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METHODOLOGY FOR ASSESSING THE LEVEL OF METHODOLOGICAL COMPETENCE OF IT TEACHERS

Abstract: The article presents the results and analysis of an experimental study on the development of methodological competence of teachers of IT disciplines in the framework of their advanced training on the online. The purpose of the article is to disseminate certain results of the study from the point of view of theoretical and methodological aspects. The task of the experiment stage was to diagnose the level of formation of methodological competence of teachers of IT disciplines of the control and experimental groups according to four key criteria of methodological competence: didactic, design, monitoring and personal. The determination of the level of formation of methodological competence skills was made using five levels: advanced, high, medium, acceptable and low, for each key criterion of the teacher's methodological competence. The experimental part of the study was conducted with teachers of IT disciplines of universities in Kazakhstan during the 2023-2024 academic year. As a result of the experimental work, a diagnosis of the development of methodological competence of teachers of IT disciplines was developed, which is of a complex nature: substantive – in the form of tests, tests of various nature on the content of course training; activity – in the form of assessment for each type of practical work of a methodological orientation (drawing up work programs for the subject, technological map of the lesson, problem tasks, etc.) ; communicative – on the basis of questionnaires, tests, analysis and self-analysis (on the development of speech culture, behavior in society, skills to organize attention, students' activities, work

in pairs and groups, etc.). In the formation of a set of diagnostic methods, the emphasis was placed on methods based on self-diagnosis, which contributes to the process of self-knowledge and self-analysis of a particular person. The authors also note that despite the variety of definitions, all studies have a common semantic basis - correlation with the labor market and social policy of society. These two parameters play an important role in determining the content of competencies, based on the psychological and biological characteristics of the individual. In the course of the study, the validity of the methods used was checked, and the results were presented, which indicate the need to develop recommendations aimed at improving the level of methodological competence of teachers of IT disciplines.

Keywords: digitalization, methodological competence, information system, professional development, IT education, continuing education, professional training.

Introduction

In our time, educational institutions have to solve more and more complex problems caused by the constantly growing requirements of society and the state to the education system. They are faced with the need to fulfill a social order, which includes the formation of graduates who are able to compete in the labor market and are ready for constant personal and professional development. In this context, the role of the psychological factor, especially the personality of the teacher, is becoming more and more important, since the success of the educational process depends on his readiness and ability to solve modern problems.

"A teacher is the most important link in the process of forming a new quality of our nation. Therefore, it is extremely important to fully provide the education system with qualified specialists," President of the Republic of Kazakhstan Kassym-Jomart Tokayev said in October 2023 at the Republican Congress of Teachers [1]. Modern schools in Kazakhstan face a serious shortage of teaching staff, which leads to a constant increase in this problem. The country lacks 5 thousand teachers, while every fifth graduate of pedagogical specialties cannot find a job in the profile. In addition, only 23% of teachers have the highest qualification category. This situation requires a radical revision of approaches to the training and professional development of teaching staff. The curricula of pedagogical specialties in universities are significantly based on outdated methods that do not take into account modern requirements. According to the head of state, it is necessary to revise and modernize curricula with the integration of new approaches and technologies [1].

The issue of advanced training of teaching staff occupies a special place in the Law of the Republic of Kazakhstan "On the Status of a Teacher" [2]. The need for continuous improvement of the professional level of a teacher in the context of rapid obsolescence of the existing pedagogical experience, the emergence of new pedagogical technologies has actualized the problem of improving methodological competence as a leading structural component of professional competence. However, the quality of his methodological training, the ability to scientifically determine and effectively apply new pedagogical technologies, to implement the principles, content, forms, methods and means of educational activity, is often at a relatively low level, which complicates the implementation of requirements. All this determines the relevance of the study.

Literature review

Studies devoted to the theoretical and methodological definition of the essence of the methodological competence of a teacher are widespread both in Kazakhstan and abroad, but there are issues that require in-depth study. The methodological base of this study is based on the works of both domestic [3-5] and foreign scientists [6-9].

According to modern ideas, the methodological competence of a teacher is determined by his ability to create an effective educational process adapted to a variety of pedagogical situations within the framework of an academic discipline [10-11].

