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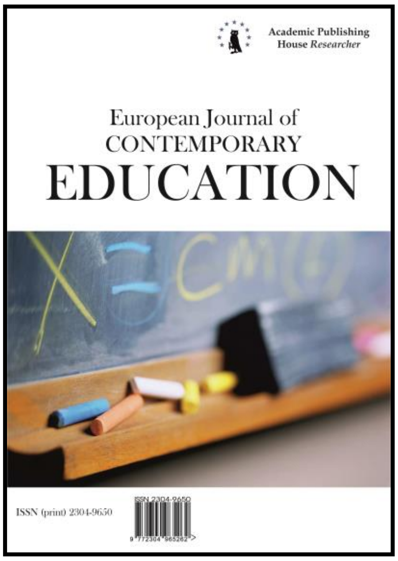

The Problems of Contemporary Education

Evaluation of the System of Methodical Training of a Physics Teacher in the Conditions of Modernization of Education

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Abstract

Training of Physics teachers remains still a quite big challenge in the context of developing secondary education system. Taking into account new objectives in teaching Physics of pupils and students within the emerging philosophy of education and the objective difficulties of mastering the content, the training of a Physics teacher should be identified as a separate problem not only in practical but also in theoretical terms. In this regard, this study considers methodological training of a future Physics teacher at the University as an element of new educational system of higher pedagogical education.

This study is the first in the above direction, the level of expected results can be characterized as methodological one. The study is aimed at the development of improved methodological training of future Physics teachers at the university in the context of high education modernization. Methodological training system of a Physics teacher has been developed that ensure better training of future teachers in Kazakhstan. Various methodological tools are applied in educational process to form scientific methodological thinking and methodological competences of students.

Keywords: methodological training system, future physics teacher, higher education system, competence approach, methodological competence, molecular physics.

1. Introduction

Professional competence of a teacher becomes more spacious in view of new educational approaches. Global status and prestige of being teacher goes up drastically owing to the management and monitoring of a methodological system. By the way, approaches of a teacher's

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professional development (Petrescuetal, 2015) are gradually updated and varied in the amount, frequency, scope and level of centralization. Labor standards for school teachers reflect quality criteria of achievements in professional competence of pedagogical education. The national educational development program for 2011–2020 addresses actual educational standards. Updating the content of education makes teachers apply new modern forms of work (http://kz.government.kz).

A number of studies performed worldwide is cutting across several aspects of a didactic nature including features of didactic teacher's training to collective cognitive activity of students (Ibrahim et al., 2016; Kintz et al., 2015), teacher's readiness to the organization of creative interaction with students (Ramankulov et al, 2016), impact of didactic teacher's readiness to pedagogical students' guidance (Shektibayev et al, 2018) and teacher's readiness to manage the learning process in small schools (Mujtaba, Reiss, 2014), etc.

However, it must be admitted that despite some successes achieved in various areas, the vast majority of research work in one way or another affects, first of all, the sphere of educational activities. Theoretical analysis of the research allowed us to determine that many questions of methodological work are still insufficiently disclosed, and most importantly – we need a holistic view for the educational process as a system of interaction of content, methods and forms of education aimed at the formation of student's personality. Although some issues were considered related to the study of certain mechanisms of methodological work as such, so far methodological work has not received proper coverage both in common pedagogical literature and in scientific research, where in particular, these issues have not been subjected to special analysis in recent years.

Practical needs of school gave rise to objective necessity of methodological teachers training for the implementation of students' mentoring and schooling. Revision of educational curricula and programs, updating textbooks and introducing active methods and forms of education were stand-alone of the methodological system as a whole, without a deep analysis how it will be implemented in a school. The development of any educational process can be predicted by analyzing contradictions associated with the structure of methodoloical system. Difficulties in its organization arise from the mismatch of the purpose and content of activities; specific tasks and means of achieving them, the content of activities and forms of organization; goals and results of training and development of students' abilities. Knowledge of these contradictions directly influences practical actions of the teacher, literacy of the organization of pedagogical and methodological interaction. The resolution of contradictions in teacher's activity is directly dependent on his/her understanding regulatory function of the methodological educational systems. From the definition of methodological work it follows that its immediate goal is to increase the level of pedagogical skills of teachers and teaching staff. The question of the goals and objectives of methodological work should be considered on the basis of level relationships, i.e. should determine the main directions that are common, necessary and typical for all schools in modern conditions, on the basis of common tasks that are rightly called the functions of methodological work.

In papers devoted to common issues of professional training of teachers, most authors consider methodological training of teachers as part of professional training (Knewstub, Bond, 2009), where methodological knowledge is formed in an integral and inseparable connection with general, psychological, pedagogical and special (subject) knowledge and skills (Jauhiainen et al., 2002).

In connection with the development of new standards of higher pedagogical education, the transition to a multi-level higher education in the theory and practice of pedagogical activity (MacPhailetal, 2013), more and more research is devoted to the development and implementation of innovative forms of educational process in higher education, including methodological training of a teacher.

