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Pedagogical Discourse on the Development of the Scientific and Innovative Potential of the Future Teacher

Abstract

Introduction. The study addresses the issue of developing the scientific and innovative potential of future teachers, as it encompasses their research skills, ability to design and implement innovative activities, and readiness to apply the achievements of modern science in the educational process. A pedagogical experiment was conducted involving control and experimental groups. In the experimental group, two test measurements were administered: pre-training and post-training. The evaluation of the program's effectiveness included measurements using the Dimensions of the Learning Organization Questionnaire - DLOQ, the Utrecht Work Engagement Scale - UWES-9, and the Innovative Work Behavior scale - IWB. *Results.* The results of the pedagogical experiment clearly indicate the emergence of a strong interest among future teachers in scientific and innovative activities, as well as the need for their systematic organization at all levels of teacher education. The experimental group demonstrated statistically significant improvements in indicators of engagement in scientific activities. The assessment of the motivational-value component for innovation development revealed an average level within the motivational-need block, with external motivation prevailing over internal motivation indicators. *Scientific novelty.* The effectiveness of practice-oriented tasks has been proven as a motivational tool that promotes active and conscious exploration of cause-and-effect relationships in nature. *Practical significance.* The implementation of a specialized teaching methodology aimed at developing the scientific and innovative potential of future teachers will significantly enhance their knowledge and competencies.

Keywords: statistically significant improvements in indicators of engagement and scientific-innovative potential.

Introduction. The issue of developing the scientific and innovative potential of future teachers has been and remains relevant within the pedagogical community over time. In the context of rapid technological advancement, globalization, and changes in educational approaches, the tasks related to teacher training are becoming increasingly complex and multifaceted.

The key issues in developing the scientific and innovative potential of future teachers include:

1. The innovative and scientific component of the psychological and pedagogical readiness of future teachers;

2. The development of personal motivation for innovation as a foundation of the university educational process;

3. The development of the scientific and innovative potential of future teachers as an integrative essence of research activity.

Based on the implementation of the idea of developing the scientific and innovative activity of future teachers as the «basic material» from which an innovative style and scientific potential are formed, it is important to substantiate, in the view of classical scholars such as V.I. Slobodchikov and V.P. Bespalko, the description of the structural components of an individual's innovative potential. Scientific potential is associated with cognitive functioning and implies the creation of a valuable intellectual product-intellectual satisfaction (A.I.Savenkov et al., 2007; V. A. Slastenin et al., 2003; L. M. Mitina et al.,1995).

The innovative potential of future educators is described as a combination of motivational, cognitive, and creative components (O.N. Knyazeva, Yu.V. Fedorova, E.I. Kolesnikova).

According to E.A. Yamburg (1997), when utilizing the scientific and innovative potential of young researchers, it is crucial to integrate scientific research into the educational process so that students can engage with new educational models and technologies, and participate in educational projects and initiatives. A.V. Mudrik emphasizes the importance of developing critical thinking and innovative competencies among future teachers within the context of educational standards (A.V. Mudrik, 2024).

The process of educational development-with its inherent innovative component-begins with the influence of the need for change in the sphere of higher education.

However, one of the main challenges in teacher education is the insufficient breadth of the academic repertoire, which highlights the importance of the psychological component-namely, the motivation of future teachers to develop their scientific and innovative potential. Motivation for self-realization through scientific and innovative potential contributes to the expansion of academic repertoire and enables the development of professionally significant and personal qualities.

The innovative potential of university students, as a professionally important personal resource with a multi-component structure, has been reliably addressed in national scientific research (S.M. Dzhakupov, G.Zh. Lekerova, U.M. Abdigapbarova, O.B. Tapalova). The range of types of activity that determine the development of an individual's scientific and innovative potential has been examined by Zh.I. Namazbayeva and N.B. Zhienbayeva.

