Innovation in the Professional Formation and Development of Future Teachers

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Abstract
The aim of the empirical research is to find out and substantiate the psychological content parameters of innovation in the professional formation and development of future teachers. The tasks are: determination of correlations of parameters of higher education students’ professional readiness for innovative activities with independent variables; finding statistically significant differences between the respondents in the samples of bachelors (group I) and master’s students (group II); comparison of the researched groups with high and low levels of the formation of the coefficients of innovation. Methods: retrospective analysis, generalization, systematization and comparison; the author’s questionnaire “Professional readiness of students for innovative activities” (RIA) (Tsuniak, 2021); method “Diagnostics of the motivational structure of the personality” (DMSP) (Milman, 1990); method “Teacher’s abilities for creative self-development” (TACSd) (Nikishina, 2009). Results. It was found that there are no statistically significant differences in the determined parameters between the samples of bachelors (group I) and master’s students (group II). A positive tendency was stated in group I in the quantitative coefficient of innovation QCI (M=.68; SD=.22; Me=.68) and in group II – the qualitative coefficient of innovation QCI (M=.68; SD=.22; Me=.68). It was established that the coefficients of innovation have four statistically significant correlations with independent variables: creative activity, social usefulness, active self-development, stopped self-development (p<.050; p<.010). Significant differences were found in the studied groups with high and low levels of formation of the quantitative coefficient of innovation (QCI) and the qualitative coefficient of innovation (Q,CI).

Discussion and conclusions. It was explained that the statistically significant correlation between QCI and the “social usefulness” parameter is evidence that the subjects are ready to bear social responsibility for innovation, take a mature social position and work for the long term. The obtained empirical results should be taken into account by the organizers of the educational process and the guarantors of specialized educational and scientific programs, who are responsible for future teachers’ academic and professional training.

Keywords: educational process, professional training, professional readiness, primary school teacher, university, distance learning, digital educational environment.

Annex

The aim of the empirical research is to find out and substantiate the psychological content parameters of innovation in the professional formation and development of future teachers. The tasks are: determination of correlations of parameters of higher education students’ professional readiness for innovative activities with independent variables; finding statistically significant differences between the respondents in the samples of bachelors (group I) and master’s students (group II); comparison of the researched groups with high and low levels of the formation of the coefficients of innovation. Methods: retrospective analysis, generalization, systematization and comparison; the author’s questionnaire “Professional readiness of students for innovative activities” (RIA) (Tsuniak, 2021); method “Diagnostics of the motivational structure of the personality” (DMSP) (Milman, 1990); method “Teacher’s abilities for creative self-development” (TACSd) (Nikishina, 2009). Results. It was found that there are no statistically significant differences in the determined parameters between the samples of bachelors (group I) and master’s students (group II). A positive tendency was stated in group I in the quantitative coefficient of innovation QCI (M=.68; SD=.22; Me=.68) and in group II – the qualitative coefficient of innovation QCI (M=.68; SD=.22; Me=.68). It was established that the coefficients of innovation have four statistically significant correlations with independent variables: creative activity, social usefulness, active self-development, stopped self-development (p<.050; p<.010). Significant differences were found in the studied groups with high and low levels of formation of the quantitative coefficient of innovation (QCI) and the qualitative coefficient of innovation (Q,CI).

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Introduction
Dynamic social changes, transformational processes, social orientation of the labor market encourage rethinking the purpose and tasks
of education in the context of future teachers’ professional development. The higher education students’ professional readiness to manage changes, to think creatively and unconventionally is the basis of a competitive specialist, their basis for self-development, professional growth and self-improvement (Machynska et al., 2022; Pečiuliauskiënė et al., 2023; Yaremchuk, 2022). It should be noted that quarantine due to COVID-19 has become a time of real testing for all participants of the educational process and an opportunity for innovation in educational practice (Tsiuniak, 2020). At the same time, with the beginning of the full-scale Russian-Ukrainian war, the higher education system of Ukraine, like other areas of the country’s life, underwent serious changes: the educational process was suspended; the buildings of Ukrainian educational institutions, which enable young people to acquire not only knowledge, but also psychological support, not to lose the sense of belonging to the Ukrainian community, were destroyed.

Innovative thinking is a key competency in today’s world, where technological development, social change and globalization create constant challenges and opportunities. A person with innovative thinking is able to critically evaluate information; to look for new ways of solving professional and life problems; easily adapts to new conditions; is ready to take risks and try new approaches. In addition, innovative thinking requires internal motivation and self-discipline. People who are able to motivate themselves are more often ready to find new and original ideas.

