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INTEGRATION OF STEM TECHNOLOGIES INTO THE PROCESS OF PREPARING TEACHERS FOR PROFESSIONAL ACTIVITIES IN INCLUSIVE EDUCATION

Abstract. The article is devoted to the peculiarities of training future teachers to implement STEM technologies in the educational process of an inclusive school, which is determined by the ability to effectively respond to the individual characteristics of each student through the latest pedagogical teaching methods aimed at developing critical thinking, creativity, communication and teamwork skills in children with/without special educational needs. The areas of professional training of future teachers (didactic, methodological, creative, research, communication, partnership and reflective) are identified, which are aimed at forming the "skills box" competencies necessary for successful work with student diversity in an inclusive educational environment. It is noted that such a set of teacher competencies will contribute to updating the content of educational activities of students with/without special educational needs. The authors substantiate the importance of using STEM technologies in the study of general education disciplines aimed at forming a holistic worldview, interest in solving the problems of inclusive education through project activities using research,



information, creative, educational, performing, and other methods. Various topics of inclusion projects are considered, which help students realize the importance of accepting human diversity in society, raise students' awareness of educational inclusion issues, and encourage them to deepen their knowledge in this area. Examples of the use of STEM technologies (LEGO construction, experimentation with animate and inanimate nature, paints, color, animation and multimedia methods and others) used in the study of disciplines of the cycle of special (professional) training of future teachers in order to increase the level of mastery of didactic, methodological, technological, information and technical components of inclusive competence are given.

Keywords: inclusive education, inclusive educational environment, future teachers, teacher training, STEM technologies, professional competence, higher education institutions.

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ІНТЕГРАЦІЯ STEM-ТЕХНОЛОГІЙ У ПРОЦЕС ПІДГОТОВКИ ВЧИТЕЛІВ ДО ПРОФЕСІЙНОЇ ДІЯЛЬНОСТІ В УМОВАХ ІНКЛЮЗИВНОЇ ОСВІТИ

Анотація. Статтю присвячено особливостям підготовки майбутніх педагогів до впровадження STEM-технологій в освітньому процесі інклюзивної школи, що визначається здатністю до ефективного реагування на індивідуальні особливості кожного учня засобами новітніх педагогічних методів навчання, спрямованих на розвиток критичного мислення, креативності, комунікативності та навичок роботи в команді у дітей з/без особливих освітніх потреб. Визначено напрями професійної підготовки майбутніх педагогів (дидактичний, методологічний, креативний, дослідницький, комунікативний, партнерської взаємодії та рефлексивний), які спрямовані на формування компетент-



ностей «skills box», необхідних для успішної роботи з учнівським різноманіттям в інклюзивному освітньому середовищі. Зазначено, що така сукупність компетентностей педагога сприятиме оновленню змісту освітньої діяльності учнів з/без особливих освітніх потреб. Автори обґрунтовують важливість використання STEM-технологій при вивченні дисциплін циклу загальної підготовки, спрямованих на формування цілісного світогляду, зацікавленості у вирішенні проблем інклюзивної освіти шляхом проєктної діяльності з використанням дослідницьких, інформаційних, творчих, просвітницьких, виконавських та ін. методів. Розглянуто різноманітні тематики проєктів з інклюзії, які допомагають студентам усвідомити важливість прийняття людської різноманітності в суспільстві, підвищити обізнаність студентів із проблем освітньої інклюзії та стимулюють їх до поглиблення знань в цій галузі. Наведено приклади використання STEM технологій (LEGO-конструювання, експериментування з живою та неживою природою, фарбами, кольором, мультиплікаційні та мультимедійні методи та ін.), які використовуються під час вивчення дисциплін циклу спеціальної (фахової) підготовки майбутнього вчителя з метою підвищення рівня оволодіння дидактичним, методичним, технологічним, інформаційно-технічним складниками інклюзивної компетентності.

Ключові слова: інклюзивна освіта, інклюзивне освітнє середовище, майбутні педагоги, підготовка вчителів, STEM-технології, професійна компетентність, заклади вищої освіти.

