DOI https://doi.org/10.30525/978-9934-26-658-4-18

METHODOLOGICAL MODEL OF TRAINING FUTURE INFORMATICS TEACHERS BASED ON PSYCHOSOCIAL DEVELOPMENT AND CRITICAL THINKING

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INTRODUCTION

The current stage of the information society's development sets a strategic task for higher education regarding a fundamental revision of approaches to training future Informatics teachers. Rapid digitalization of all spheres of life and the emergence of cutting-edge technologies require an educator to possess not only deep subject knowledge but also a high level of adaptability, critical thinking, and the capacity for continuous self-development. In this context, the development and implementation of innovative teaching methodologies that respond to the current challenges of educational digitalization and ensure the formation of professional competence for a new generation of specialists are of particular importance.

The transformation of the educational paradigm necessitates a transition to active and constructivist teaching methods. The methodology for training future Informatics teachers should be based on the integration of theoretical foundations of computer science with practice-oriented activities. It is vital to ensure such an organization of the educational process where students are involved in solving real professional cases, developing their own software products, and modeling educational situations. This allows for the formation of a holistic vision of future professional activity and the development of skills for the effective use of artificial intelligence tools, cloud services, and cybersecurity measures in the educational space.

1. Analysis of scientific research and publications

The fundamental foundations of the methodological system for training future informatics educators were laid in the works of such scholars as M. Zhaldak, M. Lapchik, V. Monakhov, N. Morse, and Y. Ramsky. At the current stage, issues of improving professional training in the information society are being actively developed by V. Bykov, L. Bilousova, S. Semerikov, O. Spirin and other Ukrainian researchers. However, the dynamic nature of the IT industry and the permanent updating of the school informatics curriculum require constant modernization of methodological approaches. The authors of the study emphasize that the key driving force

behind reforms is the creation of an ICT-oriented educational environment and the expansion of instrumental support for students' cognitive activities[1].

An important condition for the effectiveness of modern higher education is the transition to student-centered learning models. In particular, H. Tkachuk substantiates the expediency of using problem-based learning methods that activate mental activity through the resolution of situational tasks. Such an approach allows the student to take the position of an active subject of learning, while the instructor performs the role of a facilitator. The effectiveness of such training increases significantly when using online environments and services for organizing distance work, which promotes the development of creative abilities and independence in future specialists[2].

Of particular importance in the current scientific discourse is the issue of integrating cutting-edge technological solutions, such as cloud-oriented environments and artificial intelligence (AI). The study by V. Oleksiuk reveals the theoretical and methodological foundations of designing cloud-oriented environments for the training of informatics teachers, which serves as the basis for the modern infrastructure of higher education institutions[3]. At the same time, O. Klochko focuses on the development of students' critical thinking in the process of interaction with AI systems. Analysis of the experience of the USA, Poland, and Slovenia indicates that the use of AI allows for more effective analysis of complex problems, making non-standard decisions, and forming high adaptability of future educators to the conditions of the digital environment[4].

A comprehensive approach to the professionalization of future informatics teachers also involves the implementation of innovative systems for assessment and project management. Researchers[5] suggest using

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[1] Олефіренко Н., Андрієвська В. Ознайомлення майбутніх учителів інформатики з сучасними освітніми технологіями. *Фізико-математична освіта*, 33(1), 2022. С. 30–35. URL: https://doi.org/10.31110/2413-1571-2022-033-1-005

[2] Ткачук Г. В. Використання методів проблемного навчання у процесі підготовки майбутніх учителів інформатики. *Перспективи та інновації науки*, № 2(7), 2022. С. 634–645. DOI: https://doi.org/10.52058/2786-4952-2022-2(7)-634-645

[3] Олексюк В. П. Теоретико-методичні основи проєктування, адміністрування та використання хмаро орієнтованого середовища навчання майбутніх учителів інформатики. 2023. URL: https://lib.iitta.gov.ua/id/eprint/736000/1/Dis_Oleksiuk_2023.pdf

[4] Клочко О. В. Розвиток критичного мислення майбутніх вчителів інформатики та математики з використанням засобів штучного інтелекту. *Modern Information Technologies and Innovation Methodologies of Education in Professional Training Methodology Theory Experience Problems*, 72, 2024. С. 14-26. URL: https://doi.org/10.31652/2412-1142-2024-72-14-26

[5] Гуревич Р., Клочко О., Федорець В., Шаригін О., Драчук М. Оцінювання роботи студентів комп'ютерних спеціальностей над іт проектами на основі квантування професійної діяльності. *Modern Information Technologies and Innovation Methodologies of Education in Professional Training Methodology Theory Experience Problems*, *68*, 2023. Pp. 5–18. https://doi.org/10.31652/2412-1142-2023-68-5-18

methodologies of systemic quantization of professional activity (Agile, Scrum, Kanban) to monitor work on IT projects. This allows for the transformation of assessment into a reflexive-analytical toolkit that combines pedagogical and industrial practices. As noted by D. Verbivskyi, such a methodological system must be integrated and based on the unity of methodological, theoretical, and practical concepts, ensuring the teacher's readiness to work within the European educational space[6].

