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Pedagogical Experiments On The Development Of Professional Competencies Of Students Based On An Integrative Approach And Their Results

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ABSTRACT

The article presents the results of pedagogical experiments on the development of professional competencies of students on the basis of an integrative approach. The questions and assignments used in pedagogical experiments and their essence are described. Based on the conducted pedagogical experiments and the results recorded in them, teachers were recommended to teach students mathematics and specialized disciplines on the basis of an integrated approach in the formation of professional competencies.

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I. Introduction

Competence in terms of the requirements for the level of professional training of graduates of higher education institutions means the ability of the future specialist to apply a set of knowledge, skills and abilities, methods of activity in certain situations. Competence in terms of pedagogical activity is the ability to establish a link between knowledge and situation, or in a broad sense, to show the process (action and knowledge) needed to solve a problem. Integration is the process by which the different parts of a system, the whole organism, are interconnected and cause the same thing. Integrated science teaching allows for the simultaneous and interdependent study of related topics. Integration in the educational process is a specific and interdisciplinary approach, and its implementation in the classroom is an integrative approach. An integrative approach is used to integrate content that is relevant, relevant, logically interdependent, and deepens and expands. In the implementation of the integration of mathematics and specialty sciences, pedagogical experiments were conducted to quantitatively and qualitatively assess the methodology we have developed. The purpose of pedagogical experiments is to improve the theoretical methodology of developing students' professional competencies on the basis of career-oriented tasks. Pedagogical experiments were carried out in three stages in 2018-2021 at Samarkand State University, Bukhara State University and Tashkent State Pedagogical University. The first phase of pedagogical experiments was an important experiment in 2018-2019. Its main responsibilities are:

1. Identify non-traditional methods of teaching mathematics to students and their shortcomings, create a level of mathematical training for junior students.
2. Defining the integration of mathematics with the specialty sciences as a teaching subject.
3. Selection of research methods.

II. Material and Methods

In order to find possible ways and means to increase the effectiveness of the process of teaching mathematics, the structure and content of curricula in physics, physics and astronomy teaching methods were studied, and the State Education Standards for these areas were analyzed. Interviews and tests of students and students of 1-2 levels participating in preparatory courses for admission to universities in the defining stage of pedagogical experiments, observation and analysis of lessons in higher mathematics, interviews with students, written work, analysis of their results, research methods such as interviews with higher mathematics and specialty science teachers. During the pedagogical experiment, we conducted a survey of students of Samarkand State University, Bukhara State University and Tashkent State Pedagogical University, and the survey questions included:

1. What made you choose a specialty?
2. How do you assess the reputation of your future profession?
3. What do you know about your future career?
4. Is there a future for your profession? (Reserves for growth)
5. What do you mean by "professional activity"?
6. Why did you choose this university?
7. What is the purpose of being highly educated?
8. How interesting are math materials to you?
9. Do you need math in your chosen career (job) in life?
10. Can math knowledge help you gain a professional qualification? (Please explain)

The survey involved 237 first-year students of selected higher education institutions in 2018-2019. 22% of respondents who answered the first question noted that family traditions influenced career choice. At the same time, it has become clear that students are increasingly listening to their parents' advice when choosing a university. When asked how they assess the reputation of their future profession, the majority of respondents, or 53%, answered "good". Therefore, it can be said that the profession of teacher of physics, physics and astronomy has a high status among young people. When asked what they know about their future careers, 51% of learners said they had no idea about their future careers. 10% of the participants answered "yes or no". When asked if their profession is promising, 57% of those surveyed said that their chosen profession is promising and that the society needs qualified personnel in this specialty. This is not surprising, as the field of teaching physics, physics and astronomy is a more stable and promising direction. 43% of those surveyed believe their chosen profession has no future. When asked what they mean by professional activity, 49% of respondents said that they understand the idea of sharing new ideas in the first place, 28% of respondents gaining leadership in the second place, and 23% of respondents mastering professional skills in the last place. When asked what the goal of higher education is, 34% of respondents said that financial security, 26% want to achieve the desired social status, 17% want to learn, be an educated, qualified professional, 23% are interested in (social development standards, family traditions, etc.) gave. The first place corresponds to the first two positions. When asked how interesting math materials are for you, 54 percent of respondents said they were interested, 27 percent said yes, no, 16 percent said they weren't interested, and 3 percent said they didn't know. According to the survey, 37% of students consider their knowledge of mathematics to be necessary in their future careers, 24% accept mathematics knowledge only as an element of general education, and 39% believe that knowledge of mathematics is not required at all. According to these data, the official presentation of a higher mathematics course leads to a decrease in the level of motivation to study this subject and has a negative impact on the quality of knowledge.