The analysis of pedagogical science and practice shows that methodological competence is not always present in modern university graduates or practicing teachers [12-13]. In mass pedagogical practice, there are often teachers who, having deep knowledge of the subject and a high level of responsibility, do not know how to teach effectively [14-15]. The formation of methodological competence of future teachers at the university and its systematic development in the course of professional activity should become priority areas of professional training and advanced training of specialists. Thus, the relevance of issues related to the formation of the methodological competence of teachers and increasing the effectiveness of their methodological activities is confirmed by the increase in the number of studies devoted to this topic.

Research methodology

The following methods were used for the study: analysis of pedagogical, psychological and methodological literature; pedagogical modeling; observation of the activities of teachers of IT disciplines and students in the educational process; questioning and interviewing teachers; teacher testing; pedagogical experiment and statistical methods of processing the data obtained.

The implementation of the developed model by the authors in [16-17] involves the following stages of development of methodological competence of IT teachers in the process of advanced training: initial preparatory (pre-course), theoretical and practical (courses) and implementation (post-course). Therefore, in the process of experimental work, the methods were divided into three categories:

a) methods of installation, entrance diagnostics, which are used at the beginning of training of teachers in advanced training courses to differentiate course participants by the level of formation of methodological competence;

b) methods of current, in-depth diagnostics to track the intermediate results and effectiveness of the course training process, identify problems and difficulties of students;

c) methods used in the final diagnostics after the completion of advanced training courses to assess the success of students in course training programs and to determine the levels of formation of methodological competence of IT teachers. The assessment of diagnostic tools was carried out taking into account the quality criteria (according to K. Ingenkamp [18]): validity, reliability, objectivity.

Results

In experimental work, diagnostics of methodological competence teachers of IT disciplines was carried out in the course training by a small group of competent experts: subject teachers - students of advanced training courses in 2023 - 61 people, with different levels of teaching experience (Table 1).

The experimental group (EG) was made up of teachers-listeners of the control group (CG), but after completing courses to improve methodological competence.

Table 1. Teaching experience of IT teachers who took part in the experiment

Number of teachers in total	Teaching experience				
	0–2 years	3–5 years	6–8 years old	9–10 years old	over 10 years
61	18	21	10	9	3

CG results after passing the entrance test were determined as baseline (Table 2).

Table 2. Initial levels of the formation of methodological competence in teachers of CG (in %)

Levels of forma-tionmethodo-logical compe-tence teacher	level limits			didactic		projecting		monitor		personal	
	Lmin	Lmax	Lmean	people	%	people	%	people	%	people	%
low	0	60	30	26	42.6	36	59	41	67.2	29	47.5
acceptable	61	70	65.5	18	29.5	7	11.4	12	19.6	19	31.1
average	71	80	75.5	11	18	10	16.3	5	8.1	7	11.4
high	81	90	85.5	4	6.5	2	3.2	2	3.2	4	6.5
advanced	91	100	95.5	2	3.2	6	9.8	1	1.6	2	3.2
average %				19.96		39.87		49.81		34.11	
standard deviation %				14.77		23.05		25.19		15.11	

The equivalence of the characteristics of teachers in the control group according to the selected indicators was analyzed by comparing the average data, since different levels of competence have different significance. The weighted average allows you to take into account these differences, providing a more accurate picture of the overall competence of teachers. The average value for each component of methodological competence was calculated according to the formula:

$$\bar{x} = \frac{\sum x_i}{n},$$

where is the average, x $\bar{x}_i$ is each individual value in the dataset, n is the number of values in the dataset.

The standard deviation of each component of methodological competence was also calculated . Standard deviation is a measure of the variability or variability of data relative to its mean. To evaluate standard deviation, it is important to understand that it measures how much values in a dataset deviate from the mean. When we have results for the level of methodological competence of teachers, the standard deviation helps us understand how much These levels vary.

Thresholds for standard deviation:
- small standard deviation – less than 10% of the mean value (the values are close to the mean, there is little variety in the levels of competence, most teachers have a similar level of competence);
- moderate standard deviation – from 10% to 20% of the mean value (indicates that there is a moderate variety in the levels of competence of teachers);
- high standard deviation – more than 20% of the average value (a significant number of teachers have levels of competence that are very different from the average value, the need for a differentiated approach to the training and development of teachers).

