Współczesna rzeczywistość cywilizacyjna stawia przed różnymi obszarami życia społecznego nowe wyzwania i zadania, wynikające z pojawiających się zmian, transformacji i reform. Dotyczy to także edukacji i konstruowania takich systemów oświaty, które zapewnią wysoką jakość kształcenia wszystkich uczniów. (...) Nauki społeczne, które zawsze zajmowały się edukacją na poziomie teoretycznym, metodologicznym i aplikacyjnym wykazały ponowne, wzmożone zainteresowanie problematyką [integracji edukacyjnej], co widoczne jest wśród badaczy różnych gałęzi pedagogiki, psychologii, czy też socjologii. Nie mniejsze zainteresowanie przejawiają dyscypliny nauk humanistycznych, a w tym między innymi filozofia i jej obszar, jakim jest etyka. W ostatnich latach (szczególnie w dobie pandemii) w edukację coraz intensywniej wnika technologia cyfrowa, która wykorzystując technikę cyfrową i systemy informatyczne, stwarza szerokie możliwości zastosowania. Recenzowana monografia podejmuje wszystkie wskazane powyżej kwestie edukacyjne.

(...) Zaprezentowane artykuły wpisują się w wymiar społeczny oraz humanistyczny misji pedagogiki i pedagogiki specjalnej, a także ich wymiar etyczny oraz technologiczny. (...) poszczególne teksty monografii mogą stanowić cenną i inspirującą zawartość publikacji książkowej (...) oraz wartościowy, ciekawy poznawczo (...) i zróżnicowany obraz edukacji włączającej w różnych krajach, ukazujący zarazem doświadczenia w jej realizacji oraz w przygotowaniu profesjonalistów i wprowadzaniu innowacyjnych metod w proces nauczania-uczenia się.

Autorami esejów recenzowanej monografii głównie są uczeni i badacze pedagogiki i pedagogiki specjalnej. (...) podjęli [oni] zagadnienia, mające duże znaczenie dla teorii i praktyki kształcenia uczniów ze specjalnymi potrzebami edukacyjnymi. Zaprezentowali je w sposób interesujący i ważny poznawczo. Materiały zebrane w recenzowanej monografii mogą być cennym źródłem poznawczym i metodycznym dla nauczycieli przedszkoli, szkół podstawowych i średnich ogólnokształcących, pedagogów, psychologów, pracowników socjalnych, opiekuńczych, jak również innych specjalistów wspierających rozwój dzieci. Niemniej, mogą posłużyć w procesie przygotowania do zawodu pedagoga, pedagoga specjalnego oraz doskonalenia zawodowego nauczycieli już pracujących. Teksty zamieszczone w tej monografii mogą być również cennym przyczynkiem do dalszych poszukiwań badawczych. Można ogólnie powiedzieć, że treści zawarte w tej monografii mają znaczenie zarówno naukowe, jak i praktyczne. Mogą być pożytecznym źródłem dla wszystkich, którym zależy na jakości edukacji i nie jest im obojętny jej rozwój w kierunku inkluzji.

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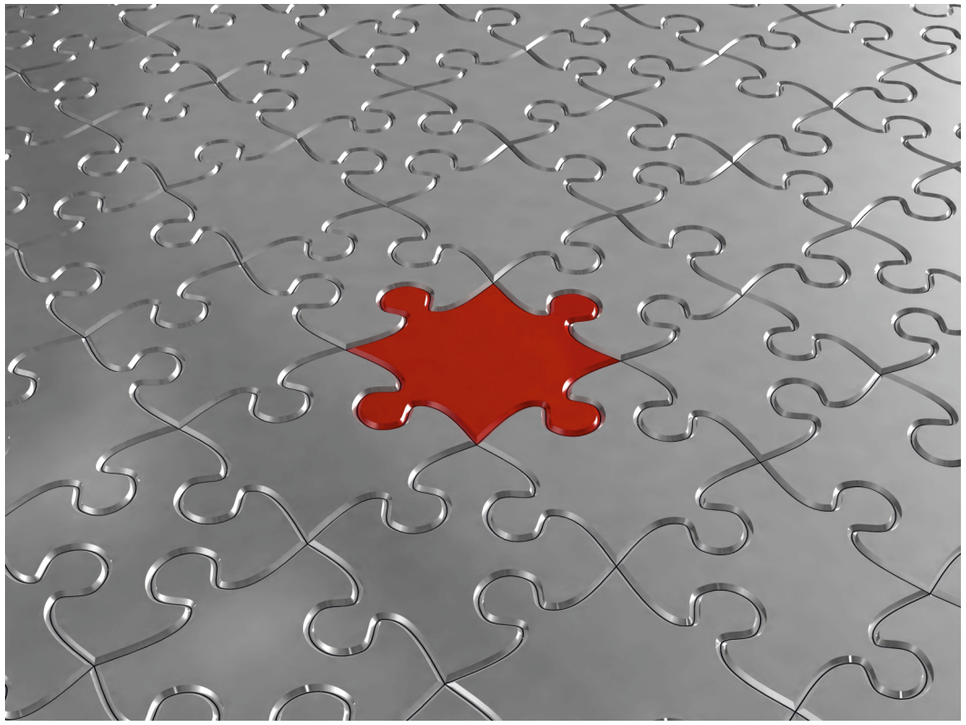

Piotrków Trybunalski 2021

Seria
PRACA Z DZIECKIEM
ZE SPECJALNYMI POTRZEBAMI EDUKACYJNYMI

Inkluzja a integracja w edukacji

Redakcja naukowa
Mariya Leshchenko, Katarzyna Szymczyk

Wydawnictwo
Uniwersytetu Jana Kochanowskiego

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Cyfrowe narzędzia wspierające edukację włączającą a kompetencje zawodowe przyszłych nauczycieli edukacji przedszkolnej i wczesnoszkolnej