As shown in international studies, modern learning environments allow the implementation of innovative pedagogy, in which learning scenarios-as noted by J. Dewey-are oriented toward developing students' critical thinking and independence. In his seminal work Democracy and Education, the author viewed the future teacher as an active participant in creating innovative practices and technologies.

P. Freire emphasized that the involvement of future teachers in the process of implementing innovative pedagogical practices and technologies significantly enhances learning outcomes and facilitates adaptation to an evolving educational landscape (P. Freire, 1995).

To intensively foster the potential of future teachers as catalysts of scientific research and innovation, M. Fullan, R. Marzano (2019) and L. Darling-Hammond (2001) emphasize the need to integrate scientific and innovative methods into their professional preparation.

Emphasizing the importance of developing innovative and scientific competencies in future teachers, C. Watkins, J. Adler, and F. Mutohhari note that certain gaps still remain:

- first, quantitative evidence on the effectiveness of professional development programs for teachers in innovative learning remains limited;

- second, although the implementation of innovative educational technologies, such as flipped learning, is widely discussed, there are still unresolved issues related to the practical application of these technologies in various educational contexts (Watkins S., 2005, Adler J. 2024).

Our comparative analysis of domestic and international literature revealed that the definition of scientific and innovative potential has diverse interpretations.

For instance, N.F. Vishnyakova suggests three approaches to studying the innovative potential of an individual through the category of creativity, viewing it as:

– a personal category related to self-actualization;

– a creative process;

– a product of activity associated with creating something new.

She justifies the concept of a potential model of innovative behavior by stating that «the process of transforming the potential capabilities of future teachers into actual ones, at the psychophysical level of personality development, means self-actualization» (Vishnyakova N.F., 1996).

D. Kokurin (2022) argues that «...innovative potential includes hidden capacities of

accumulated resources that can be activated to achieve the goals of the subjects».

M.I. Sitnikova (2007) characterizes the structure of an individual's innovative potential as comprising personal values, capabilities, goal-setting, and individuality-all traits of a person striving for self-development and continuously seeking to realize their own talents.

The structure of innovative potential, according to A.D. Karnyshev and D.V. Ushakov, is presented as an interpenetration of three components, combined into a unified block that consists of:

- professional competencies: a wide range of knowledge; multifaceted abilities and interests; the ability to independently analyze problems; communicative skills; high levels of self-esteem and academic achievement; creativity;

- scientific insight: critical and creative thinking; a rich imagination; intuitive ability to identify emerging trends;

- motivational orientation: a strong focus on achievement and success (Karneshev A.D., 2010).

A.A. Befani suggests viewing the structure of innovative potential as comprising:

- innovative identity, which is based on personal characteristics;

- innovative literacy as the core of personal self-identification;

- scientific-innovative individuality of students as the content that integrates both personal and activity-based components (Befani A.A., 2010).

In I.V. Mironova's study «The Innovative Potential of Personality as a Category of a Scientific Phenomenon», the essence of the concept «innovative potential of personality» is thoroughly examined through the etymological analysis of the terms «innovation», «potential» and «personality» (In I.V. Mironova, 2015).

In our work, we attempted to differentiate the concepts of «scientific potential» and «innovative potential» based on their fields of use, depending on the specific context of their application in the professional training of future teachers (Table 1).

Table 1. *Comparative analysis of the functional and substantive components of the concept «scientific-innovative potential»*