Steps to calculate standard deviation:
1. Calculate the average value ($\bar{x}$).
2. Calculate the difference of each value from the mean ($x_i - \bar{x}$).
3. Square each difference ($x_i - \bar{x}$)^2.
4. Find the average of these squares.
5. Extract the square root from the mean of the squares.

From the analysis of standard deviation data, it was concluded that the levels of competence of teachers differ from this data set. Data sets with a smaller standard deviation indicate more

stable and predictable outcomes, where most educators have similar levels of competence. On the other hand, data sets with a higher standard deviation indicate a wider diversity in competence levels, requiring a differentiated approach to teacher training and development.

Thus, the results of the study contributed to decision-making – to consider the standard deviation as an indicator of diversity in the levels of competence, as well as to assess the compliance of this diversity with the goals and objectives of the educational process.

The data obtained because of the survey indicate that within the framework of advanced training courses for teachers, it is necessary to focus on the development of skills to analyze program and methodological materials, assess the quality of educational resources, identify methodological problems and determine ways to solve them. In addition, to improve the ability to analyze the experience of their activities, to monitor the level of assimilation of educational material and the dynamics of students' development, to assess the compliance of the results achieved with the goals of educational activities, to predict the effectiveness of the means, forms, methods and techniques of teaching used. These skills will help teachers not only to assess the advantages and disadvantages of their own activities, but also to design the educational process based on their strengths, which in turn will contribute to improving the quality of students' educational results.

The data obtained at the beginning of the experimental work confirm that the methodological competence of the teacher is formed by a system of work, including: collection and processing of primary information; identification and formulation of the problem, determination of ways to solve it and setting a goal; planning, organization and adjustment of activities; control of results and analysis of results. Such activity requires from the teacher certain knowledge, skills and abilities, the basis of which is acquired during basic education, further improved throughout professional activity through advanced training and self-education in the system of additional professional education.

The diagnostics of teachers and the determination of the level of formation of the methodological competence of teachers at the beginning of the experimental work made it possible to confirm the legitimacy of the hypothetical assumptions put forward about the need to develop and implement organizational and pedagogical conditions for the development of the teacher's methodological competence in the unity of all its components and further improvement of its qualifications.

Each subject was asked to complete tasks aimed at developing goal-setting, analytical, diagnostic, prognostic and other skills.

Thus, the diagnostic tools developed at the ascertaining stage of the experiment made it possible to identify the levels of development of the teacher's methodological competence, which in turn contributed to an individual approach in the process of professional development.

The formative stage ensured the progress of the process of developing the teacher's methodological competence towards the intended goal. At the same time, it should be noted that the positive effect was achieved as a result of the use of predictive data obtained as a result of the use of diagnostic tools developed at the ascertaining stage. The formative stage was primarily aimed at the qualitative development of the teacher's methodological competence within the established terms of advanced training.

Within the framework of advanced training courses, the correspondence between the material under consideration and the degree of development of methodological skills and abilities of students, their intellectual characteristics and educational needs was ensured.

When organizing the educational process, it was taken into account that teachers of different ages, with different qualification categories of educational workers, as well as professional experience, undergo advanced training in the CG.

Implementing in practice an individual approach in the process of advanced training, the professional experience of students was taken into account.

In this regard, when organizing advanced training courses, the data of American research-ers A. Dreyfus, B. Daly, J. Hazard and other [19-20] about the mutual influence of the level of professional skill of the teacher, their experience and methods of teaching, as well as how the method of teaching and self-education of the teacher changes in the course of gradual pro-fessional development. One of the important conclusions of the research is that the process of professional development and all its components should be as close and adapted as possible to the levels of development of the teacher's professional skills, since they largely determine the degree of educational motivation, the effectiveness and quality of educational programs for advanced training.

Table 3 correlates the data of the teaching experience and the level of formation of the teacher's methodological competence.

