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Integration of Pedagogical and Technical Knowledge in Diagnosing Preparation for Professional Activity

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ABSTRACT

This study aims to enhance the integration of pedagogical and technical knowledge in diagnosing the readiness of prospective vocational education teachers for professional activities. Strengthening the organic connection between production structures and the natural, technical, and social sciences has been proven to positively impact educational effectiveness. In the context of vocational education, the integration of pedagogical and technical knowledge, along with the modernization of educational forms and methods, is key to developing personal and professional qualities that support the innovative potential of educators. This research employed comparative and critical analysis of scientific literature, curricula, educational regulations, and teaching materials, supported by interviews, observation, questionnaires, testing, modeling, expert evaluation, pedagogical experiments, and statistical analysis. The findings contribute to the development of methodological recommendations and the expansion of didactic possibilities for educational integration, ultimately supporting the effective preparation of future vocational educators.

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1. INTRODUCTION

The preparation of future vocational education teachers requires a robust methodological foundation that supports the integration of multidisciplinary knowledge and skills (Demchenko et al., 2021). Recent research has yielded significant scientific results in establishing methodological bases for multidisciplinary educational complexes, ensuring the sequential integration and divergence of knowledge, developing systematic models for integrative knowledge acquisition, and improving diagnostic methods for assessing the professional readiness of future specialists (Anvarovna, 2023; Cheng et al., 2021). Students in vocational education programs are not only encouraged to recognize the interdependence of pedagogical and technical knowledge, but also to implement practical actions that reinforce this connection—such as through didactic preparation tasks that involve designing lesson plans or summarizing technical texts.

The outcomes of this research have been widely disseminated, having been presented at numerous international and national conferences. To further support the integration of pedagogical and technical knowledge in diagnosing the readiness of future vocational education teachers, several organizational and didactic resources have been developed, including electronic textbook programs for courses like "Methods of Teaching Special Disciplines." These resources aim to enhance both the theoretical and practical aspects of vocational teacher education (Kramer et al., 2021).

Scientifically, this study contributes to the development of a comprehensive concept for preparing future vocational educators, establishing a set of competence parameters and quality indicators, and demonstrating the organizational and functional potential of integrated pedagogical and technical knowledge (Khimmataliev et al., 2023; Khodjayev & Bbojonov, 2023). Methodological recommendations derived from the research serve to improve the quality and effectiveness of education, curriculum design, and the overall educational process in higher education institutions through an integrative approach (Nagima et al., 2023).

Practically, the research findings offer valuable tools and assessment systems for diagnosing the readiness of future teachers for professional activity (Rieu et al., 2022). These tools are instrumental in modernizing the educational process within vocational education, improving the methodology and teaching support for both general and specialized subjects, and integrating innovative educational technologies (Msafiri et al., 2023).

The experimental component of this study was conducted over four years at several higher education institutions, including the Tashkent Institute of Irrigation and Mechanization of Agriculture and its branches, as well as the Bukhara Institute of Engineering and Technology and the Jizzakh Polytechnic Institute. The experimental work focused on evaluating students' abilities to solve pedagogical and technical-technological problems, with special attention to the integration of knowledge in diagnosing readiness for professional activity. The effectiveness of the recommended pedagogical conditions was assessed through systematic analysis of preliminary and final test results, using criteria such as completeness of knowledge, clarity of actions, independence, and alignment with vocational education objectives.This research thus provides a comprehensive framework for the integration of pedagogical and technical knowledge in vocational teacher education, offering both theoretical insights and practical solutions for improving the readiness and competence of future educators (Weisberg & Dawson, 2023).

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2. METHODS

This research was carefully structured with clear goals and steps to ensure effective and focused results. The study was carried out in three main stages. In the initial stage, the researchers observed, conducted interviews, distributed questionnaires, and analyzed documents to assess how well pedagogical and technical knowledge were integrated in evaluating students' readiness for professional work. They also reviewed relevant scientific literature to strengthen the research direction. In the formative stage, the researchers applied the designed methods to diagnose students' readiness, using observations, practical training, discussions, and additional surveys. Modular teaching technologies and the use of integrated lesson syllabuses were also implemented, and theoretical findings were turned into practical guides and recommendations. In the final stage, the developed model for integrating pedagogical and technical knowledge was tested and its effectiveness was analyzed using statistical methods and expert evaluations. The results showed that the recommended methods successfully improved the integration of knowledge for assessing professional readiness. The success of this research was supported by sufficient resources, the use of modern educational technology, integrated teaching practices, and a systematic, integrative approach, ensuring that pedagogical and technical knowledge could be effectively combined to evaluate students' readiness for the professional world.