Streszczenie

Artykuł stanowi próbę ukazania form stosowania nowoczesnych technologii w pracy nauczycieli. Obecny poziom rozwoju ICT znacznie rozszerza możliwości nauczycieli i uczniów w edukacji włączającej. Korzystając z technologii informacyjno-komunikacyjnych, osoby z niepełnosprawnościami są w stanie pokonać bariery w uczeniu się, korzystając z różnorodnych materiałów dydaktycznych w przystępnym formacie. Autorki podkreślają, że technologie informacyjno-komunikacyjne w edukacji inkluzyjnej i specjalnej mogą być wykorzystywane jako narzędzie kompensacyjne, komunikacyjne i dydaktyczne. W artykule opisano główne obszary, w których wskazane jest zapewnienie wsparcia ICT w edukacji włączającej. Wdrażanie ICT zapewnia dostęp do alternatywnych źródeł informacji, które mogą być wybierane i wykorzystywane przez każdego ucznia zgodnie z jego indywidualnymi możliwościami. Zwraca się przy tym uwagę na fakt, że narzędzia ICT powinny być dobierane z uwzględnieniem specyfiki różnych rodzajów niepełnosprawności. Pedagogicznie zrównoważone i właściwe wykorzystanie technologii informacyjno-komunikacyjnych umożliwi uczniom z niepełnosprawnościami pełne uczestnictwo w procesie edukacyjnym, wypracowanie indywidualnych, akceptowanych dla nich strategii edukacyjnych.

Słowa kluczowe: edukacja włączająca, narzędzia cyfrowe, strategie pedagogiczne, wsparcie, indywidualne możliwości uczniów

Digital tools for supporting inclusive education on different levels

Abstract

In the article is stated that the current level of ICT development significantly expands the opportunities for teachers and students in inclusive education. Using ICT, people with disability are able to overcome barriers to learning by accessing a variety of teaching materials in an accessible format. The authors stress that ICT in special and inclusive education can be used as a compensatory, communication and didactic tool. The main areas in which it is advisable to provide ICT support for inclusive education, are described. The implementa-

tion of ICT provides access to alternative sources of information that can be selected and used by each student according to his / her individual capabilities. It is noted that ICT tools should be selected taking into account the specifics of various disability types. Pedagogically balanced and appropriate use of ICT will allow students with disability to participate in the educational process fully, to develop individual educational strategies acceptable for them.
Key words: inclusive education, digital tools, pedagogical strategies, support, individual capabilities

Introduction

The modern period of society development is characterized by the increasing role of information and knowledge, which become factors of social progress and well-being. The development of the information society causes changes in almost all spheres of life: from politics and government to education and culture. The availability of information and communication technologies (ICT) radically changes the way we work with data, simplifies the processes of acquiring knowledge, sharing experiences and interacting between people. Interstate and intercultural borders are becoming more transparent in the virtual world of computer networks.

The transition to the information society radically changes the usual principles: receiving more and more information from different sources, we are forced to constantly reconsider our ideas that are formed in the mind under their pressure, otherwise our actions will not meet the demands of reality[1]. The need to form in the younger generation the skills of independent, critical, operational thinking, adaptation and orientation in the information-rich space makes new demands on the content of education, its renewal and modernization.

The development of education on the basis of the principles of continuity, accessibility, personal orientation forms a conceptually new model – open education. Openness of education is its ability to provide an open space for personal development, the development of the educational system to the interests and needs of the individual and society. Open education is designed to implement the principle of lifelong learning, which is recognized by the Council of Europe as one of the most important social elements, which covers, in addition to education, also employment, economic growth, competitiveness, social security and more. It should be based on the principles of universal access to scientific knowledge and discoveries,

[1] V. Yu. Bykov, *Modeli orhanizatsiinykh system vidkrytoi osvity* [Models of organizational systems of open education], Kyiv 2008, Ukraine: Atika. [In Ukrainian].

a common desire to improve and expand the boundaries of the unknown. Open education is a kind of reform, a transition to more informal forms of learning, an important principle of which is the belief that a person seeks to learn and does so naturally, if you offer him/her more freedom.

The development and implementation of the principles of democracy, humanism and openness in education contributes to social progress and comprehensive intellectual and spiritual development of the individual. Responding to the needs of the individual and society as a whole brings us closer to the establishment of an educational paradigm, which is the need to ensure equal access to quality education for each individual, regardless of his/her characteristics and limitations.

According to the World Bank, 10-12% of the world's population belong to the category of people with mental and physical disabilities[2]. At the same time, the number of children under the age of 16 who fall into this category is estimated at 140-165 million people. 62 millions of them are children of primary school age. They face many barriers to education, which means that school attendance rates and the percentage of those who have successfully completed their studies are much lower than their peers. Of the 75 million children worldwide, who did not attend school, a third were children with disabilities. In developing countries, exclusion from the education system is much more significant for people with mental and physical disabilities, of whom about 97% can neither read nor write[3].

Failure to obtain an education deprives persons with disabilities of the opportunity to obtain a profession, a decent wage and public recognition. The World Bank estimates that 20% of the world's poorest people have various forms of disability. The level of literacy among people with disability (in the global dimension) is only 3%, and unemployment – 80%[4].

Partial solution of these social and educational problems is possible by increasing the availability of ICT for certain categories of the population[5],

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[2] Measuring Disability Prevalence. Retrieved from: http://siteresources.worldbank.org/DISABILITY/Resources/Data/MontPrevalence.pdf [In English] (2018, June, 11).