Concept	«Scientific Potential»	«Innovative Potential»
Origin of the Concept	Potential (from Latin «potential» – power) – a source, an opportunity that can be used to achieve a scientific goal.	Potential (Eng. «potential») – a combination of personal qualities that determine the possibility and limits of participation in innovation.
	Effectiveness, Quality of Scientific-Innovative Potential Development	
Personal Aspect	«Hidden capabilities» in achieving a scientific goal (M.I. Sitnikova); «Hidden sources» used by the individual to reach a specific goal (V.E. Klochko).	Internal reality of the ability to create and apply innovations in research (P.V. Khaidakyn); Combination of opportunities in the innovation sphere (V.A. Lopatin).
Formative Influence.	An inner reality of the ability to create and use innovations in the process of scientific research (P.V. Khaidakyn).	A set of opportunities in the field of innovation (V.A. Lopatin); «Inner purposefulness», with the potential to elevate values to a new level (V.A. Nikitin); The resource-based degree of readiness to realize opportunities (O.M. Krasnoryadtseva).
Result	Constructive personal contribution to scientific collaboration (L.M. Oganezov); Accumulator of scientific initiative, realization of hidden resources – core content and main goal (N.B. Zhienbayeva).	Preparation of specialists for the New Era; Innovative creation, resource elements of personal potential; Generating source introducing new elements into education with positive change regarding selected parameters (A.V. Khutorskoy).

Our comparative analysis indicates that at the core of the essential manifestation of the term «scientific-innovative potential» lies its foundational element - «potential» (from Latin potentia - «strength»).

Following I.V. Mironova's approach to the development of innovative abilities and capacities, understanding the inner processes of personality development, and its usage within higher education, we define scientific-innovative potential as:

- a complex synergistic construct combining and relating;
- personal values (goal values, relational values, educational values, instrumental values, quality values);
- the abilities and capacities of the individual (the scope and quality of knowledge, skills, competencies, and personal experience);
- individual characteristics of various mental processes (attention, memory, thinking);
- biologically determined traits (temperament, aptitudes);
- emotional stability as a counteraction to the unfavorable effects of an innovative environment;
- goal-setting orientation, focused not merely on useful outcomes but primarily on the realization of one's innovative potential.

The individuality of the person, seen as the ability for self-development and discovering appropriate ways to reveal and build hidden capabilities and capacities, thereby accumulating personal resources to solve specific tasks and achieve certain goals (Tapalova, O., & Zhiyenbayeva, N.,2024).

Based on the above, we can assert that within the framework for developing the scientific-innovative potential of future teachers, the specific characteristics of this phenomenon's development have not been sufficiently considered, and there has been inadequate representation of it within domestic pedagogical research.

Materials and Methods. In the course of this study, a survey of 80 master's students was conducted, allowing for a comprehensive assessment of the process of developing the scientific and innovative potential of future teachers. The participants included first- and second-year master's students from Abai Kazakh National Pedagogical University and Khoja Ahmed Yasawi International Kazakh-Turkish University.

The study was conducted during the first and second semesters of the 2024–2025 academic year. The research design was experimental, encompassing two measurement points: pre- and post-training assessments. The experimental approach employed a survey method.

The evaluation of the program's effectiveness utilized several established scales:

- DLOQ (Dimensions of Learning Organization Questionnaire): This instrument assesses the organizational learning environment and its alignment with learning-oriented practices.
- UWES-9 (Utrecht Work Engagement Scale – 9 items): This scale measures work engagement across three dimensions: vigor, dedication, and absorption. The Russian version of the UWES-9 has demonstrated acceptable psychometric properties, including high internal consistency (Cronbach's alpha = 0.88) and a three-factor structure that fits the data well.
- IWB (Innovative Work Behavior Scale): This scale evaluates innovative behavior in the workplace, encompassing three aspects: idea generation, idea promotion, and idea implementation. The scale employs a 5-point Likert scale ranging from 1 («very little») to 5 («very much»). Reliability coefficients (Cronbach's alpha) for the subscales have been reported as follows: idea generation = 0.82, idea promotion = 0.78, and idea implementation = 0.81.

The IWB questionnaire comprises nine items, with three items dedicated to each of the three dimensions:

- idea generation: items 1, 4, 7;
- idea promotion: items 2, 5, 8;
- idea implementation: items 3, 6, 9.

The reliability of the IWB scale, calculated using Cronbach's alpha, was 0.85, indicating high internal consistency. The reliability coefficients for the subscales were 0.82 for idea generation, 0.78 for idea promotion, and 0.81 for idea implementation. These scales collectively

facilitate the analysis of respondents' levels of engagement, innovative thinking, and readiness to learn, providing a comprehensive assessment of the program's impact on participants.