3. RESULTS AND DISCUSSION

In statistical analysis of the results of the experiment conducted to determine the effectiveness of diagnosing the readiness of future teachers of vocational education for professional activity based on the integration of pedagogical and technical knowledge in higher educational institutions, we relied on the following criteria:

Table 1. Indicators of the level of formation of professional skills based on the integration of pedagogical and technical knowledge (in percentages).

No	Indicators	In the control groups n = 184 students (percent)			In the experimental groups n_t = 180 students (percent)		
		Upper	Middle	Lower	Upper	Middle	Lower
1	Completeness of pedagogical and technical knowledge (knowledge of concepts, clarity of the connection between them)	22/33	38/40	40/27	19/54	39/38	42/8
2	Understanding of events (determining a rational order of actions, choosing several optimal options, self-monitoring)	24/34	42/39	34/27	16/53	33/32	51/15
3	Independence of action	23/33	39/38	38/29	14/48	33/33	53/19
4	The direction of actions aimed at the tasks of vocational education	21/28	41/39	38/33	11/51	28/30	61/19

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The results of the experimental work clearly demonstrate the readiness of future specialists for professional activity, which is achieved through the effective integration of pedagogical and technical knowledge. This integration encompasses not only the mastery and diagnosis of both pedagogical and technical competencies, but also the development of professional skills that are grounded in the combined application of these knowledge areas (Asad et al., 2021). Furthermore, the study highlights the importance of integrating pedagogical, psychological, theoretical, and practical knowledge, as well as the synthesis of pedagogical and technical (specialized) subjects. This integration occurs at multiple levels: intra-disciplinary integration fosters reproductive educational activities within a single discipline; interdisciplinary integration supports partially productive educational activities that span across different fields; and meta-subject integration encourages productive educational and cognitive activities that transcend individual subjects (Yaschuck et al., 2021). Collectively, these approaches ensure that future specialists are well-prepared to meet the complex demands of their professional roles (Khimmataliev et al., 2023).

Table 2. Indicators of respondent readiness for professional activity based on the integration of pedagogical and technical knowledge.

Levels	Control Groups				Experimental groups			
	At the beginning of the experiment 182 respondents		End of experiment 184 respondents		At the beginning of the experiment 176 respondents		End of experiment 180 respondents	
	number of respondents	%	number of respondents	number of respondents	%	number of respondents	number of respondents	%
Upper	35	19,2	37	20,1	34	19,3	76	42
Middle	78	42,9	82	44,6	78	44,3	84	47
Lower	69	37,9	65	35,3	64	36,4	20	11
total:	182	100	182	100	176	100	180	100

Table 2 and Figure 2 show that, based on the integration of pedagogical and technical knowledge, the level of students' readiness for professional activity at the beginning of the experiment was low, and at the end of the experiment it was high.

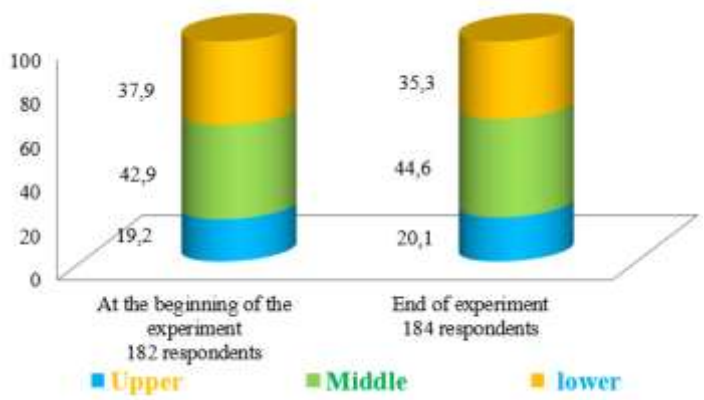

Figure 1. Control groups

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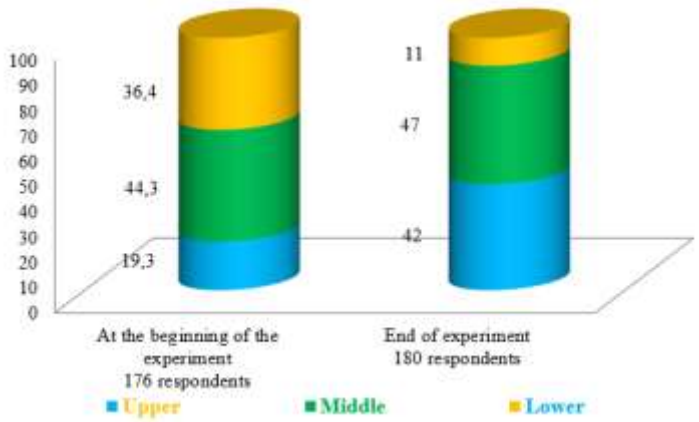

Figure 1. Experimental groups

Pearson and Student's t-test were used to determine the reliability of the obtained results. The data obtained because of the experiment in Table 1 was analyzed using mathematical and statistical methods. For this purpose, the control group's learning outcomes were determined using Xi, while the experimental groups' results were determined using Yi. The levels of "upper," "middle," and "lower" in the control and experimental groups were conditionally replaced with grades of "5," "4," and "3" respectively, and the values of the levels for the groups were determined by mi and mi. As a result, the following tables 3 and 4 were obtained based on Table 2.