Much attention is paid to the problem of methodological training of students in methodological research, and authors raise the question of improving the quality of methodological training of teachers (Cofré et al, 2019).

Since the concepts of methodical thinking and professional thinking are specific with regards to generic concept of thinking, we can start with its explanation. After we have analyzed lots of definitions of "thinking", we came to the conclusion no one of them can be fully satisfied. Moreover, such a definition may not be possible in principle, given the complexity of the object. The main thing, however, is that for our purposes it is more useful to exercise all the variety of definitions to understand characteristics that seem most important to researchers. It is no coincidence that epistemologists state "knowledge of the subject is in knowledge of its features."

First of all, it should be noted (Henriksen, 2014) abovementioned definitions consider "thinking" from different positions: as a socio-historical phenomenon, as a philosophical phenomenon, as a physiological phenomenon and as an epistemological phenomenon. This is understandable, because only a comprehensive approach to the phenomenon ensures deeper understanding. And if we set a goal to develop thinking, we will not be able to achieve it without understanding the relationship of subjective and objective in thinking, empirical and creative, rational and sensual (epistemological aspect), without understanding it as a motivated and purposeful activity that has personal significance (psychological aspect), without understanding the forms and rules of thinking (logical aspect), etc.

The efforts investigating thinking (Chen, Lo, 2019) highlight the idea of the origin of mental processes from external activities. According to this idea, a mediated structure of mental process is initially generated under conditions where a mediating link has the form of an external stimulus. When mastering this mediating link, it passes into the inner plan through the interiorization. In his and his followers' research papers Chen established a close relationship between the development of thinking and speech.

R.A. Beghetto (2007) colligating psychological mechanisms of thinking with its indicative function, believed that psychological mechanisms are revealed in the process of building a mental image that focuses on solving problems (both practical and theoretical). However, there is a certain discrepancy when classifying the types of mental operations and their interpretations. Some classifications call the types of mental operations that are not in others, although they are no less important.

The thinking takes on the role (Hernán et al., 2019) of personality (especially motivation) when the reasons are pointedly studied and in general, person's attitude to mental problems he decides. If the first of these two aspects characterizes thinking as a process, the second one distinguishes it as an activity in the course of which a person is shaping certain attitude towards the surrounding world, to other people, to emerging problems, etc.

So, all of the above identifies the following methodical thinking features of a Physics teacher: Methodical thinking is a kind of professional pedagogical thinking having dual character in connection with special subject (physical) determination. Reflexivity and responsiveness are its features associated to professional activity. Methodical thinking corresponds to the level of development of methodical science in each individual historical period, so its features are historicity and scientificity.

A functioning level of methodical thinking indicates how stable a Physics teacher engrained his methodical skills (Ozgelen et al., 2013). Thus, intelligent methodical thinking acts as the most important indicator of a teacher's *methodical readiness* to his future professional activity. Under the conditions of today when transiting to new updated standards and when school physic's education is focused on the implementation of a personal-activity approach, the development of cognitive and creative abilities of students, an adequate level of development of methodical skill is the level of methodical competence, which is provided by productive and creative levels of development of methodical thinking.

Based on research studies we've analyzed our study views to the definition for professional competency of a Physics teacher as a synonym for teacher's readiness to carry out professional activity. Teaching and learning competence of a Physics teacher as a category of lower taxonomic rank in relation to the category of professional competence of a Physics teacher can be considered as a result of his methodical training, expressed in his ability and readiness (functional and personal) to effectively perform all kinds of professional activities determined by the functional structure of methodological thinking.

Teaching and learning competence of a Physics teacher is defined as a set of knowledge, skills and personality traits facilitating successfully solve methodological issues.

In the course of the study the following tasks of scientific research were solved, to take into account specifics of circumstances, level of development of teaching staff, progress and results of educational activity. That makes it possible to formulate a set of specific tasks for the organization of methodological work on the basis of an innovative approach as follows:

- formation of innovative orientation in the activities of teaching staff in school, manifested in the systematic study, generalization and dissemination of pedagogical experience, in the implementation of achievements of pedagogical science;

- improving the level of theoretical (subject) as well as psychological and pedagogical training of teachers, time management of new educational programs, curricula of national educational standards;

- gaining new pedagogical technologies, forms and methods of training and education, time management in study new norms of effective documents, provision of scientific and methodological assistance to teachers on a diagnostic individualized and differentiated basis: young teachers; subject teachers; class teachers and educators; teachers experiencing some difficulties in teaching; teachers with little pedagogical experience to teachers who do not have pedagogical education;

- consulting teachers in self-education;

- rise of professional level and pedagogical culture.

The idea beyond the scientific approach to definition of tasks of methodological work is that the purpose and objectives can be understood as the quality of student's knowledge and model of desired future result in innovative activity of school.

