Using a Praxeology Approach to the Rational Choice of Specialized Software in the Preparation of the Computer Science Teacher

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Abstract **– From the positions of Praxeology, the aspects of the forming of the future teachers' abilities to choose software that turns out to be the most rational for the solving of the professional task are considered in the article (on the example of computer science teachers' preparation to use dynamic mathematics software (DMS). The forming of such abilities based on a formula "one task – different software" is described. The methodology of organization of such experimental studies on the base of Sumy State Pedagogical University (Ukraine) is described. The results of the statistical analysis of data are given on the basis of non-parametric sign test for dependent sample. It is educed that taking into account such approach provides the positive dynamics of the level of future informatics teachers' preparation at the significance level of 0.05.**

Keywords **– teacher's preparation, praxeology approach, forming of the abilities to choose software rationally, technology of teacher's preparation, the sign test.**

1. Introduction

State success in various spheres largely depends on the effective activity of its citizens, so the problem of forming such pupil's skills as to organize rationally their activity, to achieve on its basis positive and qualitative results, to adapt quickly to changeable social and natural conditions, should be considered as the most important tasks of the modern school. The modern globalized society in the conditions of ultra-fast development of information tools and technologies requires permanent integration of knowledge, values and pupils' experience. Taking into consideration the needs of the society teacher should be a creative personality who is able to innovatively accomplish research, professional and pedagogical activity. Teacher also should be the organizer of successful and productive activity which determines the expediency of using in pedagogical activity the praxeology principles. Praxeology (gr. praktikos – active and logos – word, doctrine) is a science which studies perfect human activity, its strategy, tactics and action systems. It is aimed to form human need in the development of his/her own intrinsic forces, potentials and abilities, humanization of work, producing a rational system of inner motives to active transforming activity and adopting social experience [5]. The attraction of praxeology ideas allows building a professional activity on the principles of reasonableness, optimality, and greater effectiveness, and a system of professional training of future teachers as specialists of "innovative type of thinking and culture".

Nowadays every Ukrainian teacher is aware of the need to involve informational tools into the educational process. And it is not only about the use of generally known software of office type (such as text editors and spreadsheets, presentation programs, database management system etc.). A variety of software tools makes the educators pay attention to the question of choosing the best product in the range of similar ones from the position of solving professional problems. The question is not trivial, as purely Ukrainian product may be used, but whether it would be rational and reasonable from the standpoint of the modern education services in the context of development of software tools, information and communication systems in the world. In this sense, the use of object-oriented environments, and the

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rationality of their choices in the frame of solving professional problems acquire special meaning.

Concepts for the increasing activity efficiency, rational and productive pedagogical activity were the subject of theoretical and philosophical studies of Ukrainian scientists (V. Andrushchenko, V. Arutiunov, A. Konversi, V. Kremen, Ye. Slutskyi, V. Svintsitskyi, V. Khramov, V. Yaroshovets, etc.) and foreign researchers (O. Lengler [4], I. Kolesnikova, T. Kotarbinskyi, T. Dombrovskyi, T. Pshcholovskyi, O. Titova, etc.). In particular, I. Kolesnikova and O. Titova point out the importance of developing teacher's optimal form of action, as well as the ability to think rationally, and to use various computer tools in their own pedagogical activity [3].

Realizing the need for the reformation of secondary school and the complexity of the situation on the teachers' labor market, especially teachers' of mathematics, physics, computer sciences, which are directly involved in the formation of the Ukrainian nation as an educated strategic human resource of the country, we studied the issue of their training in the context of the development of the information and the knowledge society [6,12]. In particular, earlier was carried out a retrospective analysis of the specialized software in the sphere of mathematics [7, 11]. Such analysis revealed the presence of software of two classes. The first one includes systems of computer mathematics or SCM (in particular, *MAPLE*, *Mathematica*, *Maxima* and similar to them), in which developers laid out the modern methods of numerical and symbolic calculations, mathematical laws of data processing and the rules of mathematical logic. These systems are especially effective in the solution of various applied problems, first of all, problems of mathematical modelling in science and engineering. The second class includes dynamic mathematics software or DMS (in particular, *GeoGebra*, *The Geometer's Sketchpad* and similar to them) which provide not only the opportunity of drawing bright and clear sketches, constructing various graphs, visualization of solutions of equations, inequalities and their systems, but also the possibility of dynamic changes in the initial mathematical model, studying the set of its numerical characteristics or their relations on the basis of visualization [1,8,10].