[3] *Inkliuzyvnoe obrazovanye: put v budushchee. 48-ya sessyia Mezhdunarodnoi konferentsyy po obrazovanyiu: Zakliuchytelnyi doklad* [Inclusive education: the path to the future. 48th Session of the International Conference on Education: Final Report]. Retrieved from: http://www.ibe.unesco.org/fileadmin/user_upload/Policy_Dialogue/48th_ICE/ICE_FINALREPORT_rus.pdf [In Russian] (2018, June, 11).

[4] ICT for inclusion: reaching more students more effectively. Retrieved from: http://iite.unesco.org/pics/publications/ru/files/3214675.pdf [In English] (2018, June, 11).

[5] Yu. H. Nosenko, *Elektronna inkliuziia yak efektyvna stratehiia zabezpechennia*

the introduction of open access repositories with educational and scientific content, which will provide alternative ways to acquire knowledge despite time or space constraints.

The role of information and communication technologies in supporting inclusive education

Over the last twenty years, there have been significant changes in the field of education. In particular, the range of teaching aids has significantly expanded: in addition to traditional ones, multimedia tools are being introduced that integrate plain text with sound, graphics, video, animation, etc. Extensive use of ICT and interactive multimedia, simplified access to global networks, in particular, the Internet, suggests that:

- The learning process gradually becomes independent of the physical location of its subjects;
- The number and variety of resources available to students in extracurricular activities has increased significantly;
- The locus of control in the initiation of the educational process has passed to the students: they themselves are able to initiate the process at any time convenient for them, in any place[6].

It should be noticed that the range of educational needs of people with disability is much wider than that of healthy ones: on the one hand, they must acquire the knowledge, skills and abilities necessary for full social interaction on a par with their peers. On the other hand, they have additional needs caused by their functional limitations, which in some cases make it impossible to use standard teaching methods and can also negatively affect performance and self-esteem.

The implementation of the humanistic paradigm involves the introduction of inclusive education, which is an evolutionary stage after medical (segregation) and integrated models of special education. Over the last 20 years, the concept of "inclusion" or "social model" has been evolving in Ukraine and around the world, focusing on changes in society so that it ensures equal participation of every citizen in the exercise of his / her rights

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dostupnosti i vidkrytosti osvity [Electronic inclusion as an effective strategy for ensuring the accessibility and openness of education]. In *Pedahohichni innovatsii: idei, realii, perspektyvy,* 2016, 2 (17), 116-123. [In Ukrainian].

[6] ICTs in Education for People with Special Needs : specialized training course (2006). Moscow: UNESCO Institute for Information Technologies in Education. Retrieved from: http://iite.unesco.org/pics/publications/en/files/3214644.pdf [In English] (2018, June, 11).

and gives him / her such an opportunity[7]. Unlike integration (normalization), inclusion is based on the recognition and respect of individual human differences. Fundamental in this concept is that it is not the individual who should adapt to social, economic relations, but on the contrary – society should create conditions to meet the special needs of each individual[8].

According to researcher A. Kolupayeva, inclusion is based on the recognition and respect of individual human differences and involves maintaining the relative autonomy of each social group, and the ideas and style of behavior inherent in the traditionally dominant group should be modified based on pluralism of customs and opinions[9]. At the same time, individual features should not be perceived as an exceptional, doomed phenomenon, the presence of a violation does not determine the marginality of human life. The focus of this model of social behavior, according to scientists[9], are:

1) Autonomy;
2) Participation in public activities, the creation of a system of social relations;
3) The acceptance of each individual by society, without restrictions.

For the first time, the issue of inclusive education in the modern sense was discussed at the international level in 1994 at the Salamanca Conference, the main principles of which were:

- The right of every person to education, giving him/her the opportunity to achieve and maintain a sufficient level of education;
- The presence of unique abilities, interests and learning needs of each person;
- Development of special educational programs that take into account the characteristics and needs of each student;
- providing people with special needs with access to general education, taking into account their characteristics;
- raising the level of qualification of teachers in order to ensure their quality

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[7] N. Z. Sofii, Yu. M. Naida, *Kontseptualni aspekty inkliuzyvnoi osvity* [Conceptual aspects of inclusive education]. In Danylenko L.I. (Ed.). *Inkliuzyvna shkola: osoblyvosti orhanizatsii ta upravlinnia* [Inclusive school: features of organization and management] (pp. 9-16), Kyiv 2007, Ukraine. [In Ukrainian].

[8] O. V. Martynchuk, *Inkliuzyvne navchannia ditei z osoblyvymy potrebamy v zahalnoosvitnomu prostori* [Inclusive education of children with special needs in the general education space]. In *Teoriia ta metodyka navchannia ta vykhovannia*, 2011. 29, 88-93. [In Ukrainian].

[9] A. A. Kolupaieva, *Inkliuzyvna osvita: realii ta perspektyvy* [Inclusive education: realities and prospects]. Kyiv, Ukraine 2009, "Sammit-Knyha". [In Ukrainian].

work in accordance with the principles of inclusive education[10].

It is worth noting that at the present stage of development, the society (in a broad sense) has come to recognize and affirm the right of persons with disability to full participation in public life and is trying to realize the need to create conditions for full realization of this right. Obviously, today the emphasis is shifting from human adaptation to the environment towards adapting the environment to meet human needs, which is the basis of inclusion.

The theoretical and practical concept of inclusion has become fundamental in the development of modern models of education for people with disability on the basis of their full socialization. Ukrainian researchers do not view individual diversity as a source of difficulty, but, on the contrary, as an attribute of reality that should be perceived and, moreover, valued. In this approach, we reject the definition of the norm as something homogeneous and stable, but see the norm in diversity. The existence of different categories of students, each of whom has his/her own educational needs, becomes the basis on which all modern pedagogy should be built [9,11,12].

Thus, the ideology of inclusive education is based on the exclusion of any discrimination, equal treatment of each individual, regardless of his/her characteristics, as well as understanding the need to adapt educational institutions to individual needs, creating equal access to quality educational services.