Summarizing the analysis of scientific sources, it can be stated that the training of future informatics teachers today requires a synergy of the traditional methodological base and flexible innovative approaches. Priority areas include the development of critical thinking, the implementation of problem-based learning in a digital environment, and the use of software development methodologies in the educational process. It is this comprehensive approach that ensures the formation of professional competencies necessary for effective activity in the context of global technological transformations of the New Ukrainian School.

The **aim of the work** is to develop a modern methodological model for teaching future informatics teachers, aimed at developing students' productive creative thinking through the use of project methodologies, systemic quantization of activity, and online collaboration tools.

2. Theoretical foundations of the research

The effectiveness of developing any methodological system for training future Informatics teachers requires consideration of students' psychological characteristics. If the goal of our work is to form professional competence through innovative and problem-based methods, then the success of its implementation directly depends on how well the proposed tools resonate with the internal needs of the student as an individual undergoing intensive personal, professional, and social development.

In this context, the analysis of the age characteristics of students requires special attention, as it is during the university years that a fundamental transformation of worldview occurs. In particular, the renowned psychologist E. Erikson, in his theory of psychosocial stages of personality development, noted that the period from 12 to 19 years covers adolescence, and from 19 to 29 years – early adulthood. The transition from adolescence to adulthood is the key process that students undergo during university studies. No longer a child, but not yet an adult, the individual faces new social roles and the demands associated with them. The adolescent chooses a

[6] Вербівський Д. С. Концептуальні основи застосування інноваційних технологій в підготовці майбутніх вчителів інформатики. *Наукові записки Серія: Педагогічні науки*, 2024, 212. С. 72-76. DOI: 10.36550/2415-7988-2024-1-212-72-76

future profession, hesitates whether the choice was right, and begins university studies, within whose walls they undergo important stages of their personal development and maturation[7].

Adolescence (up to 19 years, which corresponds to the 1st and 2nd years of university study) belongs to the fifth psychosocial stage according to E. Erikson's theory. This stage plays a vital role in forming a sense of personal identity, which will influence human behavior and development throughout life. Adolescents need to develop a sense of self-awareness and personal identity.

At this age, students actively explore themselves, wanting to find out who they truly are as individuals. It is typical for them at this stage to strive for the assertion of self-worth and to experiment with different roles, activities, and behaviors. E. Erikson believed that without this, the process of forming a strong identity and developing a sense of direction in life is impossible.

The adolescent mind is essentially a mind of moratorium, a psychosocial stage between childhood and adulthood, between the morality learned by the child and the ethics to be developed by the adult[8].

During adolescence, children explore their independence and develop a sense of self-worth. It becomes extremely important for them to find answers to the questions: "Who am I?" and "Who do I want to be?". If they succeed in resolving this, the adolescent develops self-identity and fidelity to themselves. Those who remain unsure of their beliefs and desires will feel insecure and confused about themselves and their future. Success leads to the ability to stay true to oneself, while failure leads to role confusion and a weak sense of self-worth.

For 1st and 2nd-year students, it is necessary to create learning conditions in which they reveal themselves as individuals and develop the professional qualities of a future Informatics teacher. Therefore, it is important to apply person-centered, problem-seeking learning methods with an emphasis on an individual approach to each student in the classroom.

The use of problem-seeking teaching methods encourages students not just to look for the right answer, but to form their own point of view, argue it, and, most importantly, bear responsibility for the decisions made. This directly affects the strengthening of the "Self-concept" and the overcoming of that very insecurity.

[7] Malone J.C., Liu S.R., Vaillant G.E., Rentz D.M., Waldinger R.J. Midlife Eriksonian psychosocial development: Setting the stage for late-life cognitive and emotional health. *Dev Psychol*. 2016, 52(3). Pp. 496-508. DOI:10.1037/a0039875

[8] Erikson E. H. Childhood and society (2nd Ed.). New York: Norton. 1963. 433 p.

The instructor acts as a mentor, tutor, and guide who helps to identify and develop the student's strengths, overcome difficulties, and supports and directs their efforts towards achieving the set goal – becoming an Informatics teacher.

In the role of a tutor, the instructor does not provide ready-made answers but accompanies the student in the process of searching for them. For example, when a future Informatics teacher encounters an error in writing program code, the instructor-tutor does not fix it themselves but asks relevant questions, encouraging the student to analyze the logic of the algorithm and find the wrong solution independently. Such an approach teaches critical thinking, the ability to express one's own point of view, and responsibility for decisions, which helps overcome the fear of mistakes, turning them into valuable experience.

Parallel to this, the instructor must act as a mentor who supports personal growth and helps students experiment with various social and professional roles. Since adolescents strive to assert their sense of self-worth, the mentor creates an atmosphere of trust where the student can safely "try on" the role of a leader or a speaker. For example, during attempts to conduct a fragment of a lesson, the mentor does not focus exclusively on criticizing methodological errors but helps the student find their own teaching style, encouraging the manifestation of individuality and emotional intelligence. This allows the student to emerge from a state of uncertainty, believe in their own strength, and form a stable professional identity that will become the foundation for their further development as a teacher.

