centre of training at the university (subject-object training);
- Development of students' self-reliance and research skills;
- Reorientation of training in Mathematical didactics from training in content and logic of the subject itself to the logic of the activity (personality-oriented training);
- Boosting the students' training motivation;
- Complex approach to development of training projects for balancing the trainees' psychological functions.

Object of study are third-year students of Mathematics and Information Technology. *Subject of study* is private learning and research in mathematical didactics in the process of developing a training project. In developing the technology of the project method, we first determine the system of teacher's and students' actions, as well as the stages of interaction in the training/teaching process. The topics of project development in mathematical didactics are varied in terms of content and volume. The projects are individual and group ones, and the time for their fulfilment is 30 hours per semester under the curriculum. The time for fulfilment of group projects is allocated within the semester, with global problems being selected and decomposed into partial ones. Each student participates in two short-term individual projects (up to 8 hours each), and one mid-term group project (up to 15 hours) within a semester.

- **Model of project training technology**

We present the content of a project training technology through one of the developed group projects on the subject of *Methodological approaches to teaching*

identities and equalities (8-th form). It was tested and approved during the second semester for part II. 'Special methodology of mathematics'. It is integrated into practical seminars in observation at school [3].

Stages of project technology	**Activity by the university teacher**	**Activity by the students – future maths teachers**
1. Preliminary preparation for project development а). Setting the project's main subject	Formulates subjects for the project	Consider, discuss and make a common decision
	Suggests a joint choice of the project's subject	Joint activity for selection of the subject
	Participates in the discussion of the subject	Select subjects themselves to be discussed and put them up for discussion to the whole group
б). Setting sub-subjects within the project's main subject	Develops topical catalogue for the project in advance*	Each student chooses a sub-subject or suggests a new one.
	Participates in the discussion of sub-subjects	The students suggest options for sub-subjects
в). Team set-up	Assists teams' set-up set	Each student sets their sub-subject and role in the team
г).Preparation of materials for research	Sets the aims and tasks for research (catalogues from literature sources, web sites)	Carry out activities related to search for answers in compliance with the aim of the project
д). Deciding on the presentation's format	Participant in the discussion	Discuss various forms: video, catalogue, album, poster, written development of a lesson, multimedia presentation, etc
2. Project development	Consults and coordinates students' activity, encourages them and provides guidance	Students carry out research on their own
3. Summing up scores	Provides consultation, marks and corrects papers and encourages the students	Sum up the scores of work on sub-subject
4. Presentation	Organises the expert evaluation (jury, experts)	Reports the project's results
5. Reflection	Evaluation of their own teaching performance on the basis of the achievements and the project's evaluation	Carry out reflection on the training process on the basis of other's evaluation. Group reflection is advisable.

Table 1. *A set of activities in a project training technology*

A catalogue of the subjects and sub-subject on the project is submitted at the beginning of the school year (table 2). The choice of a subject by the students is based on the principle of 'free negotiation' but in such a way that the teams should consist of at least two students and all sub-subjects should be chosen. Project activities are fulfilled successively and within a system (table 1).

The following criteria of the project's evaluation are set out in advance:

- Skills at collecting and structuring the information on the subject;
- Methodological and mathematical expertise upon presentation of the information;
- Presentation and originality of the presentation (multimedia presentation, poster, role-playing, situation-playing, etc;
- How convincing and well-grounded the development is;
- Aesthetic design of the development.

During the project's work stage, the teacher teaches their students how to collect and process the information, how to build the research and how to present the results.