It should be emphasized that the Ukrainian school course curriculum of computer science is provided with the sections devoted to the study of specialized software of subject-oriented direction, including mathematical. The curriculum of training specialists in the field 014.09 Secondary education (computer science), that is, future teachers of computer sciences, also includes the study of special courses oriented to form skills of using both SCM and DMS. But, as professional practice shows, the teachers' ability to rationally choose the software tool for solving professional task does not form during the special course. It remains an urgent problem of studying a sufficient number of specialized software tools for providing a possibility to choose the most rational in the teacher's work. In other words, theory and practice of teacher training in the context of the rational election of software for solving professional tasks on the basis of a praxeology approach has not yet been the subject of comprehensive scientific research, and we have oriented our scientific and pedagogical searches within the training of computer science teachers.

2. Results and Discussion

The problem of forming future computers science teachers' skills to rationally choose the software tool for solving professional tasks was solved by us in two stages. The first stage was intended to identify a sufficient number of specialized software in the field of mathematics. We chose DMS, because its mastering is more acceptable from the standpoint of school mathematics. It would allow further selection of more appropriate (rational) software. It is the software, the use of which requires the minimum time on its mastering and allows to support quickly, visually and efficiently the learning process.

According to its results [9] it was determined that the optimal amount for ensuring the readiness of future teacher to use DMS is number 5, that is, the mastering of five softwares of the same type allows the teacher to feel himself/herself prepared for their application in his/her professional activity. In particular, among DMS we recommend *Gran, GeoGebra 5.0, MathKit, The Geometer's SketchPad, Cabri3D*.

The second stage was connected exactly with the formation of the skills to choose the most rational product among five available DMS for solving concrete mathematical problem. The realization of this stage involved a study of the peculiarities of computer science teachers' work – the first aspect, as well as the peculiarities of training students who were only trained for such professional activity, – the second aspect.

In the context of the first aspect, we have carried out a survey of computer science teachers (total number was 72 individuals) who work in schools of Sumy region (Ukraine). The questionnaire for computer science teachers, among other things, contained the following questions.

1. Which SCM do you offer pupils for learning?
2. Which DMS do you offer pupils for learning?
3. What types of mathematical problems are discussed at computer science lessons?

4. What software do you use while learning?
5. What forms of learning do you offer at this time?
6. Are students interested in other software tools in the field of mathematics?
7. Is it enough literature to support the correspondent topic?

Processing the questionnaire results has allowed us to draw the following conclusions.

Not every general educational establishment of Ukraine is provided with the opportunity to study various specialized software in the field of mathematics. Frequently computer science teachers at the lessons acquaint the pupils with a DMS for solving problems of plane geometry and the basis of the analysis. And more frequently they use DMS for solving problems with parameters, stereometric tasks or tasks related to statistical data processing.