The sixth stage of psychosocial development is Intimacy vs. Isolation. This stage covers the period of early adulthood when people explore personal relationships. This stage lasts from 19 to 29 years, which coincides with the period of study for 3rd and 4th-year university students. A characteristic feature of the sixth stage is that students begin to open up more to others to develop close and committed relationships, looking for someone who can become closer to them than family members.

E. Erikson considered it vital for people to be open to forming close ties. If this stage is successful, the individual will build happy and strong relationships. Failure leads only to a sense of loneliness and isolation[9].

In the context of the sixth stage of psychosocial development according to E. Erikson, the role of the instructor undergoes fundamental transformations, moving from a purely didactic function to the role of a facilitator of personal growth and social integration. Since in the period of early adulthood (19–29 years) the central task of the personality is to overcome the dichotomy between intimacy and isolation, the higher

[9] Erikson E. H. Identity: Youth and crisis. New York, NY: W. W.Norton & Company, 1968

education instructor becomes a significant “other” who models peer relationships. In interaction with senior students, the instructor acts as a coach who not only transmits professional competencies but also creates a safe communicative space for the manifestation of openness and trust. This contributes to the formation of students’ ability to establish deep professional and personal connections, which is a basic condition for successfully passing this stage.

An important aspect of the instructor’s activity at this stage is the transition to subject-subject interaction, where the student is perceived as an equal partner in scientific and professional search. The instructor acts as a representative of the professional community, integration into which allows the student to overcome the feeling of social alienation and find belonging to a certain group outside the family circle. By providing constructive feedback and encouraging group collaboration, the educator helps the student build skills in emotional intelligence and empathy. Thus, the instructor indirectly influences the prevention of social isolation, stimulating the student toward self-disclosure and the formation of a stable capacity for intimacy, which is the key new formation of this age period.

The instructor’s awareness of the patterns of students’ psychosocial development is a fundamental condition for the determination and implementation of adequate methodological tools in the process of teaching informatics disciplines. The differentiation of teaching approaches should directly correlate with the current stage of personality formation, which allows for the optimization of the educational process according to the age and psychological needs of students.

The transition period from the fifth to the sixth stage of development is characterized by a deep revision of value orientations, a rethinking of life priorities, and professional choice. For 3rd and 4th-year students, this stage is often accompanied by a crisis of educational motivation and a shift in emphasis from cognitive activity to the search for interpersonal intimacy and affiliation. Given this, the design of an educational environment that prevents a decline in academic interest through the integration of interactive interaction technologies is of critical importance. Creating conditions for active group communication contributes not only to the mastery of technical knowledge but also to the formation of stable social ties necessary for the successful completion of the intimacy stage.

Within the teaching of professional informatics disciplines, special emphasis should be shifted to the development of “soft skills”, which serve as tools for adapting to the requirements of the modern labor market. Priority areas become the development of communicative competence, the ability for team-based solving of complex tasks, goal setting, and

volitional regulation in achieving results. Such an approach ensures the complex development of the student, where professional training in the field of information technology is harmoniously combined with the successful resolution of current psychosocial developmental tasks.

Taking into account the outlined psychosocial profile of the student, it becomes obvious that the teaching methodology should provide the future Informatics teacher with space for self-expression and testing various professional roles. In the period of forming personal identity, it is critically important to shift the focus from simple reproduction of knowledge to creative design of one's own activity.

One such tool that allows for the structuring of the student's creative search is the methodology of the Ukrainian lesson constructor "Puzzles", developed by a team of leading specialists from general secondary education institutions[10].

The lesson constructor consists of 4 puzzles (Fig. 1):

1st puzzle: Planning, which includes the stages of forming a lesson idea according to the topic, the expected outcome, and the definition of 1–3 key questions depending on the complexity of the lesson's educational topic.

2nd puzzle: Lesson design – this is the distribution of theoretical and practical educational material, as well as the establishment of time frames for each stage.

3rd puzzle: Tools – the developers of the lesson constructor emphasize the use of interactive exercises, multimedia materials, web resources, and specialized programs to support the active participation of schoolchildren in the learning process and ensure effective mastery of the material.

4th puzzle: Assessment and reflection, including methods for evaluating students' knowledge and skills, as well as analyzing the effectiveness of the lesson and its compliance with the set learning goals.

The adaptation of the school lesson constructor for the level of a Higher Education Institution (HEI) requires shifting the focus from methodological support for the teacher to the research and professional-project activity of the student, taking into account the change in the instructor's role according to the student's psychosocial stages of development. In higher education, each "puzzle" becomes more complex, considering the types of classes and integrating modern student teaching methods (Fig. 2).