Statement of the problem. One of the directions of socio-cultural modernization of modern education is to create conditions for the learning and development of every child, regardless of their physical, intellectual, emotional and other characteristics. This challenge means the need to develop inclusive general education, which embodies the idea of accessibility and quality by providing educational services in accordance with the needs and capabilities of all children. Changes in approaches to teaching and upbringing of all categories of children put forward new requirements for the professional activities of teachers.

The professional activity of a teacher in an inclusive classroom is a great responsibility for the final result of teaching, upbringing and development of a child (educational goal) and his or her motivational and value attitude to professional activity, possession of effective ways and means of achieving pedagogical goals, ability to create and reflect. The specificity of pedagogical activity is determined by the dual nature of its object: the student and the means of educational activity used by the teacher



to develop the child's personality in all its diversity: curiosity, purposefulness, independence, responsibility, creativity, which ensure successful socialization, increase the competitiveness of the individual and, as a result, society and the state. At the same time, the system of teaching aids includes a set of material and information objects that can be used by students and teachers during the educational process and that must meet the requirements for their effective and safe use in accordance with educational needs.

In this context, teachers need special training and a deep understanding of methods and approaches that would allow them to work effectively with a diversity of students, providing everyone with optimal conditions for learning and development. One of the key areas of professional training for teachers to implement inclusive education is the mastery of STEM technologies, which open up wide opportunities for integration and individualization of the educational process, synthesis of scientific knowledge and practical experience. Their use in the educational process contributes to the development of critical thinking, problem-based and project-based learning, as well as the development of teamwork skills. In this regard, it is important to prepare future teachers to work in inclusive classrooms using STEM technologies to ensure the comprehensive development of each student, including those who need special attention and support.

Analysis of recent research and publications. Domestic and foreign scholars (I. Horbenko, I. Vasylashko, A. Kolupaieva, O. Lozova, O. Tynchuk, M. Ainscow, J. Dppler, D. Loreman, D. Lozova, O. Martynchuk, T. Sak, O. Taranchenko, M. Ainscow, J. Deppler, T. Loreman, D. Harvey and others have studied various aspects of the development of inclusive education, emphasizing the importance of the inclusive component of the professional competence of teachers, as well as the mastery of methodological innovations in STEM education and socialization of children with special educational needs.

The purpose of the article is to reveal the ways of using STEM technologies in the process of preparing future teachers for professional activities in inclusive education.

Summary of the main material. In accordance with the principles of society's transition to sustainable development, the rule of human rights and freedoms (Sustainable Development Goals (SDGs)), the main normative documents of the international movement "Education for All" (EFA), state acts in the field of education (Laws of Ukraine "On Education", "On Education", "On Complete General Secondary Education", The New Ukrainian School Concept, and the Concept for the Development of Science and Mathematics Education (STEM Education) emphasize equal



opportunities for success in learning and personal development for every child, taking into account their individual characteristics, who is able to use knowledge to solve a variety of problems independently.

From the first year of studying children with special educational needs in a general education school, the teacher plays a key role in creating their educational trajectory. Therefore, the quality of their professional training determines the formation of a high level of readiness to perform the functions of professional activity in the context of inclusion. That is, according to V. Kremen, teachers must be prepared for a new professional role: "Of course, he cannot be and, in principle, is not an absolute carrier of knowledge. He cannot be a supervisor of a student. He or she must be a person who accompanies the process of self-knowledge and self-development of a child, guides and dynamizes it in accordance with the specific social dispositions of each student. In this plane of the new professional role, the teacher's readiness for new functions of the educational process should also be considered. Today, it is impossible to reduce the educational process only to the assimilation of the sum of knowledge by the student, but it is necessary to teach him/her to learn..." [1, c. 137].

With the introduction of an inclusive component in the system of lifelong learning, innovative processes take place. Therefore, as T. Franchuk rightly emphasizes, "the main functional purpose of innovative education is to form the student's psychological and subject readiness for professional self-creation. It is based on a fundamentally different model of mastering the profession, which is based on the focus on the student as a subject of creating his or her own concept, technology and style of professional activity" [3, p. 35].

Investigating the problem of training a future teacher-defectologist, O. Martynchuk considers professional competence in the field of providing educational services in inclusive education as an evaluative category that can identify the degree of mastery of the teacher's professional universalism, which includes the ability to navigate complex socio-cultural situations, predict, plan and perform actions to successfully achieve the goals, adjust and adapt professional knowledge and abilities in accordance with the dynamics of change in the educational space [2, p. 156].

