

# Statistical assessment of the effectiveness of mechanisms based on the acmeological approach in the formation of pedagogical competence in physical education specialists

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**Abstract.** This study aims to assess the effectiveness of mechanisms developed based on the acmeological approach in the process of developing pedagogical competence in physical education specialists. The study was conducted in a quasi-experimental design, and a 12-week pedagogical program based on acmeological principles was applied to the experimental group, while the control group was trained on the basis of traditional training. Data were collected in the form of pre-test and post-test using standardized pedagogical competence indicators

## INTRODUCTION

Modern society places high demands on the education system to train highly qualified, motivated, competitive, initiative-driven individuals who are both spiritually and physically healthy. In the Action Strategy for the Further Development of the Republic of Uzbekistan for 2017–2021, one of the priority tasks was defined as educating a highly knowledgeable and intellectually developed generation and creating a reserve of competent scientific and pedagogical personnel in higher education institutions.

At present, the process of retraining specialists and improving their professional qualifications in the field of physical culture and sports is considered one of the key directions of the national education system. For the effective implementation of this process, special importance is attached to improving mechanisms that contribute to the development of pedagogical competence among physical education teachers within the framework of in-service professional development in general secondary education. The present study is devoted to identifying the effectiveness of these mechanisms and analyzing ways to improve them through statistical analysis.

In 21st-century pedagogical practice, there is no unified approach to defining and assessing the concept of pedagogical competence of a physical education teacher and/or physical education instructor. Consequently, there is no single, universally accepted definition of pedagogical competence. This is due to the fact that specialists interpret competence either as a set of knowledge, skills, and abilities acquired in the educational process or as the level of success in interactions with the surrounding environment [1].

When considering the organizational and pedagogical mechanisms of bachelor training in physical culture and sports education, it is first necessary to clarify the essence and content of this concept. Organizational and pedagogical mechanisms represent a system of scientific and pedagogical methods and approaches aimed at planning, coordinating, and increasing the effectiveness of the educational process. These mechanisms play a crucial role in determining the structure and content of the learning process [2].

In our view, within the educational and instructional process, these mechanisms contribute to addressing the following key tasks:

- designing and implementing curricula in accordance with the goals and objectives of the educational process;
- creating favorable conditions for the development of students' knowledge, skills, and abilities;
- effectively organizing pedagogical communication between teachers and students;
- establishing systems for monitoring and evaluating the educational process.

In the context of achieving the above-mentioned goals and objectives, the following core components of organizational and pedagogical mechanisms become particularly evident:

- curricula and study plans, which ensure a balanced integration of theoretical and practical training;
- material and technical infrastructure, which supports the educational process through the provision of modern technologies and equipment;
- pedagogical resources, comprising qualified teaching staff and contemporary instructional methods;
- social partnership, which plays an important role in organizing cooperation between educational institutions and external organizations.

The significance of the organizational and pedagogical mechanism is especially emphasized in the process of bachelor-level training in the field of physical culture and sports. In particular, this mechanism enhances the overall effectiveness of the educational process and facilitates the integration of theoretical and practical knowledge into a unified system. This integration plays a crucial role in preparing students for professional activity [3].

The concept of “competence” has been interpreted in various ways, which are generally classified into three main approaches:

- the American approach defines competence as a key characteristic of an employee who demonstrates appropriate behavior and is capable of achieving high performance at work;
- the European approach considers competence as an employee’s ability to act in accordance with the norms accepted within an organization, that is, the attainment of a minimum required standard;
- the practical approach defines competence as a set of behavioral characteristics necessary for the successful performance of job functions, reflecting the required norms of exemplary professional conduct [4].

According to B.R. Adizov (2021), leading international experts in the field of education propose the integrated implementation of two types of competencies in the teaching and learning process. These include “hard skills”, referring to professional competencies, and “soft skills”, referring to universal (general) competencies [5].

According to Sh.A. Akramova (2020), hard skills, that is, core competencies, can be acquired and mastered through formal education in educational institutions. Examples include the acquisition of foreign language proficiency, programming skills, and vehicle operation skills. In this regard, mastering intellectually algorithmized instructions is considered sufficient. During the learning process, the left cerebral hemisphere of the brain, which is responsible for logical thinking, is predominantly engaged, and a relatively high level of IQ (intelligence quotient) is required for effective mastery of such skills [6].

According to S. Sanaqulov (2020), the acquisition of hard skills requires specific and well-defined knowledge related to a particular profession, and the presence of these skills is typically determined through examinations. Sanaqulov notes that until the 21st century, educational systems primarily focused on developing hard skills among young learners. In other words, mastering a specific profession and fully acquiring its theoretical and practical foundations was considered the primary factor defining an individual as a competent specialist [7].