The fig. 1 presents the features of an inclusive approach to learning compared to others: traditional and integrated[13] in the context of the attitude to the learners' characteristics.

Inclusive education involves making adjustments and changes to the con-

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[10] *Salamankskaia deklaratsyia i ramky deistviy po obrazovaniyu lyts s osobymi potrebnostiamy, pryniatye Vsemyrnoi konferentsyei po obrazovanyiu lyts s osobymi potrebnostiamy: dostup i kachestvo* (1994). [The Salamanca Declaration and Framework for Action on Special Needs Education, adopted by the World Conference on Special Needs Education: Access and Quality] Retrieved from: http://unesdoc.unesco.org/images/0009/000984/098427rb.pdf [In Russian] (2018, June, 11).

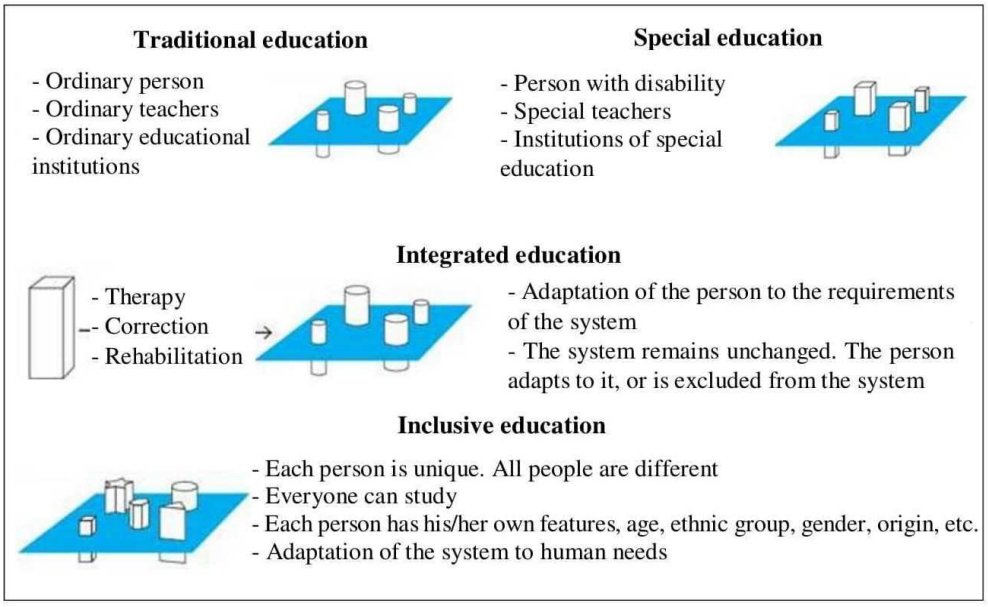
[11] Danilavichiutie, E. A., Lytovchenko, S. V. (2012). *Stratehii vykladannia v inkliuzyvnomu navchalnomu zakladi* [Teaching strategies in an inclusive school]. Kyiv, Ukraine: "A.S.K.". [In Ukrainian].

[12] Taranchenko, O. M., Naida, Yu. (2012). *Dyferentsiiovane vykladannia v inkliuzyvnomu klasi* [Differentiated teaching in an inclusive classroom]. Kyiv, Ukraine: "ATOPOL". [In Ukrainian].

[13] Puliaevskaia A. *Inkliuzyvnoe obrazovanye i IKT* [Inclusive education and ICT]. Retrieved from: https://nitforyou.com/ikt-inklyuzivnogo-obrazovaniya/ [In Russian] (2018, June, 11).

tent, approaches, structure and strategy based on a single concept that encompasses all individuals in the same age group, and recognizing that the education of each individual is a responsibility of the formal education system[14].

Fig. 1. Features of the inclusive education model in comparison with other models



Preodolenye otchuzhdenyia s pomoshchiu ynkliuzyvnykh podkhodov v obrazovanii: zadacha i kontseptsiya reshenyia [Overcoming alienation through inclusive approaches in education: the task and the concept of its solution]. Retrieved from: http://unesdoc.unesco.org/images/0013/001347/134785r.pdf [In Russian] (2018, June, 11).

Within the framework of an inclusive approach, the diversity of students and their individual differences are considered not as a problem, but as an opportunity to enrich the educational process. The goal of inclusive education is to ensure that the entire education system promotes an environment

[14] Preodolenye otchuzhdenyia s pomoshchiu ynkliuzyvnykh podkhodov v obrazovanii: zadacha i kontseptsiya reshenyia [Overcoming alienation through inclusive approaches in education: the task and the concept of its solution]. Retrieved from: http://unesdoc.unesco.org/images/0013/001347/134785r.pdf [In Russian] (2018, June, 11).

in which educators and students are willing to accept the challenges and benefits of diversity. This approach allows finding methods of transformation of educational systems to meet the needs of a wide range of learners[15].

As stated in one of the UNESCO documents[16], the current level of ICT development significantly expands the opportunities for teachers and students, simplifying access to educational and professional information, the functionality of teaching aids and effective management of the educational process, promotes integration of national information systems with international information resources in the field of education, science and culture.

The compensatory property of new technologies allows people with disability to take an active part in the educational process despite functional limitations. Using ICT, these people are able to overcome barriers to learning by accessing a variety of teaching materials in an accessible format.

ICT in special and inclusive education can be used as a compensatory, communication and didactic tool.

The use of ICT as a *compensatory tool* means their use as technical support for traditional learning activities – reading and writing, facilitating access to didactic resources and educational interaction, partially compensating or replacing the lack of natural functions.

As a *communication tool*, ICTs can be used to provide an alternative form of communication, to support alternative communication, as a tool that facilitates and / or enables communication, allowing people with disability to communicate in a more convenient way.