In our opinion, the competence-based approach is necessarily related to the professional context, which creates conditions for preparing future teachers for professional activities in inclusive education in the following areas:

- didactic – aimed at the formation of professional knowledge and skills (analytical, prognostic, organizational, diagnostic, correctional) of the subjects of learning; promotes effective orientation in the field of education,



upbringing, development of children, solving pedagogical problems, structuring scientific (theoretical) and practical knowledge in order to create an effective inclusive educational environment;

- methodological – determination of the ability to work by finding out the professional aptitude, psychological readiness for the chosen type of work and the degree of social responsibility for its course and results; solving organizational and activity tasks (implementation in practice of the planned educational process based on interaction with students); formation of skills of analysis, synthesis, comparison, abstraction, generalization of pedagogical phenomena, professional important mental qualities, such as analogy, imagination, flexibility and critical thinking);

- creative – study of the level of professionalism, reflective and innovative potential, degree of skill of the future specialist and assessment of the social significance of his innovations proposed in the process of creativity; development of a high level of moral consciousness; constant search for optimal original solutions to the tasks; creative style of thinking; ability to see the problem; identify contradictions; developed creative imagination, imagination, speed and flexibility of thought, curiosity, accuracy, courage; desire to achieve an effective result in the context of the;

- research – the optimal combination of scientific and practical training; creative search and implementation of new pedagogical technologies based on a personality-oriented approach to the organization of an inclusive educational process; professional self-improvement and self-realization; development of observation, intellectual activity, own research style, flexibility and originality of thinking, intuition, objectivity, criticality and others;

- communicative – purposeful manifestation of the personality potential to exchange various kinds of information by verbal and non-verbal means; involves constant work on the culture of verbal and non-verbal communication; recognition of the importance of the student's personality; conscious striving for self-knowledge, self-development, self-improvement and self-realization of participants in the educational process; formation of goodwill, interest in interaction with children, tolerance, empathy, congruence, sociability, collectivism;

- partnership interaction – cooperation of participants in the educational process on the basis of parity, equality, mutual respect and joint (team) work, taking into account the experience, knowledge and capabilities of partners, when the success of some participants in joint activities stimulates more productive and purposeful activities of its participants; encourages a culture of diversity in an inclusive educational environment;



development of respect for the individual, goodwill, positive attitude, trust in relationships and relationships; development of distributed leadership skills;

- reflective – study of the sphere of self-consciousness of the individual in the context of the degree of development of the "I", understanding of communication partners in the process of work; self-knowledge of the subject of internal mental acts and state; system-forming factor of professionalism, which ensures conscious overcoming of stereotypes of personal experience by rethinking it and introducing innovations in pedagogical activity; contribute to the provision of control and correction and encourage self-development and self-improvement; development of critical thinking.

As you can see, these areas reflect the "4K" competencies, or social skills, identified by the World Economic Forum (2020) as the key to success in the labor market in the next 20-30 years:

- Creativity is the ability to navigate information flows, see cause and effect relationships, weed out the unnecessary, understand the causes of failure and draw conclusions;

- Critical Thinking is the ability to be creative, which allows you to assess the situation from different angles, make non-standard decisions and feel confident in changing circumstances;

- Communication is the ability to establish contacts, listen and hear the interlocutor, convey one's point of view and come to an agreement;

- Coordinating With Others - the ability to unite in joint activities as equal partners to achieve the goal [4].

This set of competencies "skills box" combines basic knowledge as "tools" for cognition and transformation of the world, social skills as a set of human skills that allow for successful interaction with others. At the same time, the "skills box" of an inclusive education teacher includes methodology and approaches to updating the content of science and technology education, technology for organizing project and research activities of students with/without special educational needs. That is why STEM technology is widely used in inclusive educational environments today. It is based on the application of an interdisciplinary and applied approach, as well as the integration of four fields of knowledge "Science, Technology, Engineering, and Mathematics into a single system. Thus, the teacher turns from a "carrier and translator of ready-made knowledge" into an organizer of cognitive, research, creative, and communicative activities of his or her students.