2. Materials and methods

300 (Three hundred) third-and-fourth-year students took part in a survey to make clear current situation with physics teaching in general education institutions of Kazakhstan and analyze prospects of its development and level of methodological training of graduates from the Faculty of Natural Sciences of the International Kazakh-Turkish University named after Akhmed Yassawi; Faculty of Physics and Mathematics of South Kazakhstan University named after M. Auezov and Kyzylorda State University named after Korkyt Ata.

The survey showed that students suffer from not so much a lack of knowledge as low intellectual culture, stiffness of thinking, lack of self-educational skills. Most youth Physics teachers undergo difficulties when they have interned or at the beginning of their teaching career. Below are the most frequently called difficulties:

- psychological and pedagogical (inability to master classroom discipline, individual approach, psychology and age peculiarities of students)

- classroom time management (slight practical experience, large teaching load, difficulties in classroom time management)

- communication (students, students' parents and colleagues interaction)

- methodology (lack of knowledge for scientific analysis of programs and textbooks, inability to select programs and textbooks, fully apply technologies, methods and means of training).

To determine these difficulties, a survey of young teachers and students was conducted, as well as testing of students. Table 1 illustrates various difficulties experienced by specialists with a wide range of education.

Table 1. Difficulties commonly found in survey returns by students and graduates

Level of education	**Difficulties**			
	Psychological and pedagogical	**Organizational**	**Communicative**	**Methodological**
Third-year students	24 %	34 %	26 %	16 %
Fourth-year students	14 %	32 %	20 %	34 %
Youth teachers	10 %	16 %	10 %	64 %

Psychological and pedagogical aspects cause the least difficulties. Organizational difficulties are most experienced by those who have less teaching experience. Methodological problems are forged as work experience grows. Theoretical analysis and results of the survey they allowed us to identify the existing contradiction and thus justify it relevance of our research.

While studying chosen discipline of general physics course "Molecular physics", it was clear that students change their attitudes to the main components of physics teaching with growing of work experience (Table 2).

Table 2. Students' attitude to the individual components of profeccional training

Components of profeccional training	**Third-year students**	**Fourth-year students**	**Graduates, youth teachers**
Subject knowledge	55 %	50 %	25 %
Knowledge of psychological and pedagogical principles of education	20 %	20 %	5 %
Teacher's personal skills	20 %	10 %	20 %
Knowledge of training methods in molecular physics	5 %	20 %	50 %

Those students, who have just started learning methods of teaching physics, tend to exaggerate the importance of subject training and underestimate methodological training. Graduates and first-year young teachers already understand that the main thing in professional training of the teacher must be methodical preparation (50 %).

During the study, senior students were asked to evaluate the quality of their methodological training (Table 3). As can be seen from presented results, the degree of satisfaction with the results of methodical training of students is different, but among third-year students it is higher than among graduates. The students significantly increase requirements for their training after training internship (at the fourth year of higher education), when they are able to apply obtained subject and methodological knowledge under real conditions of the forthcoming practical pedagogical activity.

Table 3. Students from Akhmet Yassawi International Kazakh-Turkish University evaluated their methodological readiness

Specialty, Educational level	**Excellent**	Good	Satisfactory	Unsatisfactory
5B011000-Physics				
Third-year of education	12	28	10	2
Fourth-year of education	8	20	26	4
5B060400-Physics Physics in English				
Third-year of education	20	25	15	—
Fourth-year of education	14	27	21	2

The readiness of graduates for independent acquisition of knowledge, development of skills of intellectual work and skills to perform individual mental operations is shown in Table 4.

Table 4. Readiness of graduates for self-education, development of intellectual work and abilities to separate mental operations

Surveyed abilities	Positive take (in %)
choose the most important from educational material	88
plan an answer	89
make an abstract	95
use reference books and dictionaries	95
prepare a report, abstract	88
use common approaches to solving professional problems	53
analyze the content of physical concepts	46
perform logical operations	
• analysis and synthesis	51
• generalization and systematization	60
• comparison and contrast	62
• establishing causal relationships	41

Analysis of the results shows (Sarybayeva et al., 2018) only 50 % of graduates possess skills characterizing a sufficient level of intellectual development. This suggests that in the course of training the University teachers do not pay necessary attention to developing training, building of personal qualities needed to perform cognitive functions in the subsequent professional activities, primarily methodical thinking.

A survey conducted among students of the third and fourth years of the faculty of Natural history of the ICTU named after Akhmet Yassawi, showed that the desire to enter physics course is subjected by different reasons: most of the students are interested in the disciplines of subject training (Physics, English) and only a half wanted to be a teacher.