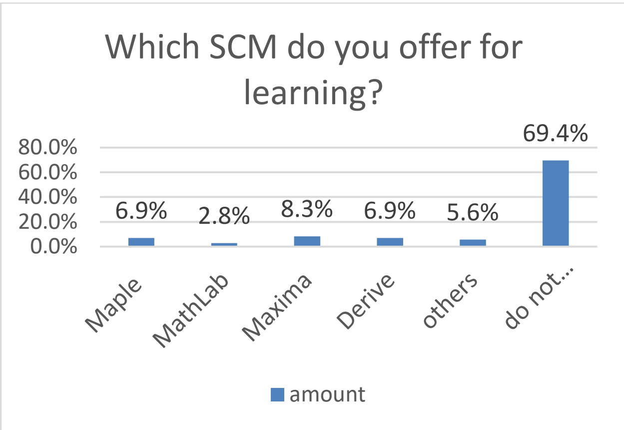

Figure 1. The results of answer to the question 1 of questionnaire

The analysis of attracting specialized software by computer science teachers at their lessons has showed that most frequently the teachers for their lectures select *Gran* and *DG*. Taking into consideration the fact that the majority of teachers of Sumy region were trained in Makarenko Sumy State Pedagogical University (Ukraine) and the choice of used tools could be based on those software, which were studied during the study at the University (and at that time it was softwares *Gran* and *DG*), we decided to conduct additional study on the selection of the most attractive DMS among teachers who work only 5-7 years. There were 39 individuals.

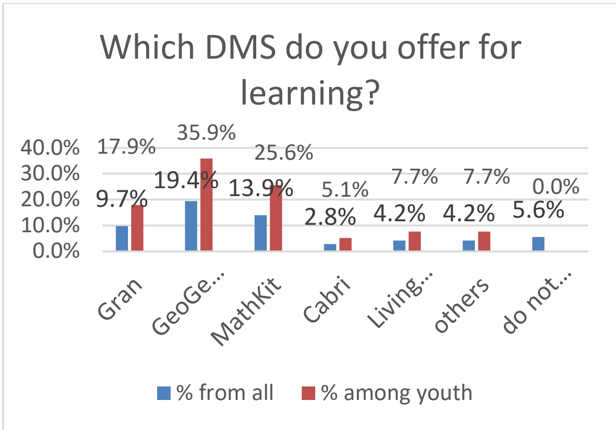

Figure 2. The results of answers to the question 2 of the questionnaire

The results of the survey revealed the inclination of the young teachers towards the *GeoGebra* software.

Table 1. The results of answers to the questions 3-4 of the questionnaire

	Type of mathematical problem	SCM	DMS				
			Gran	*GG*	*MK*	*DG*	*GSP*
1	Planimetric problems on construction		+	+	+	+	+
2	Planimetric locus problems		+	+	+	+	+
3	Geometric problems on the study		+	+	+	+	+
4	Problems on solving equations	Maple, Maxima	+	+	+		+
5	Problems on the drawing function graphs	Maple, Maxima	+	+	+		+
6	Problems with parameters		+	+	+		+
7	Stereometric problems on sections		+	+			
8	Problems on statistical calculations		+	+	+		
9	Problems of the basis of the analysis	Maple, Maxima	+	+	+		

As a rule, pupils are offered to get acquainted with SCM and DMS in the form of labs or workshops, with already determined manner of work, and the lack of time does not allow to use problematic or project technologies, interactive teaching methods etc. Teachers admit the total indifference for the study of specialized software in the field of mathematics that is not bound to the school curriculum, and also emphasize on too small amount of methodical literature, which would help computer science teacher in organizing learning of specialized software in another subject area.

With the help of our observations we have also found that quite often the following situations happen:

1) necessary tools are not provided by the developers of separate DMS for solving a certain class of problems;

2) the problem is solved by computer tools of the selected DMS, but these tools cannot be considered to be well-chosen for solving a certain class of problems in relation to other DMS tools.

Therefore, the implementation strategy of the special course, which focuses on development of skills to rationally choose the software tool support, was defined as targeted working out skills to use the tools of different DMS to solve the same problem.