The disciplines of the general training cycle, which aims to form a holistic worldview and interest in solving socio-political and economic problems, are of great importance in the professional development of a future



teacher. Since inclusion is designed to ensure full participation of all members of society in all spheres of life, the content of the disciplines of this cycle should address the problems of forming a new philosophy of state policy towards children with special educational needs, improving the legal framework in accordance with international agreements on human rights, accessibility and barrier-free spaces, society's attitude to otherness and acceptance of human diversity.

In our opinion, when studying the disciplines of this cycle, it is advisable to use different types of projects, in particular: research, information, creative, educational, performing, group, individual projects using 3D modeling, to create aesthetic and artistic and graphic images and objects using special computer programs available for children (Blender 3D, Tinkercad, Onshape).

The topics of the projects can be very diverse: "Disability and modern society", "Inclusion is an attempt to know the other", "Equals among equals", "Different opportunities - equal rights", "Doomed to happiness", "Outstanding historical figures with disabilities", "Barrier-free - the philosophy of a society without restrictions!", "Barrier-free space and universal design of your city (village)", "Inclusive reconstruction of Ukraine", "Inclusive communication", "Cultural treasures for all", "Culture hidden behind barriers" and others.

During such classes, future teachers had the opportunity to trace the cultural and historical retrospective of the process of formation of public recognition of a person with developmental disabilities and relevant educational paradigms; identify ways to implement integrated (inclusive) education in the world and in Ukraine; identify cultural and educational achievements of people with disabilities; get acquainted with the relevance of philosophical reflection on the inclusive educational process in relation to the axiological foundations of society; realize the relationship between "I and the Other" as a correlation of the Such work contributed to students' awareness of the chronology of society's attitude towards people with special needs, encouraged them to recognize the values of social and educational inclusion, the role of the teacher in inclusive educational processes to accept children with special educational needs, and aroused interest in acquiring special knowledge of inclusive activities.

In order for inclusive education to be effective, it is necessary to change the mentality of the whole society and, above all, of future teachers who implement the policy of inclusion as an organic component of their professional thinking. The complexity and versatility of the primary school teacher's profession, the depth of its content, the understanding of the values



of inclusive activities, the peculiarities of methodological, technological, technical, and information support for an inclusive educational environment were revealed in the process of studying the disciplines of the cycle of special (professional) training.

The use of STEM technologies will contribute to the expansion of the methodological and technological component of the teacher's inclusive competence:

- experimenting with living and non-living nature, paints, colors and others. allows to organize children's acquaintance with the properties of water, air, inanimate and living nature objects, optical phenomena and will help to enthuse children with/without special educational needs to study a variety of properties of the world around them ("Growing Crystals", "Rainbow in a Glass, Water Cycle, Lemon Fountain, Apple Resuscitation, Time Measurement, Create a New Color, Drawing with Salt (Cereals), Make an Easter Egg from Soda and Paint and others;

- LEGO construction and paper construction are aimed at the intellectual and creative development of children with/without special educational needs through the implementation of LEGO Education initiatives by solving local problems that arise in the process of working with thematic LEGO construction sets and promotes an organic combination of play, creative and correctional and rehabilitation work in terms of motivational, cognitive, intellectual, physical, emotional, activity, communication and others areas of children's development ("Designing Animals", "Designing Houses", "Christmas Toys", "My Yard, My School", "Traffic Rules", "My City", "Transport" and others);

- animation makes it possible to demonstrate the results of work on various projects by creating a child's own animated film as a productive synthesis of artistic and technical creativity through the development of information and communication, digital, and media technologies (Animatron, Clipchamp). The plots of the cartoons are familiar situations of everyday life: communication, work, rest, excursion, travel, study, friendship and others, which cover various spheres of life of children with disabilities, IDPs, migrants, national minorities and others. ("Rainbow", "Light a Smile", "Shadow Theater", "Crooked Duck", "Broken Wing", "Old Lion", "Without Words", "Walk in the Dark" and others);

- multimedia methods and tools as a system of complex interaction of visual and audio effects under the control of interactive software using modern hardware and software tools that combine text, sound, graphics, photos, video and others. in one digital reproduction allows to equip students with knowledge in an accessible visual, mechanical, audio and



emotional form, promotes the development of observation, thinking, attention, memory, imagination, speech, interest in creativity, the need for new knowledge and a sense of independence (Smart Board software and hardware complex; multimedia applications Linkway Live, Story Board Live, Multimedia applications; entertaining multimedia Infotainment; correctional and rehabilitation: Briolight S interactive sandbox, ePresenter EP-I interactive floor, Elpix interactive touch tables and others), which are used to organize educational games and video fragments, multimedia presentations and simulators).