Project task	Sub-subjects of the main project
Theoretical and research task	1. Identities and equalities in mathematics textbooks for the 8-th form (content and comparative analysis, methodological problems, approaches to their solution). 2. Identities and equalities in methodological specialized literature and on the Internet. 3. Identities and equalities in extracurricular forms of training in mathematics (problems for study groups, contests).
Research task	4. Propaedeutic stages of mathematical concepts and statements from the identities and equalities section. 5. Motivating functions of the problems from Identities and equalities . 5. Single (unified) approaches to the introduction of concepts and statements. 7. Single (unified) approaches to mastering concepts in the lessons with the identities and equalities section.
Information and demonstrative task	8. Links between subjects in learning identities and equalities 8.1. Identities and equalities in biological sciences. 8.2. Identities and equalities in architecture. 8.3. Identities and equalities in gymnastics [2]. 8.4. Identities and equalities in Bulgarian medieval history [1]
Role and simulation task	9 Fulfilment of the practical aims of the training from the identities and equalities section (applied aspect of training in mathematics – fragments of lessons). 10. Development of training technologies from the identities and equalities section and presentation of simulated or real situations.

Creative task	11. Heuristic technologies for teaching identities and equalities (interactive teaching methods).

Table 2. *Topical catalogue of the project of Methodological approaches to teaching identities and equalities project (8-th form) and types of project problems.*

The final stage is presentation and defence of the project subjects. Some results of the test and approval of the project technology are presented in Appendix 1. The final result of the project tasks is shaped up as a *project portfolio* which is a tool for an objective evaluation of the students' activities done on their own. As a result of the work on this group project, presentations were delivered at the seminars in methodology of training in mathematics, articles were developed for the students' workshops, and a diploma paper was defended on the subject of 'Geometrical transformations in the plane' by Dilyana Staleva.

- **Prospects before project training**

Project technologies are oriented towards independent (individual and group) activity of trainees. The particular benefits of the project training technology in building the methodological expertise of future mathematics teachers involves achieving much higher ends, that is, apart from the implemented specific aims, a new result is achieved in the students' cognitive powers and their ability to work on their own. It is no coincidence that project technologies belong to the technologies of the 21 century because modern teaching technologies require that the concept of active training be accepted - training should be based on communication, research, practical application and professional reflection.

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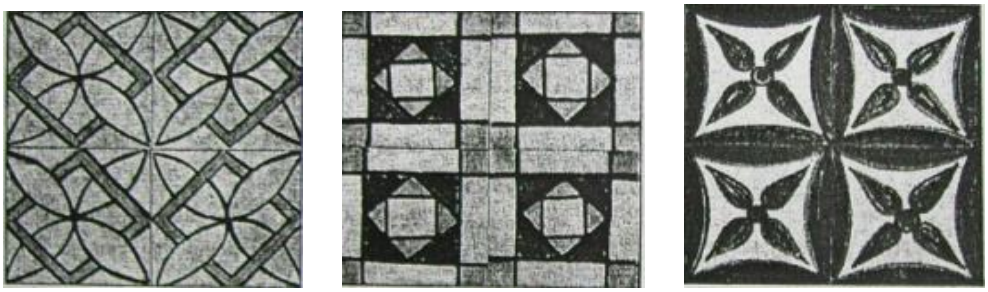
Appendix 1.

I. Presentation of 'Identities and Equalities – a Look Back'

Designs with a centre of symmetry

Carving with an axis of symmetry

Rotation in designs (the first two slates are from the Paleolithic era)

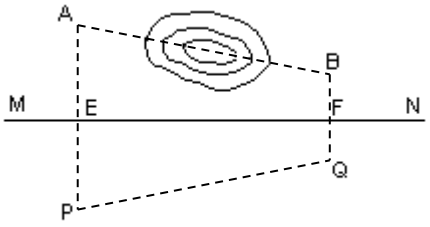


Ceramic designs on slates and vessels from medieval Bulgaria [1]

II. Fragment of a project for catalogue of applied problems with identities and equalities

(designing the practical aims of the training in mathematics)

Problem 10. Find the distance between two accessible points, A и B in an even location between which there is an obstacle (a lake, fences, etc).

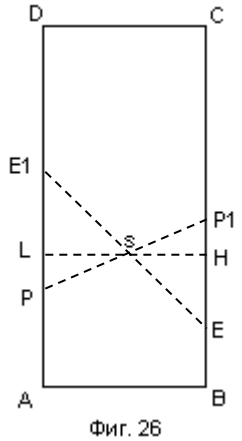


Фиг. 10

In order to find the distance between points A and B (fig. 10), we mark a straight line MN, so that to be able to pass towards it perpendiculars from points A and B. Then, using a jetty, we drop the perpendiculars AE and BF to the straight line MN.