According to Sh.K. Rakhmatullayeva (2019), candidates’ hard and soft skills are assessed through an evaluation stage aimed at identifying their professional knowledge and skills required for a specific position. This includes expertise in methodologies, project documentation, and strategies for working with risks [8].

One of the most widely used methods for analyzing teachers’ pedagogical competence is classroom observation. This qualitative approach allows evaluators to directly observe how teachers interact with students, conduct lessons, and manage classroom dynamics. Depending on the specific focus of the assessment, observations may be structured or unstructured. Structured observations typically involve standardized rubrics that describe specific competencies and behaviors to be evaluated. This method enables observers to provide objective judgments based on predefined criteria, thereby facilitating the identification of strengths and weaknesses in teachers’ instructional practice [9].

## EXPERIMENTAL RESEARCH

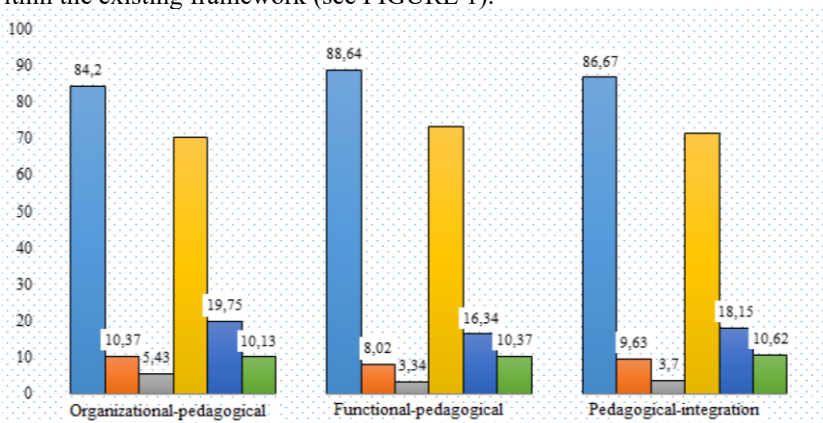
The term **competence** originates from Latin and in Uzbek conveys the meanings of “appropriate,” “adequate,” or “corresponding.” It may be understood as the ability of an individual to solve simple and complex problems by appropriately applying knowledge, skills, and practical experience. In many cases, the term “**professional competence**” is used. This concept refers to the ability to successfully apply one’s practical experience, knowledge, and skills in the performance of professional duties [10].

The primary objective of the present study was to examine the influence of organizational-pedagogical, functional-pedagogical, and pedagogical-integration mechanisms in the process of professional development and to develop scientifically grounded recommendations for their improvement.

According to the results of the questionnaire survey, responses from 162 participants – comprising 81 respondents in the experimental group and 81 respondents in the control group – were analyzed. The indicators of pedagogical competence **mechanisms** were expressed in percentage terms based on three response options: “yes,” “no,” and “unstable” (see FIGURE 1).

The diagram presented in FIGURE 1 illustrates the percentage distribution of responses from the experimental group (81 participants) and the control group (81 participants) with respect to mechanisms related to pedagogical competence. Responses are categorized into three indicators: “yes,” “unstable” and “no”.

In the formation of pedagogical competence, the first mechanism—the organizational-pedagogical mechanism—received strong support from the experimental group, with 84,2% of respondents selecting the response “yes.” This result indicates that, under the influence of this mechanism, participants developed pedagogical competence and demonstrated a high level of readiness for professional activity, specifically for conducting physical education lessons. However, even after the training program, 10,37% of respondents expressed an “unstable” opinion regarding this mechanism, while 5,43% rejected its influence by responding “no.” These findings indicate the necessity for further systematic reforms within the existing framework (see FIGURE 1).



**FIGURE 1.** Percentage distribution of responses from the experimental and control groups according to pedagogical competence mechanisms (n = 162)

Although the proportion of affirmative (“yes”) responses among participants in the control group reached 70,12%, this result was significantly lower than that of the experimental group. A total of 19,75% of respondents in this group demonstrated a degree of instability, as reflected in their “unstable” responses. Furthermore, 10,13% of participants – 4,4% higher than in the experimental group—evaluated the mechanism’s influence negatively by selecting the response “no.” Thus, the clear advantage of the experimental group with respect to this mechanism (84,2%) once again confirms the effectiveness of the training program implemented during the professional development process.

With regard to the second mechanism, namely the functional-pedagogical mechanism, 88,64% of respondents from the experimental group supported the strength of the mechanism’s influence by selecting the response “yes”. This finding indicates that the training program played a significant role in enhancing the professional competence of physical education teachers by strengthening the impact of this mechanism. Among respondents with a pedagogical work experience of two years or less, 8,02% expressed uncertainty regarding the influence of this mechanism, as reflected in their “unstable” responses, while 3,34% selected “no,” indicating that these individuals had not yet been fully integrated into pedagogical professional activity.