[10] ДІЗНайся: про дистанційне і змішане навчання. URL: https://osvitoria.university/courses/diznaysia/

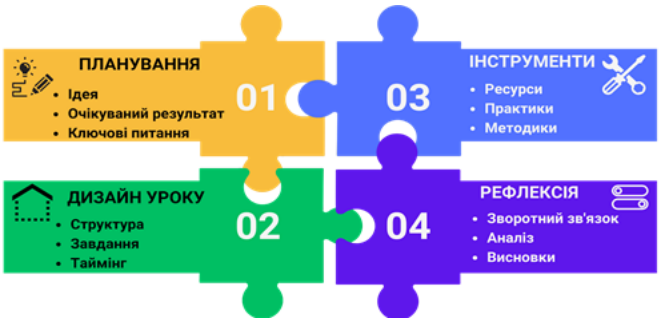

Fig. 1. Lesson constructor according to the "Puzzles" methodology[10]

Fig. 2. Adapted Lesson Constructor (Author's Development)

Puzzle 1: Goal Setting and Strategic Planning.
Puzzle 2: Didactic Design and Knowledge Architecture.
Puzzle 3: Technological Tools and Development Environment.
Puzzle 4: Professional Reflection and Verification of Results.
Let us describe each puzzle in detail.

Puzzle 1: Goal Setting and Strategic Planning. At the HEI (Higher Education Institution) level, this stage transforms from topic planning into the planning of Learning Outcomes in accordance with the course curriculum.

The goal-setting and strategic planning puzzle serves as the foundation for creating an effective session, as it involves idea generation, posing key questions, and forecasting expected learning outcomes.

- **Idea Generation:** Not merely familiarization with the session topic, but examining it through the lens of professional standards and current technology stacks (e.g., not just "Algorithms," but "Algorithm Optimization in High-Load Systems").
- **Key Questions:** These are transformed into scientific or engineering problems (Problem-based learning). Instead of asking "What are arrays?", we ask: "Which data structure will ensure minimum complexity for a search operation in real-time conditions?".

While designing the session, the instructor focuses on achieving the expected learning outcome, taking into account the general and subject-specific competencies provided by the educational program for students majoring in 014.09 Secondary Education (Informatics and Mathematics)[11] and the Professional Standard for Teachers of General Secondary Education Institutions[12]. The student does not just master the educational material but actively applies it to solve practical tasks or situations, which helps internalize and consolidate the acquired theoretical knowledge.

The key questions of the first puzzle are an essential tool for building the structure of the educational process. They help students navigate the learning material for a deeper understanding and prepare them for its perception. Engaging and stimulating key questions encourage students to participate in active discussions, search for answers, and conduct their own research, fostering creative thinking and the formation of a personal point of view.

Modern sessions help students "immerse themselves in reality", where the primary emphasis shifts to professional simulation and critical thinking. Expeditionary sessions or field research, Case Studies[13], Hackathons or Workshops[14], business games[15] or simulations[16], and Flipped

[11] Освітньо-професійні програми та навчальні плани кафедри математики та інформатики Вінницького державного педагогічного університету імені Михайла Коцюбинського. URL: https://fmft.vspu.edu.ua/kafedra-matematyky-ta-informatyky/opp.html

[12] Професійний стандарт «Вчитель закладу загальної середньої освіти». URL : https://mon.gov.ua/npa/pro-zatverdzhennia-profesiinoho-standartu-vchytel-zakladu-zahalnoi-serednoi-osvity

[13] Ситуаційна методика навчання: теорія і практика / упоряд. О. Сидоренко, В. Чуба. Київ : Центр інновацій та розвитку, 2001. 256 с.

[14] Soia O., Kovtoniuk M., Kosovets O., Petrovych S. Project-Based Learning as an Integration of Critical Thinking and Teamwork Skills of Future Teachers of Mathematics and Computer Science. *In: Faure, E., et al. Information Technology for Education, Science, and Technics. ITEST 2024. Lecture Notes on Data Engineering and Communications Technologies*, vol. 222, 2024. pp. 385–399. Springer, Cham. URL: https://doi.org/10.1007/978-3-031-71804-5_26

[15] Ділові ігри в навчальному процесі : метод. рек. / уклад. В. М. Петренко. Одеса : ОРІДУ НАДУ, 2016. 48 с.

[16] Інноваційні методи навчання у вищій школі : навч. посіб. / за ред. О. В. Падалки та ін. Київ : Наукова думка, 2018. 240 с.

Classroom[17,18,19] models provide extensive opportunities for creative learning. These formats help students actively explore themselves, experiment with different roles, and vary their learning activities and behavior, which aligns with the developmental needs of students according to E. Erikson's theory.

Hackathons and workshops, as forms of project-based learning and small-group work, perform a dual function: professional socialization (where students learn to interact and distribute roles, helping them understand their personal and professional strengths and weaknesses) and the development of emotional intelligence through collaborative activity (to learn empathy and the ability to listen to others, which is the foundation of a mature personality).