Table 3. Correlation of teaching experience and the level of formation of the components of the teacher's methodological competence (in %)

Levels of formation of the components of methodological competence			Teaching experience				
			0–2 years	3–5 years	6–8 years old	9–10 years old	over 10 years
Number of teachers			18	21	10	9	3
didactic	low	26	18	8	0	0	0
	acceptable	18	0	12	6	0	0
	average	11	0	1	4	6	0
	high	4	0	0	0	3	1
	advanced	2	0	0	0	0	2
design	low	36	16	19	1	0	0
	acceptable	7	2	2	2	1	0
	average	10	0	0	7	3	0
	high	2	0	0	0	2	0
	advanced	6	0	0	0	3	3
monitoring	low	41	18	21	1	1	0
	acceptable	12	0	0	7	4	1
	average	5	0	0	2	3	0
	high	2	0	0	0	1	1
	advanced	1	0	0	0	0	1
personal	low	29	21	3	1	3	1
	acceptable	19	4	9	3	2	1
	average	7	0	0	6	1	0
	high	4	1	1	0	2	0
	advanced	2	0	0	0	1	1

The implementation of modern forms and methods of activity in the educational process of advanced training made it possible to identify a number of problems in the course of exper-imental work, among which the main ones were significant difficulties for teachers in iden-tifying, formulating a problem and making professional decisions and outlined the need to include teachers in direct methodological activities in the learning process, the need for pro-fessional support in the post-course period.

The next stage of the experiment was the verification of the effectiveness of the work car-ried out on the implementation of organizational and pedagogical conditions for the devel-opment of the methodological competence of the teacher in the process of advanced training.

During the control experiment, it was necessary to solve the following tasks:

1) correction of the process of development of the teacher's methodological competence in the course of advanced training, taking into account the previously obtained results;

2) final diagnostics of the level of development of the teacher's methodological competence.

The purpose of the final diagnostics was to determine the degree of effectiveness of the experimental work. To solve this problem, test tasks and questionnaires were used, while these tests and questionnaires were developed on the basis of the same principles that were used at the ascertaining stage of the experiment when conducting similar diagnostic methods.

Table 4 and Figure 1 present the results.

Table 4. Results of the experiment on the formation of components of methodological competence in teachers of CG and EG (%)

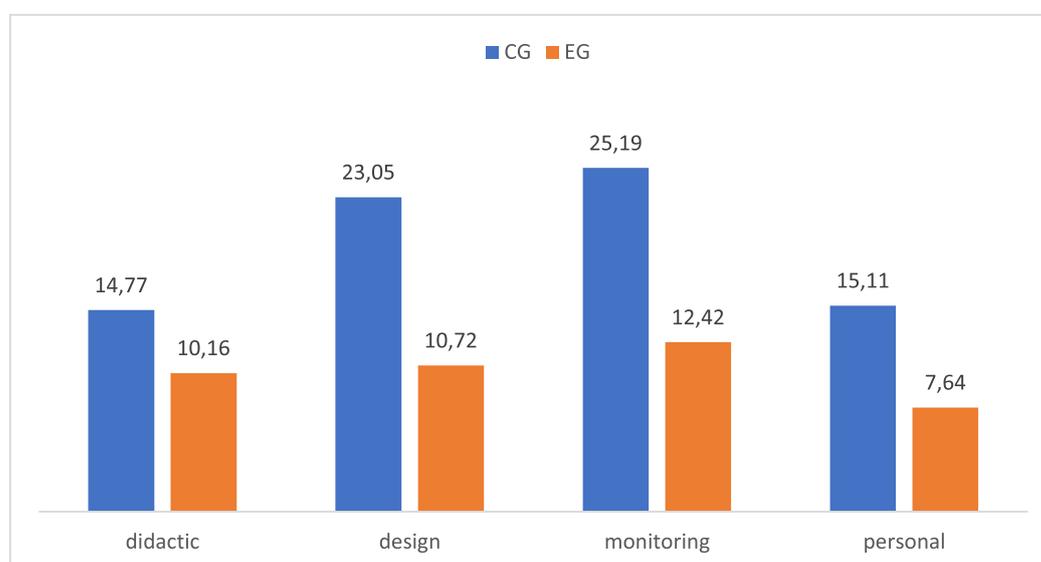| Levels of formation methodological competence teacher			low	acceptable	average	high	advanced	average %	standard deviation %
didactic	CG	people	26	18	11	4	2	19.96	14.77
		%	42.6	29.5	18	6.5	3.2		
	EG	people	1	9	22	21	8	28.75	10.16
		%	1.6	14.7	36	34.4	13.1		
design	CG	people	36	7	10	2	6	39.87	23.05
		%	59	11.4	16.3	3.2	9.8		
	EG	people	6	6	23	11	15	25.41	10.72
		%	9.8	9.8	37.7	18	24.5		
monitoring	CG	people	41	12	5	2	1	49.81	25.19
		%	67.2	19.6	8.1	3.2	1.6		
	EG	people	25	6	10	16	4	27.69	12.42
		%	40.9	9.8	16.3	26.2	6.5		
personal	CG	people	29	19	7	4	2	34.11	15.11
		%	47.5	31.1	11.4	6.5	3.2		
	EG	people	18	18	13	5	7	23.91	7.64
		%	29.5	29.5	21.3	8.1	11.4		