Among participants in the control group, 73,29% selected the response “yes”; however, this result is 15,35% lower than that of the experimental group. Correspondingly, 16,34% of respondents selected “unstable,” and 10,37% selected “no”. These results confirm that the experimental group demonstrated a higher level of success (88,64%) in understanding the importance of the functional-pedagogical mechanism in the formation of pedagogical competence.

Furthermore, according to the questionnaire survey conducted to assess understanding of the role of the pedagogical integration mechanism in developing pedagogical competence among physical education specialists, a high proportion of affirmative responses (86,67%) was recorded in the experimental group. Due to both objective factors (limited pedagogical experience) and subjective factors (graduates of sports-related, rather than education-oriented, programs), 9,63% of respondents continued to express uncertainty even after the training program, indicating difficulty in understanding the mechanism’s influence and applying it in professional pedagogical practice.

Additionally, 3,7% of respondents in this group selected “no,” reflecting resistance to personal and professional development.

In contrast, 71,23% of representatives from the control group—comprising participants with more than 11 years of pedagogical experience—demonstrated an understanding of the mechanism’s impact by selecting the response “yes.” However, 18,15% expressed uncertainty (“unstable”), and 10,62% explicitly rejected the mechanism’s influence by selecting “no.” Therefore, the experimental group also demonstrated a clear advantage with respect to the pedagogical integration mechanism (86,67%).

Overall, the questionnaire survey conducted to identify the significance of effective mechanisms in the formation of pedagogical competence demonstrated that the experimental group exhibited higher percentage indicators across all mechanisms. This finding confirms the effectiveness of the training program applied during the experimental phase of the study. In contrast, higher levels of uncertainty (“unstable”) and lack of understanding of the mechanisms’ influence within the context of physical education lessons (“no”) among participants in the control group indicate lower professional effectiveness and a less developed level of pedagogical competence.

## RESEARCH RESULTS

The results of the study show that the highest outcome was recorded in relation to understanding the influence of the functional-pedagogical mechanism, with 88,64% of participants in the experimental group responding affirmatively [10-35].

Thus, based on the diagram presented in Figure 1, it can be concluded that the experimental group is capable of effectively applying pedagogical competence mechanisms in physical education lessons. We interpret this outcome as a result of the influence of the new training program and methodological materials implemented within the professional development courses.

To assess the validity of the questionnaire used to evaluate mechanisms for forming pedagogical competence, the results were further examined using two nonparametric statistical tests: the chi-square test ( $\chi^2$ ) and the Mann–Whitney U test.

**First analysis.** A statistically significant difference was identified between the experimental group and the control group with respect to the effectiveness of the organizational-pedagogical mechanism in the formation of pedagogical competence among physical education specialists ( $\chi^2 = 6,32$ ;  $p < 0,05$ ). This result indicates that participants in the experimental group achieved greater success in organizing pedagogical processes.

**Second analysis.** Within the scope of the functional-pedagogical mechanism, the chi-square value was  $\chi^2 = 7,81$  ( $p \leq 0,005$ ). This finding likewise indicates that teachers in the experimental group successfully applied a functional approach in their professional activities (see Table 1).

**TABLE 1.** Assignment of the phases in the slots Differences in the interrelationships among mechanisms for forming pedagogical competence according to the  $\chi^2$  criterion (n = 162)

| Mechanisms for Forming Pedagogical Competence | Experimental Group (n = 81) | Control Group (n = 82) | $\chi^2$ value | P value  | Statistical difference               |
|---|-----------------------------|------------------------|----------------|----------|--------------------------------------|
| Organizational–Pedagogical                    | 84,20                       | 70,12                  | 6,32           | <0,011** | Statistically significant difference |
| Functional–edagogical                         | 88,64                       | 73,29                  | 7,81           | <0,005*  | Statistically significant difference |
| Pedagogical-Integration                       | 86,67                       | 71,23                  | 6,95           | <0,008** | Statistically significant difference |
| Note: * $p < 0,05$ ; ** $p \leq 0,005$        |                             |                        |                |          |                                      |

Analysis of the final mechanism—the pedagogical integration mechanism—shows that the  $\chi^2$  value equals 6,95 and the p-value equals 0,008, indicating a statistically significant difference between the responses of the experimental group and the control group with respect to this mechanism.

**Second analysis.** The results of the mechanism analysis based on the Mann–Whitney U test can be interpreted as follows (see Table 1).