Among the important qualities of a future teacher there are abilities to interact productively with all participants in the educational process, emotional balance, stress resistance, tolerance, communication, the ability to prevent conflicts and resolve them, the ability to work effectively in a team, developed pedagogical reflection, the ability to value the psycho-emotional health of learners. Also, a modern student of higher education must adhere to the values of the European Educational Space, including academic freedom, openness and partnership, democracy, ecological literacy (on the demand of education for sustainable development), globalization and commitment to national and cultural identity (taking into
account modern processes), self-organization and responsibility for the results of one’s activities and for the quality of education in general (Buerkle et al., 2023). The interdependence between respondents’ self-efficacy and the formed personal qualities and traits of the mentor was empirically investigated and substantiated (Halian et al., 2023a; 2023b). An important role in the professional development of a teacher is played by empathy, which is reflected in their ability to understand and distinguish the feelings and emotions of other people, empathize, behave sensitively and with understanding. Researcher O. Tsiuniak (2022) singled out the components of empathy, such as emotional sensitivity and rational perception of reality, which is manifested in the ability to be observant and attentive. The development of critical and innovative thinking allows a person to act more effectively and more successfully solve complex tasks in the professional sphere (Tsiuniak, 2022).

At the same time, a modern teacher must orientate in the information space, receive information that is the main resource of digital education, and operate it in accordance with their own needs and requirements of professional activity (create text documents, tables, drawings, diagrams, presentations; use Internet technologies, local networks, databases; develop their own electronic products (electronic lesson plans; electronic textbooks, training programs, demonstration material); must acquire new knowledge and skills that will help to work comfortably and be competitive in the educational space of the information society; adapt their teaching methods to different learning styles of students and change approaches in accordance with modern requirements; effectively manage their own time and time for conducting lessons in order to achieve maximum results; promote the development of students’ creative abilities. These skills help the teacher to effectively implement innovations, create a favorable learning environment and prepare students for the challenges of the modern world. After all, learning based on the principle of “knowing everything” is changing to the principle of “knowing how to learn throughout life and become self-realized and competitive”, and working

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swobody, відкритість і партнерство, демокра
tичність, екологічна грамотність (на вимогу
освіти для сталого розвитку), глобаліз
так прихильність до національно-культурної
ідентичності (з урахуванням сучасних проце
сів), самоорганізованість і відповідальність
за результати своєї діяльності та за якість
освіти загалом (Buerkle et al., 2023). Емпірично
dосліджено й обґрунтовано взаємозалежність
самоєфективності респондентів від сформова
них особистісних якоситів і від рів наставника
(Halian et al., 2023a; 2023b). Важливу роль у про
фесійному становленні вчителя відіграє емпа
тійність, що відображається в його здатності
усвідомлювати й розрізняти почуття та емо
cії інших людей, співпереживати, ставитися
чуйно та з розумінням. Дослідницью О. Цюняк
(2022) виокремлено складники емпатії, такі як
емоційна чуйність і раціональне сприйняття
dійсності, що відстежується в умінні бути спо
стережливим та уважним. Розвинутість кри
tичного та інноваційного мислення дозволяє
людині ефективніше діяти й успішніше розв’я
зувати складні завдання професійної сфери
(Цюняк, 2022). Водночас сучасний учитель
позвинен орієнтуватися в інформаційному про
сторі, одержувати інформацію, яка є основним
ресурсом цифрової освіти, та оперувати нею
відповідно до власних потреб і вимог про
фесійної діяльності (створювати текстові
dокументи, таблиці, малюнки, діаграми, пре
зентації; використовувати Інтернет-технології,
локальні мережі, бази даних; розробляти
власні електронні продукти (електронні
розробки уроків; електронні підручники,
nавчальні програми, демонстраційний мате
ріал); має оволодіти новими знаннями і вмін
нями, що допоможуть комфортно працювати
tа бути конкурентоспроможним в освітньому
просторі інформаційного суспільства; при
стосовувати свої методи навчання до різних
стилів навчання учнів та змінювати підходи
відповідно до сучасних вимог; ефективно
управляти власним часом та часом для прове
дення уроків з метою максимального досяг
нення результатів; сприяти розвитку творчих
здібностей здобувачів освіти. Ці навички допо
магають учителю ефективно впроваджувати
інновації, створювати сприятливу навчальну
with information based on the principles of "memorization" is gradually losing its meaning due to the development of the Internet as a global source of information, and therefore, not only knowledge, but also the skills of the 21st century are becoming important, combining media literacy and the ability to work with information (Tsiuniak, 2021).

No doubt, that the 21st century is an era of cyber socialization of society, a time of transformation, innovation, and formation of the conceptual foundations of digital education. The research of L. Sultanova et al. "Rethinking Education in the Digital Age" (2021), commissioned by the European Parliament in 2020, states that rethinking education in the digital age should become a central issue for today's policymakers for two reasons: first, only education can create a skilled workforce ready for the future profession and the changing labor market. Therefore, rethinking education in the era of digital technologies is a prerequisite for Europe’s future global competitiveness; secondly, only education can provide prerequisites for social integration and equality; participation of European citizens in digital democracy (Sultanova et al., 2021).

