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Principles and Models for Designing Individual Educational Trajectories for Future Informatics Teachers in A Digital Educational Environment

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Abstract: This article substantiates the relevance of forming individual educational trajectories for future informatics teachers in a digital educational environment. The core principles for designing individual educational trajectories are analyzed in detail, including personalization, flexibility and adaptability, modularity, a student's conscious choice and self-management, and a competency-based approach. Furthermore, various practical models of individual educational trajectories for future informatics teachers (linear with variable speed, branching, competency matrix-based, project-based, and mixed models) are extensively described. The prospects for their effective implementation using modern digital tools and platforms are also highlighted. The theoretical-methodological principles and practical models put forward in the article are emphasized to serve the purpose of enhancing the professional skills of future informatics teachers in line with modern requirements and ensuring their competitiveness.

Keywords: Individual educational trajectory, digital educational environment, future informatics teacher, personalization of education, flexibility, adaptability, modular teaching, competency-based approach, educational models, pedagogical design, information and communication technologies.

Introduction: The rapid digital transformation processes observed in all spheres of society globally are setting new, more complex tasks for the education system, particularly for the teacher training system [1]. Today, an informatics teacher must not only be a deep expert in their subject but also a competent specialist who can effectively use the latest information and communication technologies (ICT) in the educational process and develop students' critical thinking, problem-solving, and digital literacy skills through innovative approaches [4, 8]. To prepare such highly qualified personnel, it is crucial to widely apply innovative methods that take into account each student's individual psychophysiological characteristics, intellectual potential, educational needs, and professional interests [6]. In this context, the scientifically and methodologically sound formation and effective implementation of Individual Educational Trajectories (IET) for future informatics teachers, utilizing the capabilities of the modern digital educational environment, is one of the pressing issues in contemporary pedagogy.

The problem of IET has a long history in pedagogical science, with its roots in fundamental concepts such as personality-oriented education [6], differential education [2, 5], and modular teaching technologies [6,

4, 9]. The development of digital technologies has opened new doors for the effective real-time implementation of IETs. Research by foreign scholars like D. Merrill and B.F. Skinner on adaptive learning systems, S. Papert's constructivist approach, M. Knowles's principles of adult learning (andragogy), and the connectivism theory by G. Siemens and S. Downes serve as important theoretical foundations for shaping IETs in a modern digital environment.

However, despite research in Uzbekistan on the individualization of the educational process [3, 6, 7, 11] , the methodology for specifically shaping the professional training of future informatics teachers based on IETs in a digital environment has not yet been systematically and comprehensively studied. The current training process in most higher education institutions still relies on standardized general curricula, which do not fully accommodate students' personal abilities, learning pace, and future professional aspirations. The systemic use of digital technologies for personalizing education remains insufficient [10]. This situation negatively affects the effectiveness of professional competency formation and the adaptability of future specialists to the competitive labor market.

Therefore, the main objectives of this research were:

1. To clarify the pedagogical essence of the "individual educational trajectory" concept, its components, and its specific role in the training system for future informatics teachers.

2. To deeply analyze the existing and potential capabilities of the modern digital educational environment for shaping, implementing, and effectively managing IETs.

3. To develop and scientifically substantiate the core principles for designing IETs, considering the professional characteristics of future informatics teachers and modern demands.

4. To create practical models of IETs (linear, branching, competency-based, project-based) suitable for various pedagogical situations and to demonstrate their implementation methods using advanced digital tools and educational platforms.

METHODS

The research employed a combination of methodologies, including a comparative-critical analysis of local and foreign pedagogical, psychological, and methodological literature; a systematic approach to studying the educational process; pedagogical modeling; generalization and adaptation of advanced pedagogical experiences (including international ones); pedagogical observation; surveys and expert evaluation.

RESULTS

The primary results of this research are the formulation of specific principles and the development of practical models for designing and implementing IETs for future informatics teachers.

An Individual Educational Trajectory (IET) is defined as a unique, flexible educational path, content, methods, and sequence, consciously chosen and individually implemented by a learner to achieve specific educational goals, tailored to their personal characteristics (temperament, cognitive styles, motivation), intellectual abilities, learning pace, existing knowledge and skills, educational needs, and professional interests. For future informatics teachers, an IET should be aimed at the comprehensive acquisition of not only fundamental knowledge (programming languages, algorithms, computer architecture, etc.) but also skills in modern pedagogical technologies and the use of digital didactic tools.