Among the factors causing difficulties in mastering academic subjects during the training, the majority of fourth-year students named lack of personal interest (43 %), unwillingness to work systematically (52 %). Many students noted the unequal ratio of disciplines in general subject and vocational training, the factor of too little time allocated to pedagogical practice. Pointing to the poor organization of the educational process (12 %), students noted the following (see Table 5):

Table 5. Comparative data of students and teachers about the causes of poor organization of the educational process

#	Causes	Students	Teachers
1	Poor quality of lectures	54 %	32 %
2	Teacher's incompetency	52 %	30 %
3	Complicated explanation in textbooks	38 %	32 %
4	Gaps in knowledge	34 %	80 %
5	Teacher's personal negative features	31 %	11 %
6	Overloading of textbooks and lectures	31 %	61 %
7	Irrational time management between disciplines of general subject and professional internship	42 %	73 %

According to the majority of students, the development of their cognitive interests in the studied subjects is determined primarily by the following factors: teaching skills (58 %), life plans (52 %), degree of awareness of the importance of the subject in the training system (34 %). For weak and average students the level of pedagogical skills of the teacher is the most important factor (over 70 % of affirmative answers). In most cases, there is a relationship between the interest in the subject and the pedagogical skills of the teacher leading this discipline. Noting the skill of teaching as the most important factor affecting the interest in the subject (58 %), students pointed out a number of conditions that determine this skill. First of all, it is the use of interesting practical material in lectures (68 %); problematic construction of lectures, discussions in practical classes (54 %) and widespread use of visual AIDS, including e-presentations (65 %). In our opinion, the answer to the question is indicative only 12.2 % of graduates associate the results of their studies at the University with the position of "learned to solve professional problems", which indicates a low professional orientation of training. At the same time, the importance of the element of creativity in the professional activity of the teacher, students evaluate low, considering that due to the high workload in the school there is no time to do this.

3. Results

The purpose of methodological training identified by the environment of functioning and normative model of a teacher suggests a subsystem of methodical tools. Successful methodological training depends on right choice of the tools. Achieved result of methodological training can be correlated with assuming outcomes (the purpose of methodological training) and evaluated by special criteria. It provides insight into methodical readiness of a Physics teacher.

Functioning of methodological training is described by sequence of diagnostics (the primary analysis of level of methodical readiness), forecasting, programming, planning and of student's educational and methodological activity teacher's classroom management, monitoring (choice of effective technologies), control over the quality of methodical training, examining and analysis of methodical readiness, correction of educational and methodical student's activity as well as inspiration of creative educational and methodical student's activity.

Block with results in a system of methodological training includes the following sections: components of the result and diagnostic procedures. According to the principles of a system professional and activity and professional-personal approaches, the components of the result correspond to the overall goal of the system and include the following blocks: theoretical (knowledge), practical (skills and experience), motivational and value (personality qualities).

The basis for the development of procedures for identifying and assessing the results achieved in the theoretical and practical blocks are methods of element-by-element, postoperative and level analysis. Identification and evaluation of changes in the motivational value block is carried out on the basis of psychological approaches based on the methods of self-assessment (self-analysis), objective evaluation in the activity. The efficiency of the developed by the author competence-oriented system of methodical training of the future teacher of Physics was determined in the course of the experimental transforming stage of the experiment.

Experiment procedure provided methodological readiness of among physics learners from targeted groups on the basis of a model of a graduate designed by a defender of a thesis, complex of teaching and learning issues (TLI), recommendations in teaching and classroom management, methodological support to foreseen the level of methodological readiness.

The idea of the experiment was in a choice of a model of a test object. In our case, an approach for structuring methodological readiness acts as the main factor controlled by its two options: traditional and adjusted techniques. Dependent variable or response will be student's learning skills that make up operational and activity part of the competencies (a qualitative indicator of successful training). In this approach, the model of the study object acts as a single-factor. In order to evaluate how control factor (TLI complex) impacts the formation of methodological skills, it is necessary to choose methods for measuring response values. These were the assessment of methodological skills at four levels: optimal, acceptable, critical and unacceptable.

The TLI solving skills were evaluated at lectures, workshops and during laboratory lessons on molecular physics. A number of TLI and their types distinguished depending on the content of theme and forms of teaching and learning activity of the learners. Overall assessment of the TLI solving provided step-by-step assessment of such skills as:

1) analyze condition of TLI on molecular physics and set goals;
2) separate theoretical knowledge on molecular physics needed for TLI solving (identify subject area, requirements and TLI operator);
3) interpret theoretical knowledge on molecular physics provided by the problem situation (methodological, methodical, physical, psychological and pedagogical);
4) choose the tools for TLI solution on molecular physics (methods, tools and organizational forms);

5) perform desired goals on molecular physics (problem requirements);
6) analyze and assess results of TLI solution on molecular physics.

Within the framework of our study, variability of the content of methodological training and variability of methods, forms and means of formation of methodological competencies in an open educational space is of particular importance. This variability is particularly relevant in the system of multi-level pedagogical education. Moreover, different options to meet personal needs of future specialist can be selected depending on status of the university and its location. In accordance with identified requirements for definition of target element in a system of methodological training of a Physics teacher, the goals of lower taxonomic rank can be specified through the components of methodological readiness of future teacher for professional activity.