The use of ICT as a *didactic tool* has necessitated a revision of traditional approaches to teaching and learning, ushering in a new milestone in educational transformation. New technologies have brought a variety of pedagogical strategies for educating people with disability, becoming a real tool for the implementation of inclusive education.

It is worth noting that ICT tools should be selected taking into account the specifics of various disability types. Pedagogically balanced and appro-

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[15] *What is 'inclusive education*? - Interview with the UNESCO-IBE Director, Clementina Acedo. Retrieved from: http://www.ibe.unesco.org/fileadmin/user_upload/Policy_Dialogue/48th_ICE/Press_Kit/Interview_Clementina_Eng13Nov.pdf [In English] (2018, June, 11).

[16] *Information and Communication Technologies in Secondary Education* (2004). Retrieved from: http://iite.unesco.org/pics/publications/en/files/ 3214616.pdf [In English] (2018, June, 11).

priate use of ICT will allow students with disability to participate in the educational process fully, to develop individual educational strategies acceptable for them.

Among the benefits of ICT support for inclusive education are the following:

General advantages:

Contribute to the expansion of student's autonomy;

Allow to overcome communication difficulties and barriers;

Give students the opportunity to demonstrate learning outcomes in a convenient way;

Allow to develop educational tasks taking into account students' individual skills and abilities;

Benefits for students:

Independent access to educational information;

Ability to perform learning tasks at one's own pace (in asynchronous mode);

Opportunity for students to use ICT as a compensatory tool, to access educational information in an alternative way.

Benefits for educators:

Opportunity to communicate remotely with colleagues, learn the leading pedagogical experience of working with inclusive groups and disseminate one's own experience;

Improving one's own skills in using ICT to support effective work with students;

More opportunities for the preparation of didactic materials, clarity.

In particular, due to multimedia it is possible to carry out and influence correctly on various sensory zones. Materials in electronic format are easier to adapt to the needs of students (for example, large font, Braille, etc.)[6].

Among the main *areas in which it is advisable to provide ICT support for inclusive education*, it is worth noting the following:

– Determining the initial level of student personal development, i.e. the initial level with which he/she starts studying;
– Support for personal development through the formation of new skills or the development of already acquired ones;
– Improving access to educational resources;
– Overcoming geographical or social barriers through communication and network support;
– Strengthening motivation to use and awareness of the benefits of ICT as

a tools of supporting inclusive learning[6].

Among the main *types of ICT*, suitable for use as a tools of supporting inclusive education, are:

– standard technologies – personal computers (desktop PCs, laptops, netbooks, tablet PCs (tablets), etc.) with built-in settings for people withdisability;
– available data formats, or alternative formats – for example, available HTML; DAISY – digital format for recording digital audio books; Braille printers, displays and speech synthesizers, etc.;
– assistive (auxiliary) technologies – hearing aids, screen readers, keyboards with special capabilities, alternative communication systems, etc.[4]

The development and widespread availability of web and cloud-based technologies allow us to create the basis for the dissemination of relevant educational information in a faster and more flexible way. A number of technological solutions, available and often free, contribute to the development of environments for effective learning interaction:

– synchronous and asynchronous communication and collaboration (e-mail, online boards, chats, forums, web conferences, etc.);
– multimedia interaction (simulations, augmented reality, gamification, etc.);
– innovative assessment methods (adaptive testing, self-assessment, online testing, etc.)[6].

Educational content can be distributed in various formats: in the form of text on web pages, digital audio and video, animation, virtual reality environments and more.

Thus, the implementation of ICT provides access to alternative sources of information that can be selected and used by each student according to his / her individual capabilities.

Among the main *problems of ICT implementation* as a tools of supporting inclusive education we see the following:

– High cost and / or low availability of ICT, especially assistive technologies;
– Refusal to use ICT due to the low level of ICT competence of users, their ignorance about the possibilities and benefits of using these technologies in inclusive education;
– Unwillingness of teachers to use ICT due to uncertainty, negative attitude to technology in general, underestimation of the potential of these technologies in working with people with disability;
– Insufficient support of teachers and students, including lack of training

and technical support for the use of specialized ICTs, etc.

To avoid these problems, to implement the successful inclusive education via using ICT, improve its quality and accessibility for people with disability, it is necessary to provide *appropriate conditions*, namely:

– Introduction of appropriate ICT infrastructure that would meet the principles of accessibility, ease of use, flexibility and cost-effectiveness;
– Modification of curriculum components, including content, teaching methods and outcomes assessment, implementing ICT taking into account the students' educational needs;
– Raising the level of inclusive class educators' ICT-competence, their awareness of the possibilities of using new technologies in pedagogical interaction with disabled students[6].

For some students, the use of technical solutions is the only way to express their needs and views, to access a number of resources on a par with other peers in the educational process, to demonstrate success in an accessible and convenient way.

It is important to note that the introduction of ICT alone is not enough to solve all the problems of training people with disability. An integral condition is motivation, the educators' desire to apply and develop innovative teaching methods or to adapt existing ones to the requirements of the time. It is necessary to create conditions for each student so that he / she has the opportunity to obtain the necessary information and demonstrate learning outcomes in a convenient way. To do this, it is necessary to integrate ICT into all educational programs so that they harmoniously complement and support their implementation. Updating programs is not about simplifying them for students with disability, nor about lowering academic requirements or simplifying standards. Instead, it means striving to develop the knowledge, skills and abilities needed to successfully master a course in a more creative and flexible way.

Any software, e-learning resources, virtual learning environments, etc. used in the educational process must be designed and developed with inclusive strategies in mind to be available for use by any individual, regardless of individual features and limitations. In this regard, educational institutions need to ensure the universal design of the technologies they use and their compliance with the requirements of the United Nations Convention on the Rights of Persons with Disabilities.

ICT-support for inclusive education at preschool institutions.