The instructor acts not as the sole source of truth, but as a facilitator and mentor who creates an atmosphere of trust and psychological safety. Only in such conditions, where an error is perceived not as a failure but as part of the experience, can a student unlock their potential, confirm their choice of profession, and form a stable life position.

Puzzle 2: Didactic Design and Knowledge Architecture. In HEIs, session design must account for the principle of knowledge fractality and a large proportion of independent work.

The more detailed the lesson structure is – with short explanations and practical tasks – the easier it is to adapt the session to various formats, such as blended or distance learning.

After structuring the educational material, the focus shifts to selecting didactically sound methods of delivery:

- **Material Distribution:** Implemented, for example, via the Flipped Classroom model. The theoretical block is assigned for independent study in the LMS (Moodle, Google Classroom), while class time is dedicated to in-depth analysis and a practical workshop or hackathon.
- **Timeframes:** These become flexible, with the majority of time occupied by teamwork or pair programming (in the case of informatics disciplines).

Let us consider the design of a Hackathon-session on the topic "Methodology for Teaching the Concept of Information to 5th Grade Students", which combines informatics teaching methodology with an IT approach. Since the 5th grade marks the beginning of the New Ukrainian

[17] Держак Н. О. Технологія «перевернутого навчання» у закладах вищої освіти. Інноваційна педагогіка. 2020. Вип. 22, Т. 2. С. 143–146.

[18] Barrows H. S. Problem-based learning in tertiary education. *New Directions for Teaching and Learning*. 1996. Vol. 68. P. 3–12.

[19] Bergmann J., Sams A. Flip Your Classroom: Reach Every Student in Every Class Every Day. *International Society for Technology in Education*, 2012. 120 p.

School in basic secondary education, instruction must be interactive and visual, considering the age characteristics of the students.

The concept of a hackathon for student-teachers (future Informatics teachers), based on model curricula[20] and informatics textbooks for the 5th grade[21, 22], has the following structure:

Hackathon Title: Info-Quest: Grade 5.

Announcement: From Theory to Pixel: Explain Information Simply!

1. **The Problem:** The concept of "information" is very abstract. It is difficult for fifth-graders to understand the difference between data, messages, and information itself through dry textbook definitions.

2. **Team Task:** Students develop a lesson prototype that helps a 5th-grade student understand:

– What information is and its types (visual, auditory, etc.).

– Processes of information transmission and storage.

– Information encoding (binary code, ciphers).

3. **Solution Formats (Team Choice):** Students do not just write a lesson plan; they create:

– **EdTech Solutions:** An interactive exercise in LearningApps, a game in Scratch, or a Telegram bot that "communicates" with the student.

– **Gamified Lesson:** A quest-lesson scenario using QR codes, where each task reveals a property of information.

– **Visual Guide:** A series of educational memes, a comic, or a short TikTok/Reels-style video explaining a complex concept in 60 seconds.

– **Board Game:** A "Computer Science Unplugged" format that can be printed and used in a classroom without computers.

4. **Evaluation Criteria (Mentor Grid):** Each team pitches their project to a jury. Evaluation includes:

– **Pedagogical Suitability:** Does the material align with the model program and the psychology of 10-11-year-olds?

– **Creativity:** How engaging is the delivery?

– **Feasibility:** How easily can a teacher implement this in a real classroom?

– **Interactivity:** Is there feedback, formative assessment, or Bloom's taxonomy-based questions?

[20] Інформатика. Навчальні програми для учнів 5-9 класів загальноосвітніх навчальних закладів. Сайт Міністерства освіти і науки України. Загальна середня освіта. Навчальні програми. URL: http://mon.gov.ua/activity/education/zagalna-serednya/navchalni-programy.html

[21] Морзе Н.В., Барна О. В., Вембер В. П., Кузьмінська О.Г. Підручник з інформатики для учнів 5 кл. загальноосвіт. навч. закл. К. : УОВЦ «Оріон», 2022. 256 с.

[22] Ривкінд Й.Я., Лисенко Т.І., Чернікова Л.А., Шакотько В.В. Інформатика : підруч. для 5 кл. закл. заг. серед. освіти. К. : Генеза, 2022. 208 с. : іл.

Winning Team Example: The “Bit and Byte” team developed a detective lesson scenario: “The Case of the Lost Byte.”

- **Legend:** A “Golden Byte” has disappeared from the school server. Students become “cyber-detectives” to recover it.
- **Stage 1: Sketch of the Suspect (Perception and Types of Information):** An exercise in LearningApps where “evidence” is provided in different forms (sound, encrypted photo, text).
- **Stage 2: Safe Encryption (Encoding):** Using Genially (interactive room), students find a “safe” locked with binary code and must decode the password.
- **Stage 3: Route Reconstruction (Transmission and Noise):** A quiz in Wordwall where the “Byte” runs through a cable, avoiding “noise” (viruses/disconnection).

Puzzle 3: Technological Tools and Development Environment. For future Informatics teachers, this stage is paramount as they study tools both as users and as future methodologists.