As for discipline Molecular physics the goals can be formulated through the development of students' competencies corresponding to the main types of methodological activities of a Physics teacher in a school which are highlighted in our study (practical aspect of methodological readiness) and through the level of development of his methodological thinking (theoretical aspect of methodological readiness). So, as an important tool for the development of learners' methodological thinking we consider the content of educational methodology disciplines, primarily the discipline Molecular physics. The content of the discipline Molecular physics should be structured in an understandable way (Roundy et al., 2013) for learners, not as a list of theoretical provisions or scientific knowledge but as a tool for identifying and solving professional issues and problems.

The discipline Molecular physics is of great ideological importance.

Its worldview sense is confirmed by the fact that:

1. while studying the discipline the learners have the opportunity to observe the development of energy representations in the introduction of the first law of thermodynamics and its extension to specific processes
2. students keep on getting acquainted with theoretical and experimental methods by the example of fundamental experiments and experiments illustrating gas laws.
3. molecular physics ensures to deepen the concept of matter (molecules, atoms) and present a new statistical way of its describing
4. use of deductive method of studying the phenomena contributes to the development of students' theoretical thinking
5. studied aggregate transformations illustrate dialectical law of quality – quantity interconversion
6. molecular physics build up students'' knowledge about the structure and properties of a substance in various aggregate states based on two theories: molecular-kinetic theory (MKT) and thermodynamics. These theories form the basis of the content of this discipline.

Among the variety of the TLI used in Molecular physics, a significant place should be given to the issues at the lecture sessions, involving the implementation of possible educational situations. This training form, based on the game modeling of professional activity, makes it possible to bring the training as close as possible to the real conditions, provides the formation of initial methodological competencies, creates a basis for the development of independence, initiative, creativity and promotes the development of internal positive motivation of creativity in professional activity. The most common form of such issues is the presentation of a fragment of the lesson, during which a learner acts as a teacher, and other learners represent the pupils. Then, it takes from 5 to 10 minutes to simulate the situation. After the presentation it is analyzed and a teacher and pupils roles are discussed and evaluated with correction of shortcomings. Some game elements are adopted in the learning process gradually starting with simpler forms to more complicated. At the first stage, for example various situational tasks are applied, namely: to explain a way of formation of a separate fact, representation, present a new means of training, show a way for learning motivation, etc. This activity is followed by simulation exercises where a learner has to prepare by himself a stage of a lesson and, acting as teacher to formulate tasks for flashcard activity and to explain his choice and justify the use of certain means of training when studying any physical object.

Simulation tasks become more and more complicated at the following stages of training. At earlier stages a learner was tasked to do only separate teacher's responsibilities (select teaching tools, demonstrate them and explain), so next he must illustrate each lesson stage from design, training and evaluation activities, that is, to prepare a fragment of the lesson, conduct it with pupils and evaluate results of his activities. Today's teaching techniques suggest various types and forms of classroom activities (Light, 2008) such as round table, debate, discussion, workshops, and seminars on lessons learned, games, etc. However, the way of lesson conduction in most cases depends on a teacher, his desire and creativity, level of training, etc. It seems, however, that this choice should be dictated by:

1) objectives faced by a teacher in terms of methodological thinking formation

2) methodological skills as a part of the methodological competence which is to be mastered by a learner in the course of the learning process

3) educational recourses on Molecular physics

4) need to simulate professional activity.

Focusing on these provisions, we have made an attempt to develop a number of forms of practical training or their fragments, if TLI implementation takes only a part of the practical training. Let's present this in a folded form, noting that the objectives of the practical training are highlighted in terms of *the development of methodological thinking and methodological competencies* that is the purpose of our study. Purpose: revise and review learners' knowledge about isoprocesses as a model of the processes occurring in gases; the conditions of their occurrence, relationship of system parameters and graphical display of processes. An important role in the formation of a worldview competence by future teacher, and therefore the possibility of formation of learners' personal abilities plays Molecular physics of a natural science cycle. Laboratory lessons on Physics are favorable to effectively shape the scientific worldview, because laboratory activities develop experimental skills, practical skills, cognitive ability and independence. For successful formation of worldview competence by future teachers at a workshop it is necessary to widen standard procedure. In particular, students perform individual tasks described in the questionnaire. It is given about 10-15 minutes to perform these tasks. Next, students work in small groups (two or three), checking each other's tasks, complement, correct errors, and then collectively discuss the findings of the laboratory work, and they report to the teacher. The formation of worldview competence is a complex, multifaceted task, the implementation of which is difficult to assess unambiguously. It is in this case that the use of competence tasks and assignments can be an effective method. Such tasks contribute to the formation of professional competence of the teacher, which is reflected in the individual approach in the educational process, in the knowledge of textbooks and leading authors in studied discipline, in the ability to conduct an independent search for different types of information, in the continuity of new knowledge.