Figure 1. Results of the experiment on the formation of components of methodological competence in teachers of CG and EG (average %, standard deviation %)

From the analysis of standard deviation data, it can be concluded that teachers' levels of competence vary depending on the data set. Data sets with a smaller standard deviation indicate more stable and predictable outcomes, where most educators have similar levels of competence. On the other hand, data sets with a higher standard deviation indicate a wider diversity in competence levels, requiring a differentiated approach to teacher training and development.

Thus, when making decisions, it is necessary to take into account the standard deviation as an indicator of diversity in the levels of competence, as well as to assess the compliance of this diversity with the goals and objectives of the educational process.

To process the CG and EG data on the formation of the components of methodological competence in teachers, we will derive the optimal average value of all components by levels of formation (Table 5 and Figure 2).

Table 5. The level of formation of the components of methodological competence
in teachers of CG and EG (average value)

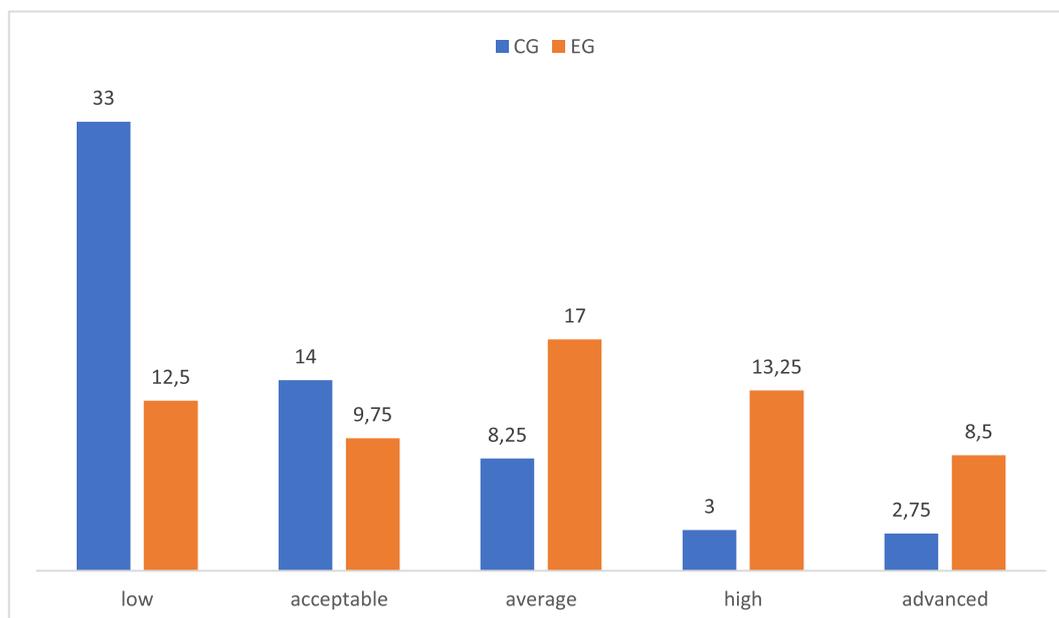| Levels of formation of the teacher's methodological competence	CG		EG	
	people	%	people	%
low	33	54.07 %	12,5	20.4 %
acceptable	14	22.9 %	9,75	15.9 %
average	8,25	13.4 %	17	27.8 %
high	3	4.8 %	13,25	21.6 %
advanced	2,75	4.4 %	8,5	13.8 %

Figure 2. The level of formation of the components of methodological
competence in teachers of CG and EG (average value, people)

To process the results of the experimental work, we will use the method for determining the reliability of coincidences and differences for experimental data presented in an ordinal scale – a statistical criterion – $\chi 2$ (Student's criterion [17]).