The use of the latest technologies in inclusive education will promote the

integration of each child into the society of peers, compensation of his/her disability by means of innovative ICT, which in general should have a positive effect on the formation of one's personality. Considering the individual as a means of human functioning in society, we do not isolate him/her in a specialized educational institution, but fully involve him/her in all types of social relations from preschool age.

The role of ICT in this process is:

1) overcoming communication barriers (if the disability concerns the violation of the senses and perception);
2) optimization of the learning process and education as a whole (for disorders of the autistic spectrum – the child is more comfortable to communicate with an adult through a technical tools);
3) distance learning (the ability to teach and educate a child remotely, if for some reason he/she cannot attend kindergarten);
4) clarity in the presentation of educational material (illustration of the material using a video series, interactive whiteboard), etc.

Education should be personality-oriented, take into account the abilities and interests of the child, the feasibility of using technical means, be fully justified from the following positions: the child's age, types of disability, its provision and technical means, compliance with the material level mental development of the child.

ICT in preschool education cannot be an end in itself, as the age feature of a preschool child is the situation of interaction with an adult, on which his mental development largely depends[17,18,19]. The situation of the use of ICT in preschool education should look like this: adult – technical means – child. The adult must firstly acquaint the child with the technical mean, teach to use it, then move on to its sharing.

The role of ICT in this process is to:

1) overcoming communication barriers (if the disability concerns the violation of the senses and perception);
2) optimization of the process of learning and education (for disorders of the autistic spectrum - the child is more comfortable to communicate with an adult through a technical means);

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[17] L. S. Vyhotskyi, *Izbrannyye psikhologicheskiye proizvedeniya: v 6 t.* 1984 [Selected psychological works: in 6 vols.]. Moscow, Russia: "Pedagogika". [In Russian].

[18] A. N. Lieontiev, (1983). *Izbrannyye psikhologicheskiye proizvedeniya: v 2 t.* [Selected psychological works: in 2 vols.]. Moscow, Russia: "Pedagogika". [In Russian].

[19] Miasyshchev, V. N. (1960). *Psykholohyia otnoshenyi* [Relationship psychology]. Lvov, Ukraine: LHU. [In Russian].

3) distance learning (the ability to teach and educate a child remotely, if for some reason he can not attend kindergarten);
4) clarity in the presentation of educational material (illustration of the material using a video series, interactive whiteboard), etc.

The introduction of multimedia technologies (MT) in the field of preschool education is one of the latest current scientific and pedagogical problems and a significant global trend[20]. The use of MT in education not only diversifies the ways and forms of information transfer to children, increases its assimilation, but also promotes the development of such processes as attention, memory, thinking, imagination, speech, develops a sense of color, composition, promotes intellectual, emotional and moral child development. The novelty of computers and interactive equipment are reflected in the expansion and enrichment of the content of knowledge, skills and abilities of the child, in the intensification of the creation of structural complexes of intellectual and motivational-emotional nature, in changing the dynamics of mental development[21].

The semantic field of the concept of "multimedia technologies" is reflected in the works of many researchers. Analysis of the source base showed that "multimedia" is generally viewed from different positions:

a) as a technology;
b) as software;
c) as hardware;
d) as a special generalizing type of data.

The author considers MT as a technology that allows using digital means (PC, tablet, multimedia board, smartphone, etc.) to integrate process and reproduce various types of signals, means and methods of data exchange, information.

Among the main advantages of using MT in the education of preschool children, in particular with disability, we define the following:

– Polysensory perception of the material;
– Promoting the development of basic mental processes (memory, attention, thinking, imagination, etc.);

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[20] Yu. H Nosenko, Zh. V. Matiukh, *Zarubizhnyi dosvid vykorystannia informatsiinokomunikatsiinykh tekhnolohii v inkliuzyvnii doshkilnii osviti* [Foreign experience in the use of information and communication technologies in inclusive preschool education]. In *Nova pedahohichna dumka*, 2015, 4 (84), 95-102. [In Ukrainian].

[21] *Vykorystannia IKT v DNZ* [The use of ICT in pre-schools]. Retrieved from: http://www.bilatserkva-dnz3.edukit.kiev.ua/vikoristannya_ikt_v_dnz/ [In Ukrainian] (2018, June, 11).

– The ability to demonstrate objects, phenomena and processes that are not available in everyday life (space objects, natural phenomena, objects of the microworld, etc.);
– Visualization and emotional coloring of demonstration material, etc.[22]
– The ability to visualize abstract data[23].

Medical research[24] has shown that the use of MT is appropriate not earlier than 5 years of age, as an earlier onset can have negative consequences for the health of the child, especially the visual analyzer, which is in the process of development. The maximum time interval of work with MT for 5-year-old children is no more than 10 minutes per lesson).

The main MTs that should be used in the educational process of PEI, in particular in working with an inclusive group (children of 5-6 years), include the following:

1. Multimedia presentation – a set of slides on a particular topic, stored in a file of a special format. Each slide can contain text, graphics, animation, audio, video, etc. This tool allows you to combine sound and images in the dynamics, which helps to activate the child's random attention. Simultaneous exposure to the two most important organs of perception (hearing and vision) allows you to achieve a greater effect. We consider it appropriate to use multimedia presentations in the study of new concepts, or their repetition.

2. Electronic educational game resource (EEGR) – is a separate type of game software designed to solve didactic tasks. EEGR is a software that combines cognitive and entertaining functions, contains tasks in the form of games and aims to enhance the cognitive activity of children[25]. The purpose

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[22] Zh. V. Matiukh, *Do pytannia vprovadzhennia multymediinykh tekhnolohii v inkliuzyvnu doshkilnu osvitu [On the issue of introduction of multimedia technologies in inclusive preschool education].* In *Modernizatsiia informatsiino-resursnoho zabezpechennia osvitnoho prostoru navchalnykh zakladiv* [Modernization of information and resource provision of educational space of educational institutions]: *international scientific-practical conference* (pp. 33-35). Kyiv, (2016, May). Ukraine. [In Ukrainian].