Below are some examples of competence tasks performed by future teachers while laboratory workshops in order to develop professional competence. We have performed laboratory works on the following scheme: determination of the size of molecules, determination of the surface tension of the liquid by the drop method, phase transitions, etc. You need to build a hierarchy of the following concepts, based on your proposed feature (principle, function): physical phenomenon, physical experience, physical quantity, physical law, and physical theory. Focus on the topic of laboratory work. Present the information you received in various forms (text, table, picture, and graph). Why do your results contradict the expected ones? (You can especially in laboratory works and practical training to lay the erroneous data.) Rethink the results, clarify simplifying assumptions. Turn this task into a personally significant, but with the same parameters. Make coarser assumptions in theory (concerning the topic of the work performed) and predict the results of the experiment. Explain them, stating the reason. Imagine the laboratory work as a scientific study, highlighting all the stages of scientific knowledge (observation, systematization of facts, hypotheses, theory, and experimental confirmation of the theory).

When evaluating each of these seven operations, it is understood that their performance at the optimal level is estimated at 3 scores, permissible – 2 points, critical – 1 point, unacceptable – 0 points. As a result, a learner can get up to 21 scores for TLI solving (Table 6).

Table 6. Effective solving teaching and learning issues while studying the theme Kinetics model of ideal gas

#	Student's name	No. of procedure							Total score	Skill level to solve TLI
		1	2	3	4	5	6	7		
1.	Respondent 1	2	3	2	1	1	2	2	13	II
2.	Respondent 2	1	0	1	1	1	0	0	4	I
3.	Respondent 3	1	2	1	2	2	1	1	10	I
4.	Respondent 4	1	1	1	1	1	0	0	5	I
5.	Respondent 5	2	3	2	2	2	2	2	15	III
6.	Respondent 6	2	3	2	2	2	2	2	15	III
7.	Respondent 7	1	1	1	1	1	1	0	6	I
8.	Respondent 8	2	3	3	2	2	2	2	16	III
Average score		1,5	1,9	1,5	1,4	1,4	1,3	1,4	10,7	

When making analysis of students' answers we considered them as integrative quality criteria and evaluate them on a scale from 0 to 10 scores where zero scores means that there is no any component and 10 scores means fully presented component. Each competence included 10 elements and fully formed competence was estimated in 100 scores. The element of the competence was considered to be mastered if the student scored 5 or more points (Table 6). The results of completed tasks were processed by mathematical statistics method. Statistical test with diverse options confirmed reliable initial data.

Efficient experimental methodological training of a Physics teacher was evaluated with the help of complete coefficient of single activities ensuring mastering of methodological competences. Perfect mastering of the competences was verified by the number of learned elements of competence (a number of activities realized). At the same time, the element of the competence was considered to be mastered if the student received at least 5 of 10 possible scores.

Fullness coefficient of single activities made by students for one of the competences was defined by the formula:

$$K_f = \frac{\sum_{i=1}^{n} M_i}{MN} * 100\% \qquad (1)$$

where N_i is total elements made by the student and N is the maximum number of elements in the competence.

$$K_f^{e.g} = \frac{\sum_{i=1}^{n} M_i}{MN} * 100\% = 73\% \qquad (2)$$

$$K_f^{k.g} = \frac{\sum_{i=1}^{n} M_i}{MN} * 100\% = 56\% \qquad (3)$$

Here M_i is the students in total who have mastered key features of the topic; M is a number of marks that the student has to learn on the topic; N is a number of students mastering methodological competence in a target group. Thus, the target group exceeded 17 %.

Successful ratio of development of methodological competence was determined after each experimental-transforming stage of the experiment by the formula

$$K_s^{e.g} = \frac{\sum_{i=1}^{n} L_i}{LN} = \frac{148*6}{190*7} = \frac{888}{1330} = 0{,}67$$
$$K_s^{e.g} = \frac{\sum_{i=1}^{n} L_i}{LN} = \frac{198*6}{215*7} = \frac{1188}{1505} = 0{,}79 \qquad (4)$$

The number of the students having identified practical value L_i in this formula (using seven symbols only); L – the number of symbols the students should understand (in our experience it is equal to seven); N – the number of the students in target group. Based on these formulas, the coefficients of target and control groups were 0.79 ± 0.67 = 0.12. It means that this ratio shows mathematical and statistical significance of our experimental results.

the Coefficient of effectiveness of methodological training was determined by the formula: P = $K_{s.}$ the experimental group / $K_{s.}$ control group * 100 %.

Confirmation of the effectiveness of experimental training is to compare the dynamics of changes in the coefficient of completeness of the development of methodological competencies, which shows an increase in the rate of formation of methodological competencies in the conditions of use of the complex (Figure 1).