That is why the problem of forming professional readiness for innovative activities in higher education students, who will be able to easily adapt to the changed conditions of today and be competitive in the labor market, becomes urgent. The modern world requires from young people the ability to react qualitatively and quickly to innovative changes taking place in society, to be self-sufficient, proactive, responsible citizens, successful people, professionally competent. Modern institutions of higher education should not only provide the educational process, but also become a platform for the creation of innovations, scientific and educational online platforms, personalized educational trajectories, and the implementation of projects.

Innovation in the professional formation and development of future teachers is understood as a complex of cognitive, affective-value and behavioral psychological parameters that are in organic unity and demonstrate statistically significant correlations and differences in the dimensions of modern educational atmosphere and that motivate the students to develop their skills and competencies. Adapting to the new paradigms of teaching and learning, the teacher must constantly update their knowledge and skills to stay competitive in the labor market.

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and professional training of future teachers. The results of the comparison of dependent and independent variables can allow finding out the effectiveness of theoretical and practical readiness and educational and methodological support of specialized educational programs.

Hypotheses: 1) the content psychological parameters of higher education students’ professional readiness for innovative activities, the motivational parameters of professional readiness and the level of abilities for creative development will not have statistically significant differences between the samples of bachelors and master’s students; 2) the parameters of higher education students’ professional readiness for innovative activities will have statistically significant correlations with independent variables; 3) comparison of the researched groups with high and low levels of innovation coefficient formation will have statistically significant differences.

The aim of the empirical research is to find out and substantiate the psychological content parameters of innovation in the professional formation and development of future teachers.

Methods
Methodology. The methodological foundations of innovation in the professional formation and development of future teachers were concepts that outlined the processes of creation, implementation of advanced practices, progressive ideas in educational practice, implementation of modern educational and management technologies (Zolotaryova, 2015; Tsiuniak, 2020). Modern empirical works, which revealed the problems of digital literacy, were studied (Iломаки et al., 2023; Mahsan, 2023), as well as the introduction of artificial intelligence into teaching practice (Jomtarak et al., 2024), dominant mental states in educational, professional and other leading types of human activity (Popovych et al., 2020; 2022).

Participants. Two sample groups of students of higher education who studied at the graduation courses of the bachelor's and master's degree programs of Vasyl Stefanyk Precarpathian National University (Ivano-Frankivsk, Ukraine) and Ivan Franko National University of Lviv (Lviv, Ukraine) rozumіємо комплекс когнітивних, афективно-ціннісних і поведінкових психологічних параметрів, які знаходяться в органічній єдності й демонструють статистично достовірні зв'язки та відмінності у вимірах сучасної навчально-професійної підготовки майбутніх вчителів. Результати порівняння залежних і незалежних змінних можуть дозволити з’ясувати ефективність теоретичної та практичної готовності і навчально-методичного забезпечення профілюючих освітніх програм.

Гіпотези: 1) змістові психологічні параметри професійної готовності здобувачів до інноваційної діяльності, параметри мотивації професійної готовності й рівень здібностей до творчого розвитку не матимуть статистично достовірних відмінностей між вибірками бакалаврів і магістратів; 2) параметри професійної готовності здобувачів до інноваційної діяльності матимуть статистично достовірні кореляційні зв’язки з незалежними змінними; 3) порівняння досліджуваних груп із високим і низьким рівнями сформованості коефіцієнтів інноватики матимуть статистично достовірні відмінності.

Метою емпіричного дослідження є з’ясування та обґрунтування психологічних змістових параметрів інноватики у професійному становленні та розвитку майбутніх вчителів.

Методи
Методологія. Методологічні вихідні положення інноватики у професійному становленні та розвитку майбутніх вчителів склали концепції, в яких окреслено процеси творення, імплементації передового досвіду, прогресивних ідей в освітню практику, реалізації сучасних освітніх та управлінських технологій (Золотарьова, 2015; Цюняк, 2020). Досліджено сучасні емпірічні праці, в яких розкрито проблеми цифрової грамотності (Iломаки et al., 2023; Mahsan, 2023), впровадження штучного інтелекту у викладацьку практику (Jomtarak et al., 2024), домінуючих психічних станів у навчально-професійні та інших провідних видах діяльності людини (Popovych et al., 2020; 2022).

Учасники. Рандомно обрано дві вибіркові сукупності здобувачів, які навчалися на випускних курсах бакалавріату і магістратури
were randomly selected. Group I consisted of bachelors aged 20–22 years (M=21.12; SD=±2.43), in total (n=56; 47.46%). Group II consisted of master’s students aged 23–38 years (M=26.44; SD=±3.98), in total (n=62; 52.54%). The following distribution was obtained by sex: female (n=97; 82.20%) and male (n=45; 17.80%).