We believe that in the context of the training of a school teacher such a special course should not be equated with certain software. It should integrate studying provided by the developers and the creation of author tools in different DMS, learning to visualize different mathematical objects and different processes that are described mathematically, with equations, inequalities, geometric objects etc. Such a course should include:

1) learning of several DMS in order:

– to show principle possibilities of using modern DMS and provided tools in it;
– to demonstrate the ways and the peculiarities of using different software for the conscious and rational choice of the right computer product to solve specific types of tasks;
– to expand the range of "automatic" solved tasks (for example, to find the extremum, construct the curve of intersection of surfaces etc.);
– to simplify or to work out skills to construct mathematical objects;

2) the realization of interdisciplinary connections not only with the academic mathematical courses, but also, for example, with physics, biology and chemistry;

3) the formation of a natural and conscious desire to use computer tools;

4) the study of various methods of solving problems realization (constructional tasks, algorithmic problems, tasks on proof, tasks of searching character);

5) the formation of critical thinking in the use of tools for reducing the likelihood of getting false results.

The subject of study of the special course should be computer-tools – virtual mechanisms or algorithms of software, or the software itself that is used for creating or studying mathematical objects or their components through numeric and geometric characteristics of the objects themselves.

The first task of the special course is to make students acquainted with the software of mathematical direction and its classification. The second task is the formation of skills to solve typical problems on the topics of school mathematics course with the use of computer tools. The third task is to form an integral vision of the ways of software usage in the training process, a critical look at the possibilities of bringing computer tools in professional activity, an ability of rational choice in the study of a particular topic or solvating a certain problem. Future teacher should be able to use computer tools for condition visualizing, step-by-step demonstration of solutions, speeding of obtaining results, checking the answer etc.

The long time of the experimental work has allowed us to find an approach to the study of the special course, which was the most effective. Lectures are going on in a usual mode, interactive board for presentations and animation making is actively used. When the involvement of DMS to the solution of the problems is demonstrated, the lecturer stops on only one DMS for a particular problem and does not demonstrate its solutions in other: technologically, everything is realized by the formula "one problem – one DMS, different problems – different DMS".

Student's preparation for laboratory class provides student familiarity with the instructions to the laboratory works that describe the solution of topic problems and that are fixed in methodical recommendations to the course. Several student sub-groups are created, who solve in one of the DMS typical topic problems (the problem statement does not differ for each group, but the DMS differs). After 15-20 minutes students compare and discuss solutions of all subgroups, clarify the advantages and disadvantages of the found solution as to the ways of realization, presentation of the results etc. After that, students are offered other topics' problems, but with the demand to solve them in each of the studied environments (according to the formula "one problem – several DMS".

In such a way of the work organization, as the experiment has shown, future computer sciences teachers know how to operate computer tools of different DMS. Critical view on estimates of the numbers of the solution steps of the same problem, quality of a visual support, possible response format, availability of tools and further rational choice of DMS are formed.

The research was conducted in 2012-2016 and was aimed at studying the question: "Does the special course help to form the skills to rationally select the product of series of DMS in the context of solving specific mathematical problems of a mathematics school course?" Due to the fact that such skills are formed throughout the study of the special course, statistical evaluation of learning results could be based on nonparametric sign test for dependent samples [2].

The special course was provided for conducting two tests – in the middle and at the end of the semester. At these lessons we offered five problems (problem variants differed only in numeric data).

Further we give an example with the methodological review.

Problem. 25 students answered the test questions. Then the students evaluated the test difficulty from 1 (very easy) to 5 (very difficult) and got the following results: 4 students evaluated the test as very easy (1 point); 6 students evaluated the test as easy (2 points); 6 students evaluated the test as difficult (4 points); 1 student evaluated the test as very difficult (5 points). Other students believed that the difficulty of the test was the average (3 points). It is necessary to construct the polygon of frequencies, distribution function, calculate the mathematical expectation, average quadratic deviation, mode and median for the obtained results.