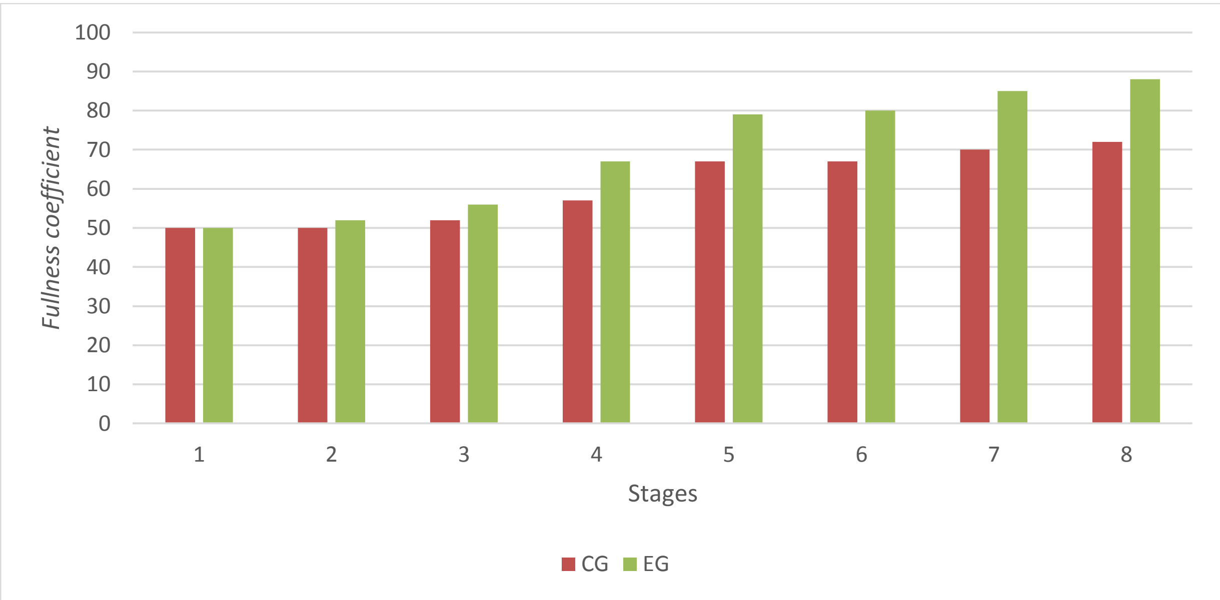

Fig. 1. Dynamics of changes in the Fullness coefficient of development of methodical competencies

The reliability of the above results and conclusions was also verified by us using the Kramer-Welch test. Checking the statistical hypothesis for a qualitatively determined the test was performed at the level of significance α = 0.05, the critical value of the Kramer-Welch test Tcrit = 1.96. We had two independent samples: the control group, which included all control classes, and the experimental group – experimental classes. We compared the number of correctly solved tasks of students in the control and experimental groups when performing these tests and based on this assessed their level of competence. We have formulated two statistical hypotheses:

H0: no difference between the numbers of correctly solved problems in the control and experimental groups.

H1: there is a significant difference between the numbers of correctly solved problems in the control and experimental groups.

As a result, it turned out that:

Before the start of the training experiment, the empirical value of Temp is 00.7 << Tcrit. Therefore, the H0 hypothesis is accepted at a significance level of 0.05;

After the end of the training experiment, Temp = 5.7 >> Tcrit, so the hypothesis H0 is accepted with a 95 % confidence difference.

Analysis of the results shows slightly higher rate of formation of methodological competencies while applying experimental technologies that confirms feasibility of their use in a system of methodological training of a Physics teacher. Some specific hypotheses were put forward to see how the TLI techniques impact the teaching and learning proves of a student:

- there is a relationship between the ability of students to solve the TLIs and their skills use methodological and methodical categories, actualize mental activities and find the ways to solve management problems;
- level of development of methodological reflection and subject-reflective relations in a teaching and learning process is associated with the ability to solve the TLIs;
- ambition and independent behavior of students in a teaching and learning process and to what extent he is satisfied to it is raised as higher the ability to solve the TLIs.

The choice of listed dependencies is subjected to their significance in the structure of the methodological readiness of a Physics teacher to perform his basic functions. Confirmation of the hypotheses served as proof to the effectiveness of the methodological training system.

The relationship between the ability to solve the TLIs and degree of development of *methodological reflection* of students was determined in several ways:

- paired comparison of students' reflection level (objectivity was checked by comparing students' characteristics given by different experts)

- through observing the students during their practical work while their self-assessment and peer assessment of the TLIs

- comparative analysis of the grades for different methodological students' skills posted by a lecturer, teacher and student during the internship, verifying the adequacy of self-assessment and assessment of experts.

Methodological reflection was evaluated at three levels according to the criteria presented in Table 7.