Table 3. Statistical data at the beginning of the experiment.

Levels	Control groups			Experimental group		
	At the beginning of the experiment 182 respondents			At the beginning of the experiment 176 respondents		
	X_i	P_i	n_i	Y_i	q_i	m_i
Lower	3	69	0,379	3	0,363	64
Middle	4	78	0,429	4	0,444	78
Upper	5	35	0,192	5	0,193	34
Total	**∑**	**182**	**1**	**∑**	**1**	**176**

$$P_i = \frac{\ddot{I}_i}{n}, \quad q_i = \frac{m_i}{m}, \quad n = n_1 + n_2 + n_3, \quad m = m_1 + m_2 + m_3$$

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Table 4. Statistical at the end of the experiment.

Levels	Control groups			Experimental group		
	At the beginning of the experiment 182 respondents			At the beginning of the experiment 176 respondents		
	X_i	P_i	n_i	Y_i	q_i	m_i
Lower	3	65	0,353	3	20	0,11
Middle	4	82	0,446	4	84	0,47
Upper	5	37	0,201	5	76	0,42
Total	∑	**182**	**1**	∑	**180**	**1**

The main task of mathematical statistics is to conduct a comparative analysis of the internal data of Tables 3 and 4 (according to Xi and Yi) and their own.

$$\bar{X} = \sum_{i=1}^{3} X_i P_i \; 3 \cdot 0{,}353 + 4 \cdot 0{,}446 + 5 \cdot 0{,}201 = 1{,}059 + 1{,}784 + 1{,}005 = 3{,}848\,;$$

$$\bar{X}\% = \frac{100 \cdot \bar{X}}{5} = 76{,}96\,\% \sim 77{,}0\,\%$$

$$\bar{Q} = \sum_{i=1}^{3} Y_i q_i = 3 \cdot 0{,}11 + 4 \cdot 0{,}47 + 5 \cdot 0{,}42 = 0{,}33 + 1{,}88 + 2{,}1 = 4{,}31\,;$$

$$\bar{Q}\% = \frac{100 \cdot Q}{5} = 86{,}2\,\%$$

At the end of the experiment, the quantitative analysis showed a clear difference in performance improvement between the control and experimental groups. The control groups only improved slightly, with an average increase of 0.7% (from 76.3% to 77.0%). In contrast, the experimental groups improved much more, with an average increase of 9.2% (from 77.0% to 86.2%). To make sure these differences were meaningful, the researchers used the Student's t-test to compare the results of both groups. This statistical test confirmed that the experimental group's better performance was significant, proving that the new integrative approach was more effective than the traditional methods used in the control groups.

$$T = \frac{|\bar{x} - \bar{y}|}{\sqrt{\frac{S_x^2}{n} + \frac{S_y^2}{m}}} = \frac{|4{,}26 - 3{,}35|}{\sqrt{\frac{0{,}1560}{134} + \frac{0{,}2309}{130}}} = \frac{0{,}41}{\sqrt{0{,}0003473 + 0{,}0015605}} = \frac{0{,}41}{\sqrt{0{,}0024034}} = \frac{0{,}41}{0{,}04907} = 8{,}36$$

The 95% critical point corresponding to the Student's t-test is tkr = 1.96, and the statistical value is greater than it:

T = 8,36 1,96 = tkr

The results of mathematical and statistical analysis confirmed an increase in the effectiveness of integrated lessons at the beginning and end of the experimental work, the effectiveness of preparation for professional activity based on the integration of pedagogical and technical knowledge. This testifies to the effectiveness of integration in the process of professional training.

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4. CONCLUSION

In summary, this study shows that vocational education teachers need to combine both teaching and technical knowledge to meet growing demands. However, current teaching methods are not enough to fully support this integration in practice, leading to some challenges. The research highlighted the importance of creating and using a clear system to assess integrative learning and its results. It also identified the basic elements and principles needed to combine pedagogical and technical knowledge, as well as the steps and content required for integrating these skills into professional training. The results from the experiments and the new teaching materials developed in this study proved that students who experienced the integrative approach were better prepared professionally than those who followed traditional methods. Overall, these findings show that integrative teaching methods are more effective for preparing vocational education teachers to face the changing needs of their field.

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6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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