[23] Zh. V. Matiukh, *Problemy ta perspektyvy vprovadzhennia multymediinykh tekhnolohii v inkliuzyvnu doshkilnu osvitu [Problems and prospects of introduction of multimedia technologies in inclusive preschool education].* In *Novi tekhnolohii navchannia*, 2016, 88, p. 65-69. [In Ukrainian].

[24] N. S. Polka, A. H. Platonova, *Onovlennia hihiienichnykh vymoh do vykorystannia v navchalnykh zakladakh suchasnykh zasobiv informatsiinykh tekhnolohii* [Update of hygienic requirements for the use of modern information technology in educational institutions]. In *Kompiuter u shkoli ta simi.* 2015, 4, p. 3-5. [In Ukrainian].

[25] S. H., Lytvynova, O. M. Melnyk, *Vykorystannia elektronnykh osvitnikh ihrovykh resursiv*

of using EEGR has a double meaning: play – the child receives a "reward" after achieving the game goal; educational and developmental – the acquisition and development of knowledge, skills and abilities. During the game, children develop positive emotional reactions, the desire to achieve the goal, which contributes to the correction and development of mental processes. It is important to remember that such a game is only a supplement to the main activities of the child, and in no case should displace the traditional game (story-role, interpersonal). We believe that EEGR should be used in the preschool group to consolidate knowledge, practice skills.

3. Cartoon film – a product of animation, created by capturing successive phases of movement of objects. From watching cartoons, children receive significant amounts of data of artistic and aesthetic, moral and ethical, cognitive and other nature[26]. Their introduction into the educational process allows to positively influence the assimilation of behaviors, algorithms for achieving goals, the development of the emotional sphere and mental processes (thinking, memory, attention, imagination, etc.). Viewing a cartoon (or a fragment of it) should begin with an introductory word from the educator, preparing children for the main semantic line, and end with the educator's delivery of problematic questions, as well as giving children the opportunity to express their feelings, attitudes and reflections. We consider it expedient to show cartoons to explain and form complex concepts: moral and ethical values, norms of social interaction, etc.[27].

Currently, high-quality multimedia software for preschoolers, which meets the basic didactic and psychological-pedagogical requirements, is usually developed and distributed on a commercial basis, and its cost can vary from a few USD to over 100 USD. This is especially true of special software for teaching children with disability.

Although many sites offer free software for preschool children, the vast

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u navchalno-vykhovnomu protsesi pochatkovoi shkoly [The use of electronic educational game resources in the educational process of primary school]. Kyiv 2016, Ukraine: "Komprynt". [In Ukrainian].

[26] V. V. Kovalenko, *Multyplikatsiina produktsiia yak zasib formuvannia sotsialnoi kompetentnosti uchniv molodshykh klasiv* [Cartoon products as a means of forming social competence of junior students]. In *Osvita ta rozvytok obdarovanoi osobystosti*, 2016, 8 (51), 16-18. [In Ukrainian].

[27] Nosenko, Yu. H., Matiukh, Zh. V. (2017, May). The Implementation of Multimedia Technology in Ukrainian Inclusive Pre-school Education. In *ICT in Education, Research and Industrial Applications. Integration, Harmonization and Knowledge Transfer: Proceedings of the 13th International Conference* (pp. 459-466). Kyiv, Ukraine. CEUR-WS.org, 1844. Retrieved from: http://ceur-ws.org/Vol-1844/10000459.pdf. [In English].

majority of these developments are characterized by a number of shortcomings that complicate their use in preschools, namely:

– Software development without the involvement of specialists in the field of psychological and pedagogical sciences, lack of proper professional expertise;
– Lack of translation into native language, or its low linguistic and grammatical quality;
– The presence of a significant number of "bugs", errors due to lack of professional testing of the product, which requires additional costs;
– Dependence of the product on one operating system (for example, the inability to run on Windows, but only on Android or iOS, etc.);
– Non-compliance with basic ergonomic and pedagogical requirements (too bright colors, sharp loud sounds, obsessive melodies that cannot be turned off or replaced, etc.);
– Lack of guidelines, instructions or advice for educators, parents on the use of software in the educational process;
– Complexity of installation (i.e., need to install additional programs);
– Lack of possibility of installation (functioning exclusively in the online mode, dependence on a network);
– Lack of technical support for the software, or its low efficiency[28].

Despite this, it is possible to find high-quality multimedia developments in free access. Thus at their selection, it is important to be guided by a number of the main criteria among which we define the following:

– Ease of installation or web access;
– The ability to run on the basis of the operating system Windows (for PC) and Android (for mobile devices), which today are the main platforms in Ukrainian educational institutions;
– Simple clear interface;
– Ergonomic design, no too bright colors and sharp sounds;
– High-quality voice accompaniment (clear diction, measured tempo, pleasant timbre);
– Availability of native language version;
– Focus on the formation and development of children's knowledge, skills and abilities defined in the state standard of preschool education.

Involvement of children in a quality educational environment from an early age has a positive impact on their further learning and socialization. Thus, according to a study by the US National Joint Committee on Learning

[28] Ibidem.

Disabilities, it was found that children with disability who had access to quality educational services at an early age show higher learning outcomes in primary school[29].

A child with disability goes through all the same stages of ontogenesis as a healthy one. The differences are in the pace of physical and mental development, the end result, and ways to achieve it. With the introduction of MT, each child is able to overcome barriers to learning, access to a variety of didactic materials in a convenient format[30].