For students, the acquisition of knowledge that is not immediate or related to a prospective activity does not meet the requirement. 67% of third-year students who had the opportunity to get acquainted with the application of mathematics in the teaching of special sciences in the teaching process answered in the affirmative to the question about the role of mathematics in the teaching of special sciences. Nevertheless, 58% of the students had difficulty learning of the specialty subjects using their knowledge of the mathematics course. At the same time, 83% of the surveyed junior and senior level students stressed the need to focus higher mathematics courses on future specialization.

In the second research phase of the pedagogical experimental work, the formation of hypotheses and research tasks, the general classification of the theoretical model and the search for ways to solve research problems were carried out. The object, subject, purpose, specific tasks and hypotheses of the research were improved and defined, teaching materials were developed for lectures and practical exercises. At this stage, the following tasks were solved:

1. The study of higher mathematics concepts, which is the most appropriate form of competence based on the integration of mathematics and specialty sciences.
2. Selection and formulation of tasks for practical content.
3. Forming a set of practical problems.
4. Preparation of methodical developments.

Students learned that the concepts they are learning are of great practical importance, and that the concepts of function and its derivatives, integrals, and the like are related to the problems of the specialty sciences in the classroom. They were invited to find solutions to problems and use information technology in the study of mathematics.

At this stage of the experiment, career-oriented tasks were developed by understanding the solution of practical problems in the field of specialty sciences. In the process of teaching mathematics, the professional competencies of students were developed through career-oriented tasks. The experiment was conducted under natural conditions, in natural time measurements during the learning process.

At the third stage of training, the development of professional competencies in students was carried out, the effectiveness of the developed methodology was confirmed.

III. Results

The purpose of the pedagogical experiment is to test the methodology of developing professional competencies based on the integration of mathematics and specialty sciences in the learning process, to test its effectiveness in solving problems and improving professional competencies. The effectiveness of the method was tested on parameters such as improving the quality of mathematical data and the level of the learning process, encouraging learners to learn mathematics.

We used the formed control tasks to determine the results. 293 students of Samarkand State University, Bukhara State University and Tashkent State Pedagogical University (12 groups in total: 6 experiments and 6 control groups) took part in pedagogical experiments (see Table 1):

Table 1.

Number of students in the experimental and control groups of higher education institutions where pedagogical experiments were conducted

№	Educational establishments	Number of students in the experimental group	Number of students in the control group	Total number of students
1.	Samarkand State University	48	45	93
2.	Bukhara State University	50	51	101
3.	Tashkent State Pedagogical University	48	51	99
General		**146**	**147**	**293**

The results of tests, examinations and written tests were used to assess the quality of mathematical data. The training in the pedagogical experimental groups was conducted in accordance with the experimental technique, the basic rules of which are reflected in the research. The objectivity of the results of pedagogical experiments mainly depends on the correct selection of experimental and control groups. When they were selected under experimental conditions, the initial preparation in all groups and other features that affected the observed parameters were approximately equal.

In the pedagogical experiment, at the beginning of the 1st semester from the control and experimental groups were conducted preliminary tests to test the level of knowledge and mastery of

students. The test results were evaluated on a five-point scale. Their results are presented in the following table by educational institutions (see Table 2):

Table 2.
Test results

№	Educational establishments	Groups	Number of students	Levels of assessment			
				«2»	«3»	«4»	«5»
1.	Samarkand State University	**Experimental group**	48	**12**	**25**	**10**	**1**
		Control group	45	**12**	**23**	8	2
2.	Bukhara State University	**Experimental group**	50	**14**	**24**	**10**	**2**
		Control group	**51**	**13**	**25**	11	2
3.	Tashkent State Pedagogical University	**Experimental group**	48	**13**	**23**	**10**	**2**
		Control group	51	**14**	**24**	11	2
General		**Experimental group**	**146**	**39**	**72**	**30**	**5**
		Control group	**147**	**39**	**72**	**30**	**6**