Procedures and Instruments. The basic method for researching the parameters of innovation is the author’s questionnaire “Professional readiness of students for innovative activity” (RIA) (Tsiuniak, 2021). Using two dimensions: the quantitative coefficient of innovation (QCI) and the qualitative coefficient of innovation (Q2CI), the key parameters were found out. The quantitative coefficient of innovation predicted respondents’ answers to test tasks. Content analysis with a coding matrix of innovative indicators was used to calculate the qualitative coefficient of innovation. The applied method contributed to obtaining reliable data on the formation of innovative readiness of students of higher education for future professional activities. Relevant dimensions of the motives that are dominant among future teachers were determined using the method “Diagnostics of the motivational structure of the personality” (DMSP) (Milman, 1990). The proposed scales: life support (LS), comfort (Cf), communication (C), general activity (GA), creative activity (CA), social usefulness (SU) relevantly reflected the subject of our research. Responses to fourteen statements made it possible to determine the level of general and creative activity. Method “Teacher’s abilities for creative self-development” (TACSd) (Nikishina, 2009) is an evaluation-reflective complex consisting of fifteen statements of one’s creative potential. Using three scales, we found active self-development (ASD), absence of a self-development system (ASDS), but the presence of creative intentions, and stopped self-development (SSD) – its complete absence. Using three psychodiagnostic tools, quantitative and qualitative dimensions were clarified, formal and content components, levels and structure of the researched variables were taken into account.

Variables. Quantitative and qualitative dimensions are defined as the dependent variables of innovation, which are reflected by the QCI and Q2CI coefficients. Independent
variables are the parameters of the motivational structure of the individual, as well as the levels of self-development. No additional variables were introduced.

**Organization of Research.** The research is empirical and presents a comparison strategy. Retrospective analysis, empirical results, and substantiation were carried out during April – December 2023. All basic requirements related to awareness, voluntariness of respondents and confidentiality of all participants and their personal data were met. The ethical committees of the organizing universities approved the research.

**Statistical Analysis.** Empirical data processing was carried out using the computer application SPSS Statistics 19.0 FP1 (19.0.0.1). The statistical editor MS “Excel” and the graphic editor MS "Word" were also used for drawing. Descriptive frequencies, correlations according to the Spearman coefficient \( (r_s) \) were determined, and the Mann-Whitney coefficient \( (U) \) was used to find out the differences. Statistically reliable levels in the study were \( p \leq 0.050 \) and \( p \leq 0.010 \).

**Results**

The obtained empirical data are presented through descriptive frequency characteristics: M – mean of the dispersion; SD – mean squared deviation; Me – median of the dispersion. These parameters were determined for each group separately, with the aim of further finding statistically significant differences between the groups. A comparison of actual dimensions of innovation among bachelors (group I) and masters (group II) is of scientific interest in the context of training future teachers. Using the Mann-Whitney coefficient \( (U) \), differences in the researched groups were determined according to the author’s questionnaire “Professional readiness of students for innovative activities” (RIA) (Tsiuniak, 2021) and the method “Diagnostics of the motivational structure of the personality” (DMSP) (Milman, 1990) (Tabl. 1).

The results of the comparison proved the absence of statistically significant measurements between the researched parameters of the questionnaire “RIA” (Tsiuniak, 2021) and the method “DMSP” (Milman, 1990). Only tendencies were found out.

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**Кількісні і якісні виміри, враховано формальні і змістові складові, рівневість і структурність досліджуваних змінних.**

**Змінні.** Залежними змінними інноватики визначено кількісний і якісний виміри, які відображено коефіцієнтами ККІ та ЯКІ. Незалежними змінними є параметри мотиваційної структури особистості, а також рівні саморозвитку. Додаткові змінні не вводили.

**Організація дослідження.** Дослідження є емпіричним і представляє стратегію зіставлення. Ретроспективне аналізування, емпіричні результати й обґрунтування проведено впродовж квітня – грудня 2023 року. Витрачено всі основні вимоги, які стосувалися поінформованості, добровільності респондентів і дотримання конфіденційності про усіх учасників і їхні особисті дані. Етичні комітети університетів-організаторів схвалили проведення дослідження.

**Статистичне аналізування.** Обробку емпіричних даних здійснено комп’ютерним застосунком SPSS Statistics 19.0 FP1 (19.0.0.1). Також використано статистичний редактор MS "Excel" і для рисунку – графічний редактор MS "Word". Визначено описові частоти, кореляції за коефіцієнтом Спірмена \( (r_s) \) та застосовано для з’ясування відмінностей коефіцієнт Манна-Уїтні \( (U) \). Задовільними в дослідженні статистично достовірними рівнями є \( p \leq 0.050 \) і \( p \leq 0.010 \).