- **Tools:** Use of professional software (IDEs, version control systems like GitHub/GitLab, Docker virtualization).
- **Interaction:** Collaborative work in cloud environments (Google Cloud, Azure), using AI for code refactoring, and organizing **Peer-to-peer reviews** via online boards like Padlet, Canva, or Miro.

The “Tools” puzzle includes choosing the optimal digital interactive means and online resources. We can classify these tools as:

- Virtual or collaborative boards (Padlet, Canva, Miro);
- Communication platforms;
- Polling and testing systems (Kahoot, ClassTime, Mentimeter, Quizizz);
- Applications for simulation and online laboratories;
- Knowledge maps (Mindomo, Mindmeister, Sketchboard, Notebook LM) for visualization.

To solve the problem of selecting the appropriate tool, we have developed a **Digital Technology Foresight Wheel** (Fig. 3). This element of forecasting links digital tools to specific puzzles of the adapted lesson constructor, ensuring the achievement of learning outcomes[23].

[23] Ковтонюк М. М., Косовець О. П., Соя О. М., Леонова І. М. Архітектура цифрових технологій в освітньому середовищі викладача як трансфер інновацій в економічний простір держави. *Modern Information Technologies and Innovation Methodologies of Education in Professional Training Methodology Theory Experience Problems*, *68,* 2023. С. 93–106. https://doi.org/10.31652/2412-1142-2023-68-93-106

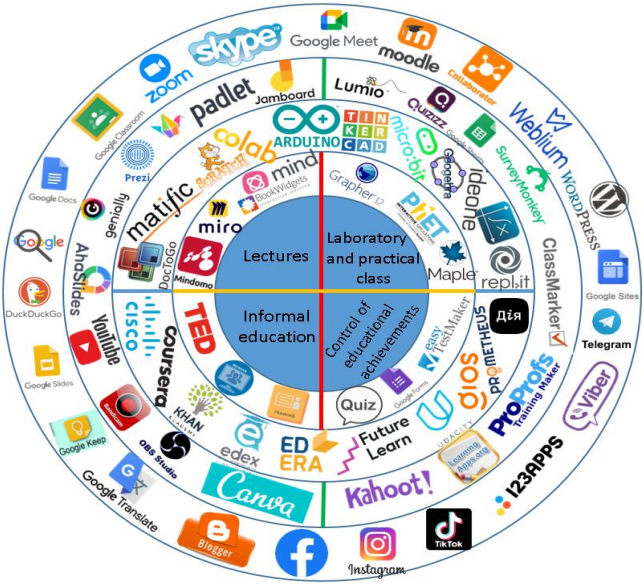

Fig. 3. Digital Technology Foresight Wheel (Author's Development)

Puzzle 4: Professional Reflection and Verification of Results. Assessment in HEIs must be criteria-based and formative.

- **Assessment Methods:** Project defense (Pitching), prototype presentation, or completion of a laboratory workshop with automated testing (Unit-testing).
- **Reflection:** Shifts into the plane of professional self-determination. The student analyzes: "Which hard and soft skills did I lack to solve the problem?" and "How can I adapt this material for my future pupils?".

After the successful implementation of all previous session puzzles, it is essential to conduct a final reflection with the students and evaluate their educational achievements. Reflection not only facilitates the consolidation of learning material, the development of critical thinking, self-assessment, and self-regulation but also contributes to increased motivation and improved quality of learning. Students have the opportunity to objectively evaluate their skills together with the instructor for further improvement of the acquired knowledge. This can be achieved through various assessment methods and techniques, such as checklists, brainstorming, discussions, and other active forms of work. Assessment must be independent, fair, objective, non-discriminatory, and characterized by academic integrity.

Fig. 4. Example of a formative assessment technique using emojis

For instance, students select a position that reflects their understanding and perception of the conducted lesson (Fig. 4). It is important to emphasize that such an evaluation of the lesson must be sincere and honest, and no grade is assigned. This helps the instructor objectively assess the level of student engagement, the effectiveness of the applied educational methodologies and teaching methods, the appropriateness of the tools used, and the allocation of time between the theoretical and practical parts of the session.

First and foremost, assessment must be independent of any external influences or the instructor's personal sympathies. The grade should be based exclusively on the student's achievements and abilities, without considering any other subjective factors.

To achieve fairness, assessment must be objective; that is, every student must be evaluated according to the same criteria and at the same level of requirements.

The non-discriminatory nature of assessment implies that the grade should not depend on the student's personal or social characteristics, such as gender, race, ethnic origin, or social status.

Integrity in assessment presupposes the absence of any manipulation by either the instructor or the student to obtain a more favorable result. Instructors adhere to ethical standards and principles of academic integrity during student evaluation.

E. Erikson, in his theory of psychosocial stages of personality development, draws attention to the development of self-identity and fidelity to oneself, confidence in one's desires, beliefs, and personal choices regarding the future, which ensures a successful transition from adolescence to the sixth stage of maturation – early adulthood.