This study surveyed 80 master's students, enabling a comprehensive assessment of the development process of the scientific and innovative potential of future teachers. The participants were first- and second-year master's students from the Abai Kazakh National Pedagogical University and the Khoja Akhmet Yassawi International Kazakh-Turkish University.

To determine whether the groups (first- and second-year master's students) were equivalent in terms of their initial knowledge levels, an independent samples t-test was conducted. The mean values and standard deviations for the DLOQ, UWES-9, and IWB scales are presented in Table 2. The analysis results showed no statistically significant differences between the groups ($p > 0.05$), confirming their similarity at the baseline level.

The reliability of the IWB scale was assessed using Cronbach's alpha, yielding a coefficient of 0.85, indicating good internal consistency. The subscales for idea generation, idea promotion, and idea implementation had Cronbach's alpha values of 0.82, 0.78, and 0.81, respectively, also reflecting satisfactory reliability. These findings suggest that the groups were comparable in their initial levels of engagement, innovative thinking, and readiness to learn, providing a solid foundation for evaluating the effectiveness of the intervention program.

Table 2. *Mean Values and Standard Deviations of Pre-Test Results*

Scale	Master's Students – 1st Year (n=35)	Master's Students – 2nd Year (n=45)	t	p
DLOQ	3.45 (0.68)	3.51 (0.71)	-0.76	0.45
UWES-9	4.12 (0.75)	4.08 (0.78)	0.49	0.62
IWB	3.98 (0.61)	3.95 (0.63)	0.37	0.71

The average score on the DLOQ scale was 3.45 (SD 0.68) for first-year master's students and 3.51 (SD 0.71) for second-year master's students. The difference between the groups on this scale was negligible ($t = -0.76$, $p = 0.45$), indicating statistically insignificant differences. The average score on the UWES-9 scale was 4.12 (SD 0.75) for first-year students and 4.08 (SD 0.78) for second-year students. The difference on this scale was also small ($t = 0.49$, $p = 0.62$), indicating no significant differences between the groups.

The IWB scale showed mean values of 3.98 (SD 0.61) for future teachers and 3.95 (SD 0.63) for practicing educators, with an insignificant difference ($t = 0.37$, $p = 0.71$), which also confirms the absence of significant differences.

The next stage-the assessment of the motivational-value component of readiness for the development of scientific-innovative potential at the stage of the ascertaining experiment-was conducted via online testing on the platform psytests.org.

Results. Table 3 presents the results obtained using the following methods: the five-factor personality questionnaire, the Academic Motivation Scale by T.O. Gordeeva with indicators of «motivation of cognition», «motivation of achievement», «motivation of self-development», and «amotivation». The «Need for autonomy and competence» scale by K.M. Sheldon, as adapted by D.A. Leontiev, including the «self-determination index».

The motivational-value component of readiness for the development of scientific-innovative potential was evaluated based on individual personality traits diagnosed by the above-mentioned methods. Statistical processing of the obtained results was performed using the Statistica 6.0 package; mean values, standard deviation, and Pearson correlation coefficient were assessed.

Table 3. *Parameters of the motivational-value component of readiness for the development of scientific-innovative potential (1st and 2nd year master's students)*

Master's Students	1st Year		2nd Year	
Parameters	Mean Value	Standard Deviation	Mean Value	Standard Deviation
Openness to Knowledge	2,87	5,53	2,97	5,43
Openness to Research Experience	3, 34	5,12	3, 54	5,32
Openness Index	3,20	4,04	3,40	4,14
Need for Competence	0,57	0,49	0,87	0,39
Need for Autonomy	0,12	0,49	0,32	0,39
Self-Determination Index	0,31	0,39	0,41	0,29

The empirical study revealed that the parameter «openness to experience» (positive attitude toward learning) (2.87/2.97) has higher scores and predominates over «openness to knowledge» (interest in new information, acquisition of new knowledge), with an openness index of 3.20/3.40.