**Результати**

Отримані емпіричні дані подано через описові частотні характеристики: M – середнє дисперсії; SD – середнє квадратичне відхилення; Me – медиана дисперсії. Ці параметри визначено за кожною групою окремо, з метою подальшого з’ясування статистично достовірних відмінностей між групами. Науковий інтерес у контексті підготовки майбутніх вчителів становить порівняння актуальних вимірів інноватики у бакалаврів (групу І) і магістрів (групу II). Застосовуючи коефіцієнт Манна-Уїтні \( (U) \), визначено відмінності в досліджуваних групах за авторською анкетою "Професійна готовність здобувачів до інноваційної діяльності" (Цюняк, 2021) і методикою "Діагностика мотиваційної структури особистості" (Мільман, 1990) (табл. 1).
We consider it appropriate to present tendencies – superiority of group I in the quantitative coefficient of innovation QCI (\(M=.68; SD=.22; Me=.68\)) and group II in the qualitative coefficient of innovation QCI (\(M=.62; SD=.23; Me=.61\)). The obtained descriptive frequency characteristics do not have statistically significant differences with the results of approbation of the “RIA” questionnaire in the research of N. Machynska et al. (2022) and in the research of O. Tsiuniak et al. (2020).

Table 2 presents the differences in the researched groups according to the method “Teacher’s abilities for creative self-development” (TACSd) (Nikishina, 2009) obtained using the Mann-Whitney coefficient (U).

The results of the comparison showed two statistically significant measurements: the superiority of group 2 according to the indicator of active self-development (AS) (U=312.000; p=.003) and the superiority of group 1 in the absence of a self-development system (SSD) (U=408.000; p=.012). Obviously, the master’s students, who continue their studies under this educational program and made up the sample population of group 2, have a formed system of self-development and purposefully implement it. This was probably the motive for continuing studies at the second educational year.

Table 1. Comparison of the researched parameters by the Mann-Whitney (U) (n=118)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Group I (n=56)</th>
<th>Group II (n=62)</th>
<th>Mann-Whitney (U)</th>
</tr>
</thead>
<tbody>
<tr>
<td>QCI</td>
<td>M=.68, SD=.22, Me=.68</td>
<td>M=.62, SD=.23, Me=.61</td>
<td>U=619.00, p=.059</td>
</tr>
<tr>
<td>Q2CI</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LS</td>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td>С</td>
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<td></td>
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<tr>
<td>TA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SU</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Group I – sample of bachelors; Group II – a sample of master’s students; M – mean of the dispersion; SD – mean squared deviation; Me – median of the dispersion; U – values by the Mann-Whitney test; p – level of statistical significance; QCI – quantitative coefficient of innovation; Q2CI – qualitative coefficient of innovation; LS – life support; СI – comfort; С – communication; GA – general activity; CA – creative activity; SU – social usefulness.

We consider it appropriate to present tendencies – superiority of group I in the quantitative coefficient of innovation QCI (\(M=.68; SD=.22; Me=.68\)) and group II in the qualitative coefficient of innovation Q2CI (\(M=.62; SD=.23; Me=.61\)). The obtained descriptive frequency characteristics do not have statistically significant differences with the results of approbation of the “RIA” questionnaire in the research of N. Machynska et al. (2022) and in the research of O. Tsiuniak et al. (2020).

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Results of the comparison demonstrated the absence of statistically significant differences in the researched parameters of the questionnaire “ГІД” (Цюняк, 2021) and the method “ДМСО” (Мільман, 1990). Only tendencies were found. We consider it appropriate to present tendencies – superiority of group I in the quantitative coefficient of innovation QCI (\(M=.68; SD=.22; Me=.68\)) and group II in the qualitative coefficient of innovation Q2CI (\(M=.62; SD=.23; Me=.61\)). The obtained descriptive frequency characteristics do not have statistically significant differences with the results of approbation of the “RIA” questionnaire in the research of N. Machynska et al. (2022) and in the research of O. Tsiuniak et al. (2020).