It was determined that there is a statistically significant difference between the experimental group and the control group regarding the effectiveness of the organizational–pedagogical mechanism ( $U = 1032,0$ ;  $p < 0,05$ ). This finding

indicates that the experimental group achieved higher outcomes for this mechanism. Similarly, responses reflecting the effectiveness of the functional–pedagogical mechanism yielded a Mann–Whitney U value of 950,5 ( $p < 0,001$ ), demonstrating a significant difference between the experimental and control groups. The experimental group was distinguished by a higher mean rank compared to the control group. Furthermore, statistically significant differences were also observed in relation to the pedagogical integration mechanism ( $U = 978,3$ ;  $p < 0,05$ ) (see Table 2).

**TABLE 2.** Differences in the interrelationships among mechanisms for forming pedagogical competence according to the Mann–Whitney U test ( $n = 162$ )

| Mechanisms for Forming Pedagogical Competence | Experimental Group ( $n = 81$ ) | Control Group ( $n = 82$ ) | $\chi^2$ value | P value | Statistical difference               |
|---|---------------------------------|----------------------------|----------------|---------|--------------------------------------|
| Organizational–Pedagogical                    | 65,7                            | 47,3                       | 1032,0         | 0,001** | Statistically significant difference |
| Functional–edagogical                         | 70,1                            | 43,9                       | 950,5          | 0,001*  | Statistically significant difference |
| Pedagogical-Integration                       | 68,4                            | 45,6                       | 978,3          | 0,001** | Statistically significant difference |
| Note: * $p \leq 0,05$ ; ** $P < 0,001$        |                                 |                            |                |         |                                      |

Thus, the results of the Mann–Whitney U test and the low p-values confirm that these mechanisms were significantly more effective for the experimental group. In particular, the pedagogical approaches applied in the experimental group—namely, the training program and instructional methods—enhanced the effectiveness of the mechanisms. This allows us to conclude that the statistically significant differences observed across the mechanisms indicate a higher level of effectiveness in the formation of pedagogical competence among participants in the experimental group.

**TABLE 3.** Percentage analysis of the growth dynamics of pedagogical competence levels after the experimental intervention ( $n = 162$ )

| Mechanisms for forming Pedagogical Competence | Experimental group ( $n = 81$ ) | Control group ( $n = 82$ ) | Growth Dynamics (%) |
|---|---------------------------------|----------------------------|---------------------|
| Organizational–Pedagogical effectiveness      | 84,20                           | 70,12                      | +14,08              |
| Functional–edagogical effectiveness           | 88,64                           | 73,29                      | +15,35              |
| Pedagogical-Integration effectiveness         | 86,67                           | 71,23                      | +15,44              |

According to the results of the experimental study (see Table 1.3), the growth dynamics for the organizational–pedagogical mechanism amounted to 14,08%. This finding indicates that effective outcomes were achieved in the experimental group through the improvement of this mechanism.

As a result of enhancing the functional–pedagogical mechanism, the growth rate reached 15,35%. The final outcomes demonstrate that this mechanism significantly improved its practical impact on the formation of pedagogical competence among teachers in the experimental group.

Improvement of the pedagogical integration mechanism led to a 15,44% increase in the level of pedagogical competence, confirming that innovative and integrative approaches consistently produce substantial positive changes.

The analysis of the results obtained during the experimental phase, particularly the comparative analysis between the experimental and control groups, confirmed the effectiveness of the acmeological approach. In this context, the effectiveness of three key mechanisms was observed:

- *organizational–pedagogical*;
- *functional–pedagogical*;
- *pedagogical integration*.

The results of the comparative analysis indicate that technologies developed on the basis of the acmeological approach demonstrated high effectiveness in the experimental group, whereas the control group exhibited relatively lower outcomes.

## CONCLUSIONS

In our view, the acmeological approach serves as an effective solution for the formation and development of pedagogical competence among physical education specialists. The experimental findings confirm that, when implemented in accordance with contemporary pedagogical requirements, this approach contributes significantly to the enhancement of specialists' professional qualities. Therefore, the broader application of this methodology in educational practice is considered appropriate.

1. For physical education teachers, the effective organization of professional activities through organizational–pedagogical mechanisms is of great importance. The 14,08% growth achieved in the experimental group through this mechanism confirms the significance of such approaches. This highlights the necessity of systematic organization of instructional tasks, careful planning, and the clear formulation of requirements for learners.

2. For physical education teachers, the practical implementation of pedagogical technologies based on functional–pedagogical mechanisms is particularly important. The 15,35% growth achieved through this mechanism clearly demonstrates the effectiveness of using innovative technologies. This underscores the need to employ information technologies, multimedia tools, and creative approaches in physical education lessons.

3. The effectiveness of physical education instruction can be enhanced by ensuring interdisciplinary integration and introducing modern innovations into instructional practice. The 15,44% growth observed in the experimental group confirms the importance of this mechanism. This further demonstrates the necessity for physical education teachers to acquire in-depth interdisciplinary knowledge and to apply it effectively in professional practice.

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