Distinctive personality characteristics of the students include needs for autonomy and competence; these parameters are prerequisites for the individual's scientific-research and innovative activity and represent productive internal motivation and psychological well-being.

Table 4. *Parameters of motivation for the development of scientific-innovative potential in 1st and 2nd year master's students*

Type of Motivation	1st Year Mean		2 курс	
	Mean Value	Standard Deviation	Mean Value	Standard Deviation
Motivation for Innovation	12,67	3,12	12,87	3,18
Achievement Motivation	12,32	3,06	12,62	3,12
Self-Development Motivation	12,02	3,18	12,72	3,25
Intrinsic Motivation	10,98	3,16	10,18	3,34
Extrinsic Motivation	11,32	3,84	11,92	3,90
Amotivation	7,98	4,05	7,05	3,99

The interpretation of the obtained results shows that the lowest indicator among master's students is the need for autonomy, which means that students more often avoid initiatives to independently master new technologies and participate in research projects. Regarding the need for new knowledge, it becomes clear that students have a reduced need for involvement in research activities.

The indicators for the need for competence point to students' desire to be competent in scientific-research activities as well as in personal growth; however, the self-determination index is quite low.

The main component of the value-motivational readiness for the development of scientific-innovative potential is motivation for innovation. It should be noted that activity motives have different content and vary according to criteria such as their place in the hierarchy and intensity, the balance of which determines the activity of the future teacher.

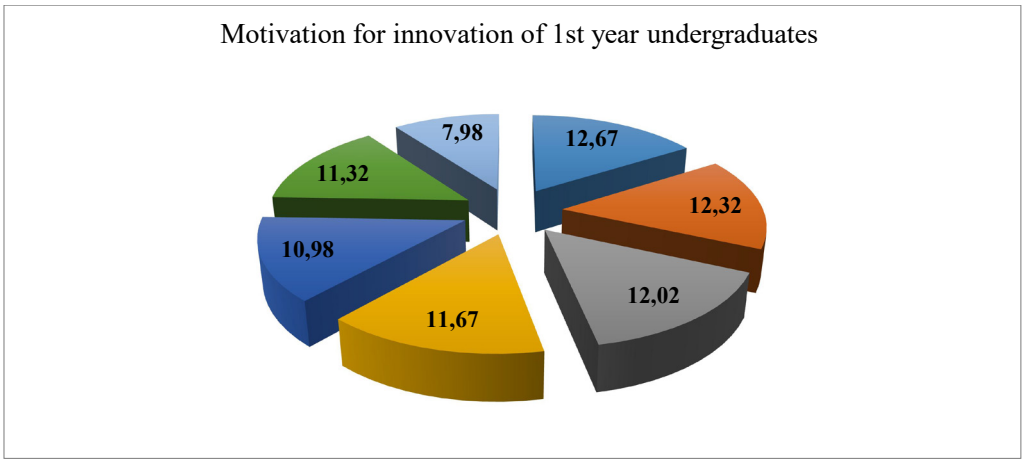

Figure 1: Parameters of motivation for innovation among 1st-year master's students

An important aspect in studying this component is the balance between intrinsic and extrinsic motivation. Table 3 and Figures 1 and 2 present diagnostic results from the Motivation Scale.