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Innovation in the Professional Formation and Development of Future Teachers

Table 2. Comparison of the researched parameters by the Mann-Whitney coefficient (U) (n=118)

<table>
<thead>
<tr>
<th>Groups</th>
<th>Parameters</th>
<th>Content parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ASD AC</td>
<td>ASDS BCC</td>
</tr>
<tr>
<td>Group 1</td>
<td>Group 1 (n=56)</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>.58</td>
<td>.51</td>
</tr>
<tr>
<td>SD</td>
<td>±.22</td>
<td>±.19</td>
</tr>
<tr>
<td>Me</td>
<td>.59</td>
<td>.50</td>
</tr>
<tr>
<td>Group 2</td>
<td>Group 2 (n=62)</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>.71</td>
<td>.44</td>
</tr>
<tr>
<td>SD</td>
<td>±.25</td>
<td>±.17</td>
</tr>
<tr>
<td>Me</td>
<td>.70</td>
<td>.45</td>
</tr>
<tr>
<td>Mann-Whitney (U)</td>
<td>U 312.00</td>
<td>408.00</td>
</tr>
<tr>
<td>p</td>
<td>.003</td>
<td>.012</td>
</tr>
</tbody>
</table>

Note: Group 1 – sample of bachelors; Group 2 – a sample of master’s students; M – mean of the dispersion; SD – mean squared deviation; Me – median of the dispersion; U – values by the Mann-Whitney test; p – level of statistical significance; ASD – active self-development; ASDS – absence of a self-development system; SSD – stopped self-development.

and scientific level. Accordingly, the absence of a self-development system or its incomplete formation showed the superiority of group 2.

According to the empirically accepted research strategy, the correlations were found out according to the Spearman coefficient (rs), among the dependent variables (QCI and Q2CI) and the content parameters that affect the innovative activity of the research participants. The correlation matrix was created on the basis of the general sample population (n=118) (Tabl. 3).

A correlation pleiad of coefficients of innovation with the researched parameters was constructed and presented in Fig. 1, which supplemented the provided data (see Tabl. 3) and allowed presenting the research results qualitatively.

The innovation parameters showed the same number of statistically significant correlations with the researched parameters – four connections for each one (p<.050; p<.010). The strongest positive relationship was recorded in the correlation pair of Q2CI with ASD (rs=.187; p=.004), and the strongest negative relationship was recorded in the correlation pair of QCI with SSD (rs=-.165; p=.006). We conclude that the qualitative coefficient (Q2CI) is the most important measure of innovation with a slight advantage over the QCI. The absence of statistically significant correlations with the following parameters was recorded: life

Note: Group 1 – sample of bachelors; Group 2 – a sample of master’s students; M – mean of the dispersion; SD – mean squared deviation; Me – median of the dispersion; U – values by the Mann-Whitney test; p – level of statistical significance; ASD – active self-development; ASDS – absence of a self-development system; SSD – stopped self-development.
According to the defined comparison strategy, the differences of the researched parameters in groups A and B (low and high levels of QCI) and groups C and D (low and high levels of Q2CI) were identified. Distribution was carried out according to the median (Me). Tabl. 4 presents the correlation matrix of the parameters of innovation with the researched parameters.

**Table 3.** Correlation matrix of the parameters of innovation with the researched parameters

<table>
<thead>
<tr>
<th>Scale Шкали</th>
<th>Parameters Параметри</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LS ЖЖ</td>
</tr>
<tr>
<td>QCI rs</td>
<td>0.179</td>
</tr>
<tr>
<td>QCI p</td>
<td>0.162</td>
</tr>
</tbody>
</table>

Note: QCI – quantitative coefficient of innovation; Q2CI – qualitative coefficient of innovation; rs – Spearman coefficient; p – nominal value; LS – life support; CF – comfort; C – communication; GA – general activity; CA – creative activity; SU – social usefulness; ASD – active self-development; ASDS – absence of a self-development system; SSD – stopped self-development; * – correlation at level p≤0.050; ** – correlation at level p≤0.010 (in bold).

**Fig. I.** Correlation pleiad of coefficients of innovation with the researched parameters (n=118)

Note: ——— positive correlations with p≤0.050; ———— positive correlations with p≤0.010; ———— negative correlations with p≤0.050; ———— negative correlations with p≤0.010.

According to the defined comparison strategy, the differences of the researched parameters in groups A and B (low and high levels of QCI) and groups C and D (low and high levels of Q2CI) were identified. Distribution was carried out according to the median (Me). Tabl. 4 presents the correlation matrix of the parameters of innovation with the researched parameters. The results show a positive correlation between QCI, Q2CI, and parameters such as life support (LS), comfort (CF), communication (C), general activity (GA), and absence of a self-development system (ASDS).

Zagria  з визначеною стратегією зіставлення, з’явилось відмінності досліджуваних параметрів у групах A і B (низький і високий

**Table 3.** Кореляційна матриця параметрів інноватики з досліджуваними параметрами

<table>
<thead>
<tr>
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<tr>
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</tr>
</tbody>
</table>

Note: QCI – кількісний коефіцієнт інноватики; ЯКІ – якісний коефіцієнт інноватики; rs – коефіцієнт кореляції Спірмена; p – номінальне значення; ЖЖ – життєзабезпечення; К – комфорт; С – спілкування; ЗА – загальна активність; ТА – творча активність; СК – соціальна корисність; AC – активний саморозвиток; BCC – відсутність системи саморозвитку; ЗС – зупинений саморозвиток; * – кореляція на рівні p≤0.050; ** – кореляція на рівні p≤0.010 (подано напівжирним шрифтом).
a comparison in groups A and B using the Mann-Whitney coefficient (U).