It is important to note that this stage is realized through collaborative teamwork, where students learn to communicate effectively, listen carefully to the opinions of others, express their ideas, and accept constructive criticism. Students carry out collective projects using interactive tools such as Canva, Trello, Google services, etc. They learn to solve problems jointly,

seek optimal solutions, and perform their duties responsibly. Furthermore, teamwork fosters mutual support, trust, and mutual respect among group participants.

Working in a team or in small groups develops students' skills in collective work, professional communication, the ability to listen and perceive other ideas, as well as to propose their own and argue for them. Psychologists consider work in small groups to be one of the most effective forms of learning, as group discussions increase learning motivation and develop the student's communicative abilities[24]. We proceed from the premise that in solving the problem of forming students' cognitive interests while studying professional informatics disciplines, a leading role is played by their analytical and synthetic activity, since only under such conditions is it possible to form a system of knowledge and acquire mathematical modeling skills when solving problems.

The main features of project-based learning in a team are:

- collaborative work, where students learn to complement each other and work toward a single result;
- the importance of the activity of each team member;
- communication;
- synergy, where the combined result can exceed the simple sum of the results of all team members;
- the opportunity to discuss ideas;
- the opportunity for the student to reveal their potential and creative abilities.

Students' project activity and the ability to work in a team effectively influence the development of the student's critical thinking, which we understand as "a distinct type of thinking that determines purposeful productive mental activity, characterized by a person's ability to clearly identify the problem that needs to be solved; independently find, process, and analyze information; logically build their thoughts and substantiate them, think flexibly, strive for the search for optimal solutions, be able to defend their own position, and be open to perceiving other views"[25].

The Ukrainian scientist O. Tyahlo[26] identifies the following blocks of critical thinking presentation: analysis of a problem-based message,

[24] Подоляк Л. Г., Юрченко В.І. Психологія вищої школи: підручник [2-е вид.]. К. : Каравела, 2008. 352 с.

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[26] Тягло О. Досвід засвоєння критичного мислення в українській вищій школі. *Філософія освіти*, 2017. № 2 (21). С. 240–257.

understanding, evaluation and self-evaluation, constructive criticism and self-criticism. Based on the research of many scholars, as well as our own studies of students' project activities, the authors of this article have established an interconnection between key concepts, personality traits, and critical thinking skills (Table 1)[14].

Table 1

Interconnection between key concepts, personality traits, and critical thinking skills

Critical Thinking Presentation Blocks[26]	**Personality Traits[26]**	**Skills Required for Critical Thinking[25]**
Analysis of the problem message	Curiosity, being well-informed, diligence in seeking information, perceptiveness.	The ability of an individual to clearly identify the problem that needs to be solved; to independently find, process, and analyze information. The ability to reflect on one's actions and understand the schemes and rules by which one operates.
Understanding	Confidence, independence, responsibility.	The ability to logically structure one's thoughts and substantiate them; to think flexibly and dynamically; to strive for the search for optimal solutions. The skill to independently defend one's convictions and find answers to objections; to analyze information; to use scientific methods, principles, and rules of logic (argumentation, proof, refutation).
Evaluation and self-evaluation	Flexibility, prudence in decision-making, tolerance.	The capacity to revise one's own position. The skill to organize control and self-control; to compare final results with goals, tasks, and activity plans; to analyze the causes of discrepancies and personal errors; to make decisions to eliminate inconsistencies in work.
Constructive criticism, self-criticism	Impartiality, open-mindedness, courage in expressing evaluations, tactfulness, sociability.	The skill to analyze one's own beliefs and arguments for critical evaluation and correction; for self-evaluation and self-correction; the ability to actualize one's own qualities and those of others; the ability to defend one's own position while remaining open to perceiving other views.

The presented lesson constructor ensures the implementation of interconnections between key concepts, personality traits, and critical thinking skills at specific stages of the session (Fig. 5).

Fig. 5. Correlation between the structural elements of the lesson constructor and the cognitive operations of a student's critical thinking (Author's Development)

To create a holistic methodological system, it is essential to trace the correlation between the structural elements of the lesson constructor and the cognitive operations of a student's critical thinking (Fig. 3). Each stage of lesson construction not only performs a didactic function but also activates a corresponding block of the student's mental activity, transforming the instructor's preparation into a process of deep intellectual inquiry (Table 2).

Puzzle 1. Goal Setting → Analysis of the Problem Message. At the strategic planning stage, the student works with raw data: the curriculum, societal demands, and the students' proficiency levels. This stage directly correlates with the analysis of the problem message. Instead of mechanically accepting a topic, the student must critically reflect: "What problem are we solving in this session? Why do I need this?". Formulating the idea and identifying key questions is a process of deconstructing a complex information message into simple and understandable semantic units.

Puzzle 2. Didactic Instructional Design → Understanding. Lesson design and knowledge architecture require the student to have a deep understanding of the internal logical connections within the educational material. It is impossible to structure theoretical and practical blocks without a clear interpretation of how one concept follows from another. Here, critical

thinking manifests through the ability to translate complex IT concepts into a clear knowledge architecture adapted to the pupils' cognitive abilities. It is not enough to know the school informatics curriculum; one must learn to explain it to students while considering their age characteristics.