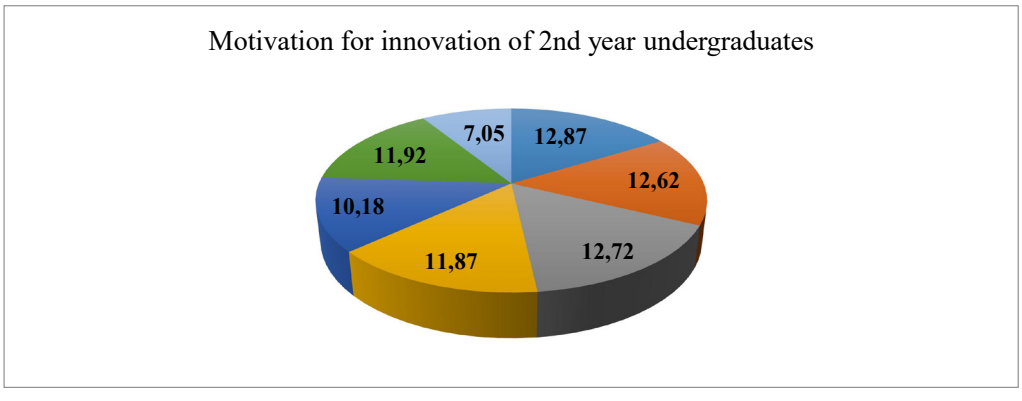

Figure 2: Parameters of motivation for innovation among 2nd-year master's students

The assessment of the motivational-value component for innovation development demonstrates an average level within the motivational-need block, with external motivation prevailing over internal motivation indicators. This indicates the need to work on developing an internal interest in the learning process and strengthening motivation for self-development in order to enhance the innovative potential of future teachers.

Discussion. The key element of the value-motivational component of readiness to develop the scientific and innovative potential of future teachers is motivation for innovative activity. This motivation is manifested in a teacher's aspiration to acquire new knowledge, seek non-standard solutions to professional challenges, and implement modern educational technologies and methods. It is important to note that the motives driving an individual's activity vary in content and qualitative characteristics: they may occupy different positions within the individual hierarchy of needs and manifest with varying degrees of intensity and stability.

The correlation of these characteristics determines the specifics of the future teacher's professional activity, shaping their readiness for research, perception of pedagogical innovations, and their practical application in the educational process. This is also influenced by several factors, such as receptiveness to change, openness to implementing new teaching methods, and the integration of technologies, as they are still at the early and intermediate stages of their careers and may actively seek opportunities for professional growth (Lian

et al., 2021). Younger teachers may also have a greater capacity to adapt to new teaching methods and interdisciplinary collaboration. They may exhibit a more flexible teaching style and a willingness to experiment with various methods (Krolevetskaya et al., 2021). Young and mid-career teachers may actively seek opportunities for professional development (McChesney et al., 2021), for example, to advance their careers; therefore, the current educational program could meet their needs for upskilling and provide them with tools and strategies to improve their research activities and innovative teaching methods. Furthermore, less entrenched habits may also play a role, making it easier for them to adopt new teaching methods and research practices (Hobbiss et al., 2021).

Conclusion. The scientific and innovative potential of a future teacher represents an integrative personal quality that combines cognitive, research, creative, and value-motivational components. Its development is based on the ability to engage in scientific inquiry, critical and creative thinking, mastery of modern digital tools, and readiness to apply innovative approaches in educational practice. The essence of this potential lies not only in the accumulation of knowledge but also in the ability to transform it into a valuable intellectual product-new pedagogical ideas, methodological solutions, and digital learning technologies. Such potential enables future teachers to become not merely transmitters of ready-made knowledge but active participants in the scientific and innovation process. Scientific and innovative potential serves as the foundation for a teacher's professional competitiveness, shaping their readiness for continuous self-development, collaboration, and participation in educational reforms. It is a key prerequisite for the successful adaptation of teachers to the rapidly changing challenges of modern society and the digital educational environment.

The parameters of motivation for scientific achievement have shown to be highly significant for future teachers in terms of their readiness to develop scientific and innovative potential. The experimental study of future teachers' scientific and innovative potential makes it possible not only to assess the current level of students' readiness for innovative activities but also to develop effective pedagogical strategies for stimulating their research activity. Thus, the scientific and innovative potential of future teachers, in the context of their scientific and innovative development, is viewed as a complex integrative personal characteristic that encompasses individual abilities and resources enabling the generation of innovative ideas and behaviors, the capacity to align personal capabilities with the conditions of professional activity, and the ability to analyze situations within the modern research environment.

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