It was found that the group with a high level of the quantitative coefficient of innovation (QCI) prevails over group A according to the indicator of active self-development (U=187.00; p=.000), social usefulness (U=329.50; p=.001), creative activity (U= 409.00; p=.007) and general activity (U=427.00; p=.012). The advantage of group A was recorded by stopped self-development (U=-313.00; p=.000).

Tabl. 4 shows a comparison in groups С and D using the Mann-Whitney coefficient (U).

It was found that the group with a high level of qualitative coefficient of innovativeness (QCI) prevails over group C according to the indicator of active self-development (U=134.50; p=.000), social usefulness (U=322.50; p=.000), creative activity (U= 222.00; p=.000) and communication (U=429.50; p=.017). The advantage of group A was ...
Discussion
The problem of psychological content parameters of innovation in the professional formation and development of future specialists of various fields is not new, it has always attracted attention (Machynska et al., 2022; Tsiuniak et al., 2020). Management of changes and innovations requires from institutions of higher education constant updating of existing educational programs, development of modern educational components that will have an anticipatory character. Artificial intelligence technologies (Amedu, Ohene-Botwe, 2024), the work of a teacher in remote and mixed formats (Anggadwita et al., 2024), competent construction of a digital educational environment (Suchikova, Tsybuliak, 2023) require permanent professional growth aimed at innovation from the future teacher. A comparison of the quantitative and qualitative coefficients of innovation (see Table 1) made it possible to record tendencies in changes in dimensions. It was explained that these tendencies demonstrate the strengthening of qualitative substantive parameters of the readiness of future masters in pedagogy for innovative activities, which indicates permanence in the formation of the outlined competencies. The advantage of the qualitative coefficient of innovation \(Q_2\text{CI}\) is much more significant as a result of finding out correlation patterns (see Tabl. 3 and Fig. I). The strongest positive relationship with the parameter “active self-development” \(\text{AS}\) \((r = 0.187; p = 0.004)\), and the negative relationship with the parameter “stopped self-development” \(\text{SSD}\) were explained by the dominant role of the personal and motivational component of students’ readiness for innovations in pedagogical activity. Such results are consistent with the data obtained by O. Tsiuniak et al. (2020). Also, the role of active self-development through the types \(U = 222.00; p = 0.000\) and \(U = 227.00; p = 0.017\). The difference is the presence of the dimension “general activity” \(U = 427.00; p = 0.012\) among the reliable parameters in the first pair of comparisons (low and high QCI), and the dimension “communication” \(U = 429.50; p = 0.017\) in the second pair of comparisons (low and high QCI).

Discussion
Проблема психологічних змістових параметрів інноватики у професійному становленні та розвитку майбутніх фахівців різних напрямків не є новою, її постійно приділяють увагу (Machynska et al., 2022; Tsiuniak et al., 2020). Управління змінами і нововведеннями від закладів вищої освіти вимагає постійного оновлення діючих освітніх програм, розробки сучасних освітніх компонент, які матимуть випереджальний характер. Технології штучного інтелекту (Amedu, Ohene-Botwe, 2024), робота педагога в дистанційному і змішаному форматах (Anggadwita et al., 2024), грамотна побудова цифрового освітнього середовища (Suchikova, Tsybuliak, 2023) вимагають від майбутнього вчителя перманентного професійного зростання, спрямованого на інноватику.

A comparison of the quantitative and qualitative coefficients of innovation (see Table 1) made it possible to record tendencies in changes in dimensions. It was explained that these tendencies demonstrate the strengthening of qualitative substantive parameters of the readiness of future masters in pedagogy for innovative activities, which indicates permanence in the formation of the outlined competencies. The advantage of the qualitative coefficient of innovation \(Q_2\text{CI}\) is much more significant as a result of finding out correlation patterns (see Tabl. 3 and Fig. I). The strongest positive relationship with the parameter “active self-development” \(\text{AS}\) \((r = 0.187; p = 0.004)\), and the negative relationship with the parameter “stopped self-development” \(\text{SSD}\) were explained by the dominant role of the personal and motivational component of students’ readiness for innovations in pedagogical activity. Such results are consistent with the data obtained by O. Tsiuniak et al. (2020). Also, the role of active self-development through the types \(U = 222.00; p = 0.000\) і спілкуванням \(U = 429.50; p = 0.017\). Перевагу групи А зафіксовано за зупиненим саморозвитком \(U = 387.50; p = 0.005\). Відмінність складає присутність серед достовірних параметрів у першій парі порівняння (низький і високий \(\text{ККІ}\)) виміру “загальна активність” \(U = 427.00; p = 0.012\), у другій парі порівняння (низький і високий \(\text{ЯКІ}\)) виміру “спілкування” \(U = 429.50; p = 0.017\).
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of self-actualization (Popovych et al., 2022), types of dispositional expected readiness (Popovych et al., 2020), the influence of a safe educational environment on motivational orientation (Blynova et al., 2023) in other activities of young people was confirmed. If the statistically significant correlations (p<.050; p<.010) of the coefficients of innovation with creative activity (CA) are obvious, then the same kind of correlations with social usefulness are somewhat unexpected (see Tabl. 3). It was explained by the fact that social usefulness is a derivative of socially responsible behavior of respondents. The presence of a statistically significant correlation is evidence that the respondents are ready to bear responsibility for innovation, take a mature social position and work for a long-term perspective. Similar results of the respondents of youth age were recorded in the research of tendency for risk in the dimensions of respondents’ life orientations (Tavrovetska et al., 2023).