Puzzle 3. Technological Tools → Constructive Criticism and Self-criticism. The stage of selecting tools is a space for constructive criticism. The student questions the effectiveness of a particular software tool: "Does this service truly help in teaching, or does it merely create a visual effect?". Self-criticism here manifests in the ability to acknowledge the limitations of one's own technical skills and the necessity of searching for optimal, rather than just familiar, technological solutions to realize the didactic goal.

Puzzle 4. Professional Reflection → Evaluation and Self-evaluation. The final puzzle of the constructor aligns entirely with the evaluation and self-evaluation block. This is where the verification of results takes place: the student evaluates not only the pupils' knowledge but also the quality of their own design. Critical thinking at this stage allows for an objective comparison of the "expected" versus the "actual," an analysis of planning errors, and the identification of areas for further professional growth.

Table 2

Correspondence between lesson constructor components and critical thinking presentation blocks according to O. Tyahlo

Lesson Constructor Puzzle	Critical Thinking Component	Student Role
Goal Setting	Problem Analysis	Researcher of context and needs
Didactic Instructional Design	Understanding	Architect of content and logic
Technological Tools	Constructive Criticism	Technological expert-analyst
Reflection and Verification	Evaluation and Self-evaluation	Reflective practitioner

Such integration allows for the preparation of an Informatics teacher who does not merely transmit knowledge but acts as a critically thinking professional capable of systematic analysis of their activities.

CONCLUSIONS

Summarizing the results of the research, it can be stated that the development of an effective methodology for training future Informatics teachers requires a synergy of psychological foundations of personality development, modern pedagogical technologies, and digital transformation

tools. The proposed methodological system is based on a deep understanding of the psychosocial state of the student, who, according to E. Erikson's theory, is at a critical stage of identity formation. Given that university studies coincide with the transition from adolescence to early adulthood, the educational process must become a platform for professional experimentation, where a young person overcomes the crisis of self-determination through active creative activity. It is during this period that the foundation of future professional behavior is laid, requiring higher education institutions to create conditions for the affirmation of personal dignity and self-awareness through the testing of various social and professional roles.

This psychological orientation necessitates a fundamental change in the role of the instructor in higher education. They transition to the roles of mentor, facilitator, coach, and guide. Within a student-centered approach, the instructor accompanies the student along their individual educational trajectory, stimulating responsibility for decisions made. This creates favorable conditions for the implementation of project-based learning methods, where professional skills are refined in the process of solving real-world pedagogical tasks. Instead of reproductive absorption of information, students are involved in the active construction of knowledge, which meets the challenges of modern education and ensures the development of productive thinking necessary for solving complex professional challenges in future teaching activities.

The central element of the presented methodology is an adapted lesson constructor consisting of four interdependent puzzles that together form a holistic model of professional activity. The first puzzle – Goal Setting and Strategic Planning – lays the groundwork for analytical work, where the student defines the conceptual idea of the lesson through the analysis of problem messages. The second puzzle – Didactic Instructional Design and Knowledge Architecture – requires an understanding of the material's logical connections and the ability to transform complex IT concepts into forms accessible to pupils. The third puzzle – Technological Tools and Development Environment – ensures the practical realization of ideas through the selection and validation of digital tools, which requires constructive criticism and a balanced selection of software. The final fourth puzzle – Reflection and Verification of Results – closes the learning cycle, allowing for an objective evaluation and self-evaluation of one's own methodological mastery.

The logical combination of these components into a single methodological system elevates the training of an Informatics teacher to a new level, where the development of critical thinking occurs organically at every stage of design. Project-based learning in such a model acts as an integrating factor, as the creation of one's own methodological product requires constant reflection and constructive self-criticism from the student. Thus, the proposed system ensures

not only the mastery of technical tools but also the formation of a stable professional identity of an innovative teacher, capable of systematic analysis and flexible adaptation in conditions of global technological transformations. This allows for the training of a specialist who is not merely a technology user but an architect of the modern educational space.

SUMMARY

The article substantiates and presents an original methodological model for training future Informatics teachers, aimed at developing productive creative thinking. The research is based on the integration of students' psychological characteristics (according to E. Erikson's theory of psychosocial stages) with modern educational technologies. Particular attention is paid to the adaptation of the lesson constructor methodology for the level of higher education, which allows for the structuring of students' professional project activities through four key blocks: goal setting, didactic instructional design, technological tools, and reflection.

The role of the instructor is defined as a facilitator, mentor, and coach, depending on the stage of the student's personality development. The interconnec-tion between the structural elements of the lesson constructor and the components of critical thinking (analysis, understanding, evaluation, and criticism) is proven. The practical significance of the work is confirmed by examples of implementing innovative lesson formats, such as hackathons, workshops, and case methods, which contribute to the formation of general and professional competencies of future Informatics teachers in a digital environment.

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