Methodological review. Support of statistical calculations can be done in software *Gran1* and *GeoGebra 5.0*. Unlike *GeoGebra 5.0*, where data must be inserted in the table and use the analysis tools, in the software *Gran1* it is offered to select the type of distribution (discrete or continuous) and the type of data (frequencies, relative frequencies or the variants). It is also worth remembering that in *Gran1* for a continuous distribution you need to enter personally equidistant middles of intervals and frequencies falling in these intervals. In *GeoGebra 5.0*, you can enter the frequency, and then in automatic mode specify the width of the pockets and the meanings.

Both are provided with possibility to build the polygon of frequencies, but the distribution function is calculated in automatic mode only in *Gran1*. Both calculate the mathematical expectation and average quadratic deviation. In *Gran1* for discrete distribution the mode is automatically determined, for continuous – median is determined. While using *GeoGebra 5.0* you can determine the mode additionally via the command line, and the program calculates the median automatically.

In the context of school mathematics we believe that the best choice in solving this problem is the software *Gran1*.

Answer: it's more rational to choose the software *Gran1*.

We estimated every reasoned and a good choice of DMS at one point. For example, if the student chooses software correctly, in our context rationally, for solving three problems from the five proposed, then he gets score 3. At the end of the semester comparative tables were made, where the results dynamics was fixed.

Each year (from 2012 till 2016) results from samples with volume 37, 35, 38, 37, 31 were accumulated. The total number of respondents was 178 individuals. Thirty results were taken at random (tabl.2).

Table 2. The test results of students

№ of student	First score	Second score	№ of student	First score	Second score	№ of student	First score	Second score
1	2	4	11	2	3	21	3	4
2	4	4	12	1	4	22	2	3
3	3	3	13	4	5	23	2	2
4	3	3	14	1	3	24	3	2
5	3	3	15	1	2	25	3	3
6	1	2	16	4	5	26	3	3
7	2	3	17	3	4	27	3	3
8	2	2	18	3	2	28	4	5
9	4	3	19	3	4	29	2	3
10	3	3	20	2	2	30	3	4

These points determined the number of respondents whose total score decreased ("–"), not changed ("0") and increased ("+") – table 3.

Table 3. Dynamics of scores in the test results of students

Dynamics of scores	Negative, «–»	Without changes, «0»	Positive, «+»	The number of changes, n=«–»+«+»
The number of respondents	4	11	15	19

In accordance with the experiment aims we have formulated the null hypothesis: the study of the special course is not conducive to the formation of the skills to rationally choose a product of DMS series in the context of solving specific mathematical problems of a mathematics school course. Then the alternative hypothesis is: the study of special course promotes the formation of such skills.

These hypotheses define one-sided sign criterion for testing dependent samples. So, according to the rule of decision making we have [2]: the value $T_{exp}=15$ (it is the number of signs "+" in the sample), $n=19$ (it is the number of respondents who have had changes in results), the field of the null hypothesis acceptance: [6] is at a significance level of 0.05.

As T_{exp} is not included to the interval of hypothesis acceptance H_0, we reject the null hypothesis and accept the alternative with conclusion that studying of the special course promotes formation of the skills to rationally choose DMS. So far as the value of T_{exp} goes beyond the cut to the right, then we are to make a conclusion about positive dynamics in the number of students who have formed a critical view at the use of a specific DMS and its tools.

3. Conclusion

Praxiological approach characterizes the practice-oriented methodological knowledge about general principles and methods of rational and productive pedagogical activity. It defines the principles and conditions of realization of the transformational teacher activity in professional work. It also defines methods, techniques, and technologies that should be possessed by the teacher; innovative methods and forms of pedagogical activity. These methods and forms in search conditions of more reliable and effective ways of obtaining the planned results acquire praxeology characteristics.

2. The study of the problem of forming future teachers' skills to rationally choose the software for solving professional problems from the standpoint of praxeology approach determines logical requirements to the organization of action within the educational process. The conducted pedagogical research gives grounds to claim that the organization of learning in the study of various pieces of software should be based on the formula "one problem – different software", which requires to focus on learning several pieces of software at the same time. Considering this approach provides a positive dynamics of the grounding level of future computer science teachers at non-parametric sign test for dependent samples at significance level 0.05.