The distribution of the respondents into groups with a low and high level of innovation coefficient formation (see Tabl. 4 and 5) additionally demonstrated statistically significant differences in important researched parameters. A statistically significant difference in the parameters of “general activity”, “social usefulness”, “active self-development” and “stopped self-development” seems logical and confirms the correlation results. Significant differences in groups A and B (see Tabl. 4) according to the “general activity” parameter (U=427.00; p=.012) can be explained by the fact that the operational-activity component has a significant impact on quantitative dimensions of innovation. Therefore, the significant differences in groups B and D (see Tabl. 5) according to the “communication” parameter (U=429.50; p=.017) can be explained by the fact that communication through communicative, perceptive and interactive functions is decisive in the qualitative dimension of innovation. The absence of a statistically significant advantage in the researched groups (see Tabl. 4 and 5) according to the parameters “life support” and “comfort” indicates that these parameters have the same effect on the readiness of future teachers for innovation and obviously depend on other, additional variables. The proposed empirical
research belongs to the initiative scientific topics of the departments and has a number of promising directions in the context of finding out the value-meaning determinants, development and research of a digital educational environment.

Conclusions

It was determined that innovation in the professional formation and development of future teachers is a complex of cognitive, affective-value and behavioral psychological parameters that are in organic unity and demonstrate statistically significant correlations and differences in the dimensions of modern educational and professional training of future teachers. It was found that the content psychological parameters of the students' professional readiness for innovative activities, the motivational parameters of professional readiness and the level of creative development abilities do not have statistically significant differences between the samples of bachelors and masters. Differences at the level of tendencies were recorded. It was established that the coefficients of innovation have four statistically significant correlations with independent variables: creative activity, social usefulness, active self-development, stopped self-development (p<.050; p<.010). The second hypothesis was proved. Significant differences were found in the researched groups with high and low levels of formation of the quantitative coefficient of innovation (QCI) and the qualitative coefficient of innovation (Q2CI), which gives grounds to state that the third hypothesis was proved. The obtained empirical results should be taken into account by the organizers of the educational process and the guarantors of specialized educational and scientific programs that train future teachers.

References


Blynova, O., Popovych, I., Hulias, I., Radul, S., зміних. Запропоноване емпіричне дослідження належить до ініціативних науково-дослідних тем кафедр і має низку перспективних напрямків у контексті з’ясування ціннісно-сенсових детермінант, розробки і дослідження цифрового освітнього середовища.

Висновки

Визначено, що під інноватикою у професійному становленні та розвитку майбутніх вчителів розуміємо комплекс когнітивних, афективно-ціннісних і поведінкових психологічних параметрів, які знаходяться в органічній єдності і демонструють статистично достовірні зв’язки та відмінності у вимірах сучасної навчально-професійної підготовки майбутніх вчителів. З’ясовано, що змістові психологічні параметри професійної готовності здобувачів до інноваційної діяльності, параметри мотивації професійної готовності й рівень здібностей до творчого розвитку не мають статистично достовірних відмінностей між вибірками бакалаврів і магістрів. Зафіксовано відмінності на рівні тенденцій. Першу гіпотезу доказано. Встановлено, що коефіцієнти інноватики мають по чотири статистично достовірні кореляційні зв’язки з незалежними змінними: творча активність, соціальна корисність, активний саморозвиток, зупинений саморозвиток (p<.050; р<.010). Другу гіпотезу доказано. Констатовано достовірні відмінності в досліджуваних групах із високим і низьким рівнями сформованості кількісного коефіцієнта інноватики (ККІ) і якісного коефіцієнта інноватики (ЯКІ), що дає підстави констатувати, що третю гіпотезу доказано. Отримані емпіричні результати доцільно взяти до уваги організаторам освітнього процесу і гарантам профільних освітньо-наукових програм, які готують майбутніх вчителів.

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