Particular attention should be paid to the ability to organize and conduct integrated lessons that promote the unification of disparate parts into a whole, deep interpenetration of knowledge of the world in diversity and unity; develop creativity, encourage active knowledge of the surrounding reality, comprehension and finding of cause and effect relationships, development of logic, thinking, communication skills; promote the development of speech, the formation of the ability to compare, generalize, draw conclusions.

Thus, the integration of general pedagogical and inclusive components contributed to the further formation of students' humane position on teaching children with special educational needs, accelerated the pace of professional self-development and self-improvement. In the process of solving important and complex problems of raising the level of professional, methodological and psychological readiness of future primary school teachers to perform an expanded range of professional functions in inclusive education. As a result, future teachers gained the necessary knowledge about the forms, methods, techniques and means of organizing the educational process in teaching subjects in an inclusive primary school using STEM technology, mastered the technologies of pedagogical (traditional intensive training, differentiated teaching, formation of cognitive strategies, developmental and interactive learning, creating a situation of success) and correctional pedagogical activities (game, art therapy, logorhythmic forms of learning and

Conclusions. The use of STEM technologies in the process of professional training of future teachers for professional activity in inclusive education is aimed at forming a holistic worldview, interest in solving the problems of inclusive education in order to increase the level of mastery of didactic, methodological, technological, information and technical components of inclusive competence. The use of STEM technologies in professional activities in inclusive education is based on their methodologically sound implementation in the educational process on the basis of competence-based and personality-oriented approaches and will



serve as a model for the effective organization of learning activities of children with different levels of development, promote deeper learning and encourage them to further professional self-development.

References:

1. Kremen V. H. (2005). *Osvita i nauka v Ukraini – innovatsiini aspekty. Stratehiia. Realizatsiia. Rezultaty* [Education and science in Ukraine - innovative aspects. Strategy. Realization. Results]. Kyiv: Znannia [in Ukrainian].
2. Martynchuk O. V. (2013). Kompetentnisnyi pidkhid do fakhovoi pidhotovky vchyteliv-defektolohiv dlia zabezpechennia osvithoi intehtatsii ditei z porushenniamy psykhofizychnoho rozvytku [Competence-based approach to the professional training of teachers-defectologists to ensure the educational integration of children with disabilities]. *Naukovyi chasopys NPU im. M. P. Drahomanova. Ser. 19 : Korektsiina pedahohika ta spetsialna psykhologhiia*. (Vols.24). (pp.153–158). Kyiv: Vyd-vo NPU im. M. P. Drahomanova. [in Ukrainian]
3. Franchuk T. Y. (2009). *Tsilisnyi osvitnii prostir : pedahohichni osnovy yoho formuvannia* [Holistic educational space: pedagogical bases of its formation]. Kamianets-Podilskyi : KPNU [in Ukrainian]
4. These are the top 10 job skills of tomorrow - and how long it takes to learn them [These are the top 10 job skills of tomorrow - and how long it takes to learn them]. Retrieved from: <http://surl.li/rifcr> (accessed 08. March 2024). [in Ukrainian].

Література:

1. Кремень В. Г. Освіта і наука в Україні – інноваційні аспекти. Стратегія. Реалізація. Результати. К. : Грамота, 2005. 448 с.
2. Мартинчук О. В. Компетентнісний підхід до фахової підготовки вчителів-дефектологів для забезпечення освітньої інтеграції дітей з порушеннями психофізичного розвитку. *Науковий часопис НПУ ім. М. П. Драгоманова. Сер. 19 : Корекційна педагогіка та спеціальна психологія*. К. : Вид-во НПУ ім. М. П. Драгоманова, 2013. Вип. 24. С. 153–158.
3. Франчук Т. Й. Цілісний освітній простір : педагогічні основи його формування : моногр. Кам'янець-Подільський : КПНУ, 2009. 243 с.
4. These are the top 10 job skills of tomorrow – and how long it takes to learn them. URL: <http://surl.li/rifcr>