We continue these perpendiculars on the other side of the straight line MN and measure the distances $EP = EA$ и $FQ = FB$. The distance between the points P и Q is equal to the distance sought between the points A и B.

Problem 26. A heavy flood has deleted the boundaries of a rectangular piece of land one of whose sides is three times larger than the other. The only things left are a water pump and a fir-tree located on the two larger sides of the rectangle, as well as an electricity pole, evenly distanced from the large sides of the rectangle and twice closer to the one short side than to the other. Restore the boundaries of the piece of land.



Фиг. 26

Let $ABCD$ be the boundaries of the land, in which case $AB = a, BC = 3a, HB = a,$ $SL = SH,$ а P, E, S are the places of the pump, the fir-tree and the electricity pole (fig. 26) respectively. The straight line PS intersects BC в $P_1,$ symmetrical to P in relation to S.

Also, E и E_1 are symmetrical in relation to S. Thus, the location of the straight lines AD и BC is determined. If we drop the perpendiculars SL и SH respectively towards AD и BC and draw L и H on

AD и BC in the same direction, the segments and in the opposite direction $LA = HB = a$, $LD = HC = 2a$,we receive the tops of the fence.

Let us designate the canal with g (fig, 11) and let $B' = \sigma_g(B)$. Let т.$X \in g$ – is a random point

Thus $B'X = \sigma_g(BX)$,

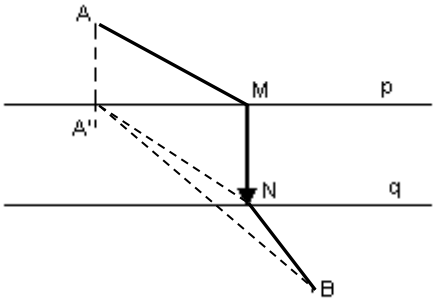
where $BX = B'X$

consequently $AX + BX = AX + BX'$

from $\Delta AXB'$ сл. $AB' \leq AX + XB'$

and obviously $AX + XB'$ will be smallest when X is the crossing point to AB' with the straight line g (in this case point P).

Problem 31. Between the inhabited locations of A and B passes a stretch of a water canal with parallel banks. Determine the location of the place of a bridge which is perpendicular to the banks of the canal so that the distance from A to B via the bridge is shortest.



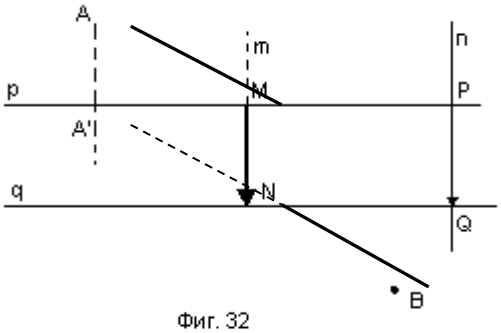
Фиг. 31

Analysis:

Let $AMNB$ be the way sought.

We examine translation $\tau_{\overrightarrow{MN}}$. Let $A' = \tau_{\overrightarrow{MN}}(A)$, where $AMNA'$ is a parallelogram and consequently $AM = A'N$ и $MN = AA'$. Then $AM + MN + NB = AA' + A'N + NB$.

In order for the distance $AMNB$ to be the shortest, the length of the broken line $A'NB$ should be the shortest. This will happen when the broken line $A'NB$ is straightened. In this way the point N which belongs to the shortest distance, should lie on the straight line $A'B$ and on the bank (straight line p) which is closer to the inhabited location A.



Фиг. 32

Solution:

1) $n \perp P; n \perp q$
2) $n \cap p = P; n \cap q = Q$
3) $A' = \tau_{\overrightarrow{PQ}}(A)$
4) $A'B$
5) $A'B \cap q = N$
6) $m \perp p$, т.$N \in m$,
7) $m \cap p = M$