To compare the levels of methodological competence of teachers before and after training, we use the control group as expected values (E), and the experimental group as actual values (O):

$$\chi^2 = \sum \frac{(O_{\text{эг}} - E_{\text{кг}})}{E_{\text{кг}}}.$$

We calculate using the formula χ^2 for each level of competence and get:

$$\chi^2_{low} = \frac{(12.5 - 33)^2}{33} = \frac{(-20.5)^2}{33} = \frac{420.25}{33} \approx 12.74$$

$$\chi^2_{acceptable} = \frac{(9.75 - 14)^2}{14} = \frac{(-4.25)^2}{14} = \frac{18.06}{14} \approx 1.29$$

$$\chi^2_{medium} = \frac{(17 - 8.25)^2}{8.25} = \frac{(8.75)^2}{8.25} = \frac{76.56}{8.25} \approx 9.28$$

$$\chi^2_{high} = \frac{(13.25 - 3)^2}{3} = \frac{(10.25)^2}{3} = \frac{105.06}{3} \approx 35.02$$

$$\chi^2_{advanced} = \frac{(8.5 - 2.75)^2}{2.75} = \frac{(5.75)^2}{2.75} = \frac{33.06}{2.75} \approx 12.02$$

Next, we sum up all the values and get $\chi^2_{EG} = 70.35$.

After that, we compare the obtained value with the critical value for the χ^2 criterion at a certain level of significance χ^2_{EG} α and the number of degrees of freedom f.

To calculate the number of degrees of freedom for each comparison, we use the formula: f = (number of categories − 1) × (number of groups − 1).

For each level of competence, we have 5 categories (levels of competence) and 2 groups (CG and EG), therefore: f = (5 − 1) × (2 − 1) = 4.

Thus, for each comparison of CG and EG for each level of competence, we will use f = 4. Usually, the significance level $\alpha = 0.05$ is used, which corresponds to a 95% confidence level. To find the critical value of χ^2 at f = 4 and $\alpha = 0.05$, we will use the standard table of critical values χ^2.

The critical value is $\chi^2 = 9.488$.

Since the actual χ^2 value (≈70.35) is significantly higher than the critical value (9.488), we reject the null hypothesis. This means that the training has statistically significantly changed the levels of methodological competence of teachers.

Within the framework of the experiment, it was revealed that the experimental group (EG) participating in the professional development program showed a statistically significant improvement in the level of formation of the components of the methodological competence of teachers compared to the control group (CG). This is confirmed by the results of the analysis of the χ^2 criterion for each of the five levels of competence.

Specifically, significant improvements were found at the advanced, high, medium, and low levels. However, at the level of tolerance, the differences between the groups were not statistically significant.

Based on this, it is recommended to continue the professional development program to further improve the level of competence of teachers in EG. It is also recommended that additional research be carried out to identify specific factors that contribute to the improvement of competence, as well as adapting the program to take into account the findings for maximum effectiveness in future educational and professional contexts.

Conclusion

Based on the analysis, it was found that advanced training courses for teachers statistically significantly increased the levels of their methodological competence. This indicates the high

effectiveness of these courses and their importance for the professional growth of teachers. To further improve the methodological competence of teachers, the following is recommended:

Continuation and expansion of training programs - development of extensive advanced training programs covering various aspects of methodological competence; inclusion of modern pedagogical technologies and approaches in training programs.

Personalized learning - based on the data obtained from the preliminary diagnosis of teachers' competence levels, offer individual training programs, as well as introduce a mentoring and mentoring system, where more experienced teachers can help their less experienced colleagues.

Practical application of knowledge - the inclusion of more practical classes in training programs, where teachers can apply the knowledge gained in real learning situations.

Support and motivation - the introduction of a motivation system for teachers who have completed advanced training courses, for example, in the form of certificates that can be taken into account during certification.

Information support - to ensure constant updating of information about new methods, approaches and research in the field of pedagogy on the site and to create a section with resources and tools that teachers can use in their work or add their best practices to share experiences.

Improving the methodological competence of teachers is a key factor in improving the quality of education. Regular professional development courses, support and motivation of IT teachers, as well as the introduction of modern educational technologies contribute to their professional growth and, as a result, improve the educational results of students. The implementation of these recommendations in the information system will help create an effective system of professional development of teachers and increase the level of methodological competence in educational institutions.

Acknowledgment

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