3. One of the determinative praxeological characteristics of the proposed technology is its effectiveness. The teacher who comprehends, summarizes, and offers his/her own pedagogical approach in the use of a particular software, improves the entire image of his/her own professional activity – the author's method. Along with this, we believe that the problem of skill to rationally choose software to support professional activity is eliminated in the process of time, when it has already gained experience with the tools of various means and identified problems and determined the possibilities of their use at computer science lessons.

4. Taking into account the fact that the number of software of a separate branch of knowledge in the world grows, their versions are updated through the addition of new computer tools, there is often a problem for teachers to rationally choose one piece of software among a variety of others. The solution of this problem, on the one hand, encourages working teachers to get acquainted with such tools on refresher courses or independently, and, on the other, requires a revision of the curriculum of those courses that are focused on the study of subject oriented software.

5. Our gained experience can be approximated in the training of specialists of other spheres, so the curricula of their training should include special courses on the study of several software tools in their fields of knowledge.

References

[1]. Drushlyak, M. G. (2014). Computer Tools “Trace” and “Locus” in Dynamic Mathematics Software. *European Journal of Contemporary Education,* 4, 204-214.

[2]. Grabar, M., & Krasnyanskaya, K. (1977). Application of mathematical statistics in educational research. Nonparametric methods. *M.: pedagogika, 1977.–136 p*.

[3]. Kolesnikova, I. A., & Titova, E. V. (2005). *Pedagogical Praxeology: manual for students*. Moscow: Izdatel'skij centr «Akademija».

[4]. Lengler, O.A. (2012). Application of praxeology approach in the process of development of subjectivity of students. *Pedagogicheskoe obrazovanie v Rossii*, 5, 203-207.

[5]. Pshholovskij, T. (1993). *Principles of perfect activity: (Introduction to Praxeology).* Kyiv: In-t prakseologii.

[6]. Semenihina, O. V., & Drushlyak, M. G. (14-16 May 2015). On the Results of a Study of the Willingness and the Readiness to Use Dynamic Mathematics Software by Future Math Teachers. *ICT in Education, Research, and Industrial Applications: Integration, Harmonization, and Knowledge Transfer. Proceedings of the 11th International Conference, ICTERI 2015*, 21-34.

[7]. Semenihina, O. V., & Drushlyak, M. G. (2014). Computer Mathematical Tools: Practical Experience of Learning to Use Them. *European Journal of Contemporary Education*, 9(3), 175-183.

[8]. Semenihina, O. V., & Drushlyak, M. G. (2014). Computer tools of dynamic mathematics software and methodical problems of their use. *Information Technologies and Learning Tools*, 42(4), 109-117.

[9]. Semenihina, O. V., & Drushlyak, M. G. (2015). Dynamic Mathematics Software: a Quantitative Analysis in the Context of the Preparation of Math Teacher. *Information Technologies and Learning Tools*, *48*(4), 35-46.

[10]. Semenihina, O. V., & Drushlyak, M. G. (2015). Organization of Experimental Computing in Geogebra 5.0 in Solving Problems of Probability Theory. *European Journal of Contemporary Education,* 1, 82-90.

[11]. Semenihina, O. V., & Drushlyak, M. G. (2016). Dynamic mathematics software as means of visualization of mathematical knowledge: analysis of the terminological field. *Pedagogichni nauki: teorija, istorija, innovacijni tehnologiï*, *2* (56), 383-389.

[12]. Semenihina, O. V., & Drushlyak, M. G. (2016). Dynamic Mathematics Software as a Necessary Component of Modern-Math-Teacher Preparation in Ukraine. *Journal of Advocacy, Research and Education*, *5*(1), 29-37.