Principles for Designing IETs

The study identified the following core principles for designing IETs in a digital environment:

- Principle of Personalization: This involves diagnosing and considering each student's initial knowledge and skill level, individual learning styles (visual, audial, kinesthetic), cognitive abilities, and specific career goals (e.g., teaching at a secondary school, academic activities, software development).
- Principle of Flexibility and Adaptability: This ensures the ability to adjust the educational process—its content, pace, and methods—in real-time based on the student's learning dynamics and emerging needs or high abilities.
- Principle of Modularity: The educational content is divided into logically complete and relatively independent learning modules, each aimed at forming specific competencies. This allows students to "assemble" their IET from various compulsory and elective modules like a "constructor".
- Principle of Conscious Choice and Self-Management: Granting students the opportunity to choose courses, modules, specialization tracks, learning pace, and even assessment methods to increase their engagement, responsibility, and self-management skills.
- Principle of Competency-Based Approach: The entire educational process is focused on the purposeful formation of fundamental, special, and general professional competencies necessary for a future informatics teacher's career (e.g., mastering modern programming technologies, creating

innovative pedagogical software).

- Principle of Practical and Contextual Learning: Theoretical knowledge is reinforced through real-life situations, practical professional tasks, educational projects, and case studies.
- Principle of Continuous Constructive Feedback and Diagnostics: Systematically monitoring a student's achievements and shortcomings throughout their learning activity and providing timely, specific, and constructive feedback to make necessary adjustments to the IET.
- Principle of Technological Competence Orientation: The process of implementing an IET should itself continuously develop students' practical skills in using the most modern digital tools, software, and online platforms.

Models of IETs for Future Informatics Teachers

Based on these principles, the following practical models were developed:

- Linear Model with Variable Speed: The content and sequence of educational materials are the same for all students, but each student learns at their own individual pace. This model is effective for acquiring fundamental knowledge and basic skills.
- Branching (Adaptive) Model: At certain "nodes" in the learning process (e.g., based on diagnostic test results or personal interests), the student is given the opportunity to choose from different learning paths, specialization courses, or tasks of varying complexity. For instance, after mastering "Programming Fundamentals," a student could choose "Object-Oriented Programming," "Web Development," or "Data Analysis".
- Competency Matrix Model: A detailed matrix of necessary professional competencies for a future informatics teacher is developed. The student, after analyzing their strengths and weaknesses, designs their own "learning route" to develop priority competencies, using a set of modules, courses, and projects. The e-portfolio is a key tool for tracking progress in this model.
- Project-Based IET Model: Students build their IET by carrying out one or more large-scale, practical creative projects (e.g., "Creating an interactive e-learning resource for schoolchildren"). In this model, the teacher acts as a facilitator, consultant, and expert rather than a traditional knowledge provider.
- Mixed (Hybrid) Model: This model combines the most effective elements of the other models in a flexible manner. For example, a linear model might be used for foundational knowledge, followed by branching or project-based approaches for specialization. This is considered the most flexible and practical model for implementation.

The successful implementation of these models requires the creative use of Learning Management Systems (LMS) like Moodle and Google Classroom, MOOCs like Coursera and edX, and advanced digital tools such as VR/AR technologies and specialized software.

DISCUSSION

The principles and models presented in this study are expected to yield significant positive outcomes. The focus on individual needs is anticipated to substantially increase the quality and effectiveness of education. Providing choice and transparency in achievements should consistently stimulate students' intrinsic motivation. A practice-oriented, competency-based approach ensures that future teachers are well-prepared for real professional activities and adaptable to the demands of the modern labor market. The process itself enhances students' digital literacy and fosters skills for independent, lifelong learning.

However, the widespread implementation of IETs faces several challenges. Faculty members need to master new pedagogical roles (tutor, facilitator, mentor) and possess advanced digital skills. Developing a high-quality and diverse base of educational materials tailored to individual needs is complex and labor-intensive. Educational institutions require a robust material and technical infrastructure, including reliable high-speed internet and modern computer equipment. Finally, traditional standardized assessment methods must be revised in favor of new, innovative tools (e.g., portfolios, project defenses) to objectively evaluate individual achievements and competencies.

Overcoming these challenges requires a systematic approach, including continuous professional development for faculty, collaborative development of national digital resource platforms, and the critical study and creative adaptation of international best practices.

CONCLUSION

In conclusion, designing and implementing IETs for future informatics teachers based on scientifically sound principles and effective models is a crucial and promising direction for modern pedagogical education. The principles and models discussed provide a solid foundation for elevating the professional training of highly qualified and competitive informatics teachers to a qualitatively new level.

Recommendations for future work include integrating IET mechanisms into the curricula of pedagogical universities, continuously developing national digital

education platforms , organizing regular training for faculty on working in an IET environment , and developing scientifically based criteria for evaluating the effectiveness of IETs. Future research should also explore the potential of using Artificial Intelligence (AI), Big Data (Learning Analytics), and Machine Learning algorithms to enhance the implementation of IETs.

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