The method developed by P.I.Tretyakov was used to determine the level of learning in the educational process. Taking into account all the indicators listed above, the level of knowledge of students is reflected as follows (see Table 3):

Table 3.
Students' levels of knowledge

№	Knowledge level	Description of education level
1.	**Lower**	**the student learns the information after a long training and then does not know it completely, it is difficult to highlight the necessary information, after the general exercise with the whole group, the task is performed mainly on samples. It takes a long time to understand the information**
2.	**Medium**	**students learn new information after a certain training, distribute it immediately as needed, and see it in a private setting after the necessary exercises. It takes more time to master knowledge and work methods, to transfer them to new situations, to reach a higher level of knowledge**
3.	**High**	**the student learns the material freely, has mental operations, knows how to distinguish the main thing, in general, can independently develop the positions described in the lesson, easily transfers knowledge to new situations, achieves high levels of knowledge and methods of acquiring them in a short time has**

According to this technique, the following generalized scheme was used to diagnose the level of education:

1. The teacher selects a small amount of basic material.

2. Before teaching new material, the teacher repeats the previous material, which is necessary for the acquisition of new information, and then explains the new material.
3. Shows an example of applying new material in a similar and modified situation.
4. Conducts independent work among students, which includes the following tasks:
   a) write down what you just learned;
   b) answering questions on the content of the new material;
   c) perform the task according to the sample;
   d) performance of a task in a changed situation;
   e) apply the knowledge gained in a new situation.

IV. Discussion

The generalized tasks outlined above should be used by us in the preparation of independent work on any topic and topic. During the pedagogical experiments, independent work was carried out for control and experimental groups on various topics (see Table 4):

Table 4.

Results of independent work carried out during pedagogical experiments

№	**Educational establishments**	**Groups**	**Number of students**	**Levels of assessment**		
				«3»	**«4»**	**«5»**
1.	Samarkand State University	**Experimental group**	48	**5**	**30**	**13**
		Control group	45	**19**	19	7
2.	Bukhara State University	**Experimental group**	50	**9**	**26**	**15**
		Control group	**51**	**22**	21	8
3.	Tashkent State Pedagogical University	**Experimental group**	48	**9**	**24**	**15**
		Control group	51	**23**	19	9
General		**Experimental group**	**146**	**23**	**80**	**43**
		Control group	**147**	**64**	**59**	**24**

To determine and assess the level of mathematical knowledge of students, the method defined by V.P.Simonov was used. In the pedagogical experiment, a ten-point measurement structure was used to assess students' knowledge (see Table 5):

Table 5.

Existing and changing relationships in the ten-point measurement structure

Recommended measurement	**Modified measurement**	**Available measurements**
1 point - very weak	Professional competence minus	3 points
2 points - weak	Three minus	
3 points - unsatisfactory	Three	
4 points - satisfactory	Three plus	
5 points - not good enough	Four minus	4 points

6 points - good	Four	
7 points - very good	Four pluses	
8 points - excellent	Five minus	5 points
9 points - great	Five	
10 points - perfect	Five plus	

The existing and changing relationships of the ten-point scale formally allow the teacher to make a final assessment in accordance with the State Education Standards on a five-point scale and in fact on a three-point scale. Based on this assessment criterion, the composition of the assessment of students' levels of education was determined (see Table 6):

Table 6.