Table 7. Methodological reflection

Level of methodological reflection	Criteria for assessment
High	Understand importance to develop methodological reflection; know requirements for methodological activity, analyze and assess performed actions adequately to the requirements; able to identify the main drawbacks in a teaching and learning process, find out own difficulties in its implementation; ready to find the way to overcome difficulties; able to analyze learning activity of other students and express an interest to their opinion about his/her own activity
Average	realize the need for the development of methodical reflection; know requirements of methodological activity; analyze and evaluate their actions are not always adequate to the requirements; do not always notice the main shortcomings of a teaching and learning process; have difficulties to formulate their fails in own learning process; identify the ways to eliminate the difficulties with the help of a teacher or other students
Low	Have no idea about the value of methodological reflection or virtually do not think about; have difficulties in characterizing the requirements to fulfill a teaching and learning process; do not evaluate their actions adequately to the requirements; cannot explain the difficulties in methodological activity; unable to identify the ways to address their difficulties in a teaching and learning process

Let's focus on the procedure of assessing the level of development of students' methodological reflection. As it was shown, solving TLIs at the workshops is analyzed by the student, and then it is evaluated by the team of students (a method of discussion). At the end of the classroom activity, a teacher characters the TLI's solution, team's assessment and self-assessment of the student. The results of student's reflection activity along with the grades for the TLI solving are recorded in a school register. When we looked after the students we drew attention that a great part of students embarrassed during their self-analysis and mutual analysis of the TLI at the initial stage. Meanwhile, the level of students' methodological reflection has increased significantly in the course of methodical organization of students' involving in reflection activity. We have identified the dependence of the level of development of methodological reflection on the level of development of skills to solve the TLI at the end of the pedagogical experiment (VIII session). Satisfaction index is one of the indicators that show effective methodological training. In the course of the experiment, we repeatedly found out the ratio of students' satisfaction with their methodological training. The satisfaction ration was evaluated on a scale where quite satisfied (+1), mostly satisfied (+0.5), I can't say (0), not very happy (-0.5), dissatisfied (-1).

To evaluate this we applied the formula:

$$S_{index} = \frac{a(+1) + b(+0,5) + c(0) + d(-0,5) + e(-1)}{N} \quad (5)$$

where a, b, c, d, e are the number of answers in order of a scale and N is total students involved.

The study showed that in the experimental groups the indicator of the ratio to the quality of methodological training is quite high and averages 0.83, while in the control groups it is lower about 0.54. It should be emphasized that the index of satisfaction has been intensively increased in response to inclusion of students in the teaching activities associated with the solution of the TLI. Thus, indicators +1 and +0.5 in the VI session evaluated 48.6 % of students, and in the VIII session already 87.5 %, Thus, it can be concluded the technologies of formation of methodological readiness positively affect the attitude to the methodical activity of future Physics teachers.

The analysis of the obtained data shows that the most influential are such types of educational and methodical activities of students, which are associated with organized independent work on the systematization of knowledge, planning of their activities, regulation and active implementation of TLI solution. These results once again emphasize the effectiveness of the developed technology for the implementation of the competence-oriented system of methodological training of future Physics teachers.

The study performed is of theoretical and experimental nature. In the course of experimental activity we've done the following:

1) confirmed theoretical provisions justifying the need and the possibility of implementing a competence-oriented system of methodological training that best meets today's requirements for a Physics teacher

2) proved pedagogical expediency of building logic of a Physics teacher's methodological training according to structure of methodological thinking and types of methodological competences

3) established interrelation between the methodological competence and methodological thinking

4) revealed the adequacy of methodological tools of realization of the developed system and its goals consisting in the formation of methodological competence of a Physics teacher

5) found out dependences between the student's ability to solve the TLIs and his skills to operate methodological and methodical categories, update mental operations, find the ways to solve management problems; the level of development of methodological reflection of students; students' satisfaction ratio with the results of their educational and methodical activities and the development of students' creative potential.

The research program is fully completed within the set tasks. However, the results of the study do not exhaust all aspects of the problem under consideration. As promising directions of research we can identify specifying the content and means of methodological training of a Physics teacher; investigate interdisciplinary links in the methodological training of a Physics teacher; further improvement as teaching methodological disciplines focused on the development of methodological competence of future Physics teacher.

5. Conclusion

Representative results of our empirical study are as follows:

1) studied and characterized methodological training of modern physics teacher and revealed relevant shortcomings in the formation of methodological competence of learners in the process of higher education

2) pedagogical experiment confirmed the effectiveness of developed methodological tools for the implementation of competence-oriented system of the methodological training with educational tasks as a core element

3) applying of TLI confirmed the effectiveness of the developed by the author of educational and methodical tasks in the formation of methodological thinking and methodological competencies

4) in the experiment we established relation of formation between the methodological thinking and competence that confirmed theory about the unity of theoretical and practical aspects in the methodological competence

5) established dependences between the students' abilities to solve the TLI and:

- skills to operate with methodological and methodical categories, actualize mental operations and find the ways to solve management problems
- level of development of methodological reflection of students
- student's index of satisfaction with the results of their educational and methodological activities
- development of students' creative potential.

6) established slightly higher rate of formation of methodological competences in the conditions of application of experimental technologies that confirms the expediency of their use in the system of methodological training of a Physics teacher

7) in the course of experimental work we've proved pedagogical expedience of logic the methodological training of a Physics teacher in accordance with the structure of methodological thinking and types of his methodical activity.

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