The structure of the assessment of the level of education

10-point scale	**The main indicators of the level of education of students**	**Acquired knowledge**	
		In percent	**Degree**
1 point, very weak	He attends classes under the dictatorship of teachers and students, tries to enter the algorithm to implement the practical part of the material	Up to 1%	Separation, recognition (level of acquaintance)
2 points, weak	With the help of a teacher or students, he or she remembers and repeats some of the basic concepts and concepts of the theory, distinguishing the object from similar things only when presented in a finished form. By applying this theory, one cannot perform any practical tasks independently	2% to 4%	
3 points, unsatisfactory	He remembers most of the theoretical material, but cannot explain anything, he is confused in the answers. In practice, it cannot solve the problem. Spontaneity reigns in the decision	5% to 9%	Forgetting (reprocessing)
4 points, satisfactory	He remembers all the theoretical material, unable to do practical work on the subject. Practical exercises with the help of teachers and students allow for many calculation errors	10% to 16%	
5 points, not good enough	He can explain some theoretical concepts, sometimes thinking operations, only the algorithm solves known operations. Allows for calculation errors	17% to 25%	Comprehen-sion (conscious repetition)
6 points, good	Demonstrates the ability to answer a wide range of questions, understand theoretical knowledge, and draw independent conclusions. Without hesitation solves problems with a certain algorithm	26% to 36%	
7 points, very good	Unequivocally and logically presents theoretical material without external assistance, is able to generalize and draw conclusions. Applies theory to practice. Uses the actions taken in the decision	37% to 49%	Basic skills (reproductive level)
8 points, excellent	A complete understanding of the essence of the theory, its application in practice, in particular, demonstrates thinking. In the time allotted for this, he performs practical tasks, sometimes correcting mistakes himself	50% to 64%	
9 points, great	Easily performs practical tasks, independently develops new skills. Uses theory freely. Solves non-	65% to	Transfer (creative

	standard tasks. Prevents calculation errors	81%	degree)
10 points, perfect	Applies scientific, creative, non-standard knowledge in practice. He is able to study independently, work with additional literature, textbooks, computers	82% to 100%	

Comparing the experimental and control groups of students, the following results were obtained (see Table 7):

Table 7.

Results of a comparison of students' experimental and control groups

Educational levels	**Distribution of appropriate points**	**For all universities**	
		Experimental group	**Control group**
Separation, recognition (level of acquaintance)	1 point	3	7
Forgetting (reprocessing)	2 points	3	9
Comprehension (conscious repetition)	3 points	41	70
Basic skills (reproductive level)	4 points	72	49
Transfer (creative degree)	5 points	27	12
General		**146**	**147**

Two control studies were conducted at the end of the first semester and in the middle of the second semester to determine the level of mathematical knowledge of students in the experimental and control groups (see Table 8):

Table 8.

Levels of students' mastery of mathematical knowledge

Evaluation indicators	**Experimental group**		**Control group**	
	first control	**second control**	**first control**	**second control**
2 points	10	3	13	11
3 points	72	30	70	70
4 points	51	81	50	52
5 points	13	32	14	14

At the end of the experiment, the final control work was carried out (see Table 9):

Table 9.

Results of final control work

№	**Educational establishments**	**Groups**	**Number of students**	**Evaluation levels**			
				«2»	**«3»**	**«4»**	**«5»**
1.	Samarkand State University	**Experimental group**	48	**1**	**9**	**29**	**9**
		Control group	45	**4**	**21**	17	3
2.	Bukhara State University	**Experimental group**	50	**1**	**11**	**28**	**10**
		Control	**51**	**4**	**26**	18	3

3.	Tashkent State Pedagogical University	**Experimental group**	48	**1**	**11**	**28**	**8**
		Control group	51	**4**	**26**	18	3
General		**Experimental group**	**146**	**3**	**31**	**85**	**27**
		Control group	**147**	**12**	**73**	**53**	**9**

V. Conclusion and Acknowledgement

Based on the results of this pedagogical experiment, the following recommendations can be made on the effectiveness of developing students' professional competence in teaching mathematics on the basis of integration with special disciplines:

- The role and place of career-oriented tasks in the development of students' professional competencies is of great importance.

- It is necessary to develop a set of career-oriented tasks linking mathematics and specialty sciences in each specialty. Based on them, the methodology for developing students' professional competencies should be improved through consolidation (consolidation), federalization (generalization) and data dissemination methods.

- The use of computer programs (MathLAB, MathCAD, MapleV, AutoCAD and S ++) in career-oriented tasks and their solution in practical training is the basis for students to consciously understand the need for in-depth study of mathematics and information technology to acquire professional competencies.

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