To effectively involve children with disability in the educational process, it is necessary to implement a number of conditions, including the design of individual educational trajectories, the introduction of new pedagogical approaches, methods and tools. MT, which allows to combine different forms of information presentation (text, graphics, audio, video, animation, etc.), simplify access to didactic materials, provide them in a way acceptable to each child, contribute to the individualization of learning and more effective development of basic mental processes. Such prospects are of paramount importance for children with disability.

ICT-support for inclusive education at schools
Health-saving use of ICT by students with disabilities

In the conditions of continuous digitalization, the problem of safe, health-saving use of new tools by the younger generation becomes relevant. At the same time, a particularly vulnerable group are children and adolescents with functional limitations, including visual impairment. Based on the analysis of literature, we identified the main problems of pedagogically unbalanced use of ICT, their impact on students' health, including those with visual impairments, and possible solutions.

Problem 1. Inadequacy of computer-based tools to students' individual characteristics (age, height, etc.). The use of standard workstations by children (especially primary school students, whose body is in the process of intensive restructuring and development) is associated with the formation of incorrect posture, inability to cover the image with both visual analyzers at the same time, inconvenience of keyboard and mouse manipulation. All this

[29] *Learning Disabilities and Young Children: Identification and Intervention.* Retrieved from: http://www.ldonline.org/article/11511/. [In English] (2018, June, 11).

[30] Yu. H. Zaporozhchenko, *Vykorystannia zasobiv IKT dlia pidvyshchennia yakosti inkliuzyvnoi osvity* [Using ICT tools to improve the quality of inclusive education]. In *Informatsiini tekhnolohii v osviti*, 2013, 15, 138-145. [In Ukrainian].

leads to the emergence and deepening of diseases of the musculoskeletal system and eyes.

For example, regular observation of objects on the monitor (both stationary and liquid crystal) at an angle due to both incorrect posture and wide screen format, leads to loss of ability to see clearly with both eyes (binocular vision impairment)[31]. It was shown that reading from the monitor could lead to negative biomechanical and physiological effects on the head and cervical spine. Therefore, the approach to the use of monitors by visually impaired students should be balanced, differentiated and dosed.

Ways to solve. The problem can be partially solved by creating adaptive workplaces – specially created work environments for students, some components of which can be customized (adapted) depending on individual characteristics and needs (height, angle of view, etc.). Before starting a lesson in which the use of ICT is planned, students are encouraged to preadjust (adapt) the workplace for comfortable work (independently or with the help of a teacher).

The most comfortable working conditions are provided by liquid crystal monitors with a diagonal of at least 19 inches[32]. The convenient location of the monitor is important (to avoid deformation of the child's posture at work). The lighting of the room in which ICT is used should be optimal (not too dark, not too bright) to avoid contrast between the lighting and the monitor. Observance of the current sanitary and hygienic norms, time regulations of work with ICT, recommended for each age category, alternation of different types of activities in the classroom is a mandatory condition. These rules are especially important for visually impaired children.

Problem 2. Easy adaptation of children to the uncomfortable conditions associated with the use of ICT. Fascinated by bright multimedia images on the monitor, they may not pay attention to visual discomfort for a long time (screen flicker, unadjusted brightness and contrast, glare, etc.). Abnormal

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[31] Zh. V. Matiukh, Vykorystannia multymediinykh tekhnolohii v doshkilnii osviti yak aktualnyi napriam *naukovo-pedahohichnykh doslidzhen* [The use of multimedia technologies in preschool education as a topical area of scientific and pedagogical research]. In *Multymediini tekhnolohii v osviti ta inshykh sferakh diialnosti* [Multimedia technologies in education and other fields of activity]: *Proceedings of scientific-practical conference* (pp. 66-67). Kyiv, 2016, November, Ukraine. [In Ukrainian].

[32] V. V. Loboda, *Navchalne Internet-seredovyshche yak zasib motyvatsii movlennia starshoklasnykiv z vadamy slukhu* [Educational Internet environment as a means of motivating speech of high school students with hearing impairments] (Extended abstract of PhD dissertation), Kyiv 2010, Ukraine. [In Ukrainian].

work in front of the screen leads to accommodation disorders and pain in the eyes, often due to prolonged concentration on the monitor, instinctive approach, reducing the distance between the eyes and the monitor. A visually impaired child may take a low-quality image for granted without making any effort to improve it. As a result, prolonged work on the monitor can lead to visual strain, which is especially dangerous for children with accommodation and convergence disorders (myopia, hyperopia, strabismus). In turn, visual strain leads to general fatigue, headache, irritability, decreased efficiency, and others. It is dangerous that the change in health may not appear immediately, but accumulate over time, eventually becoming a chronic process[33].

Ways to solve. Adults (educators and parents) should ensure that a quality image is displayed on the monitor by adjusting the settings (contrast, overall color gamut, color and background combination, etc.). The selection of these parameters for each individual student with visual impairment is carried out taking into account its individual properties (visual acuity and field of vision, features of color perception, etc.). It is important to normalize the time that students spend in front of the screen. Visually impaired children should read data from the monitor without the need for excessive visual stress, for which it is advisable to use special software applications ("Magnifier" from Windows, Magic and others)[34,35]**Błąd! Nie można odnaleźć źródła odwołania.**.

Problem 3. Low quality software, electronic educational resources (EER) used in the educational process. Defects of the visual interface lead to increased visual stress and fatigue, exhaustion of the nervous system. The use of such EER in working with children with visual impairments can cause negative disease dynamics. Particularly dangerous is the inclusion in the image of flickering elements that can cause epileptic seizures in students

[33] V. M., Zaika, O. M. Yushchenko, Osoblyvosti sotsialnoi roboty z liudmy yaki maiut funktsionalni obmezhennia zdorovia [Features of social work with people with functional disabilities]. In *Sotsialna robota v suchasnomu suspilstvi: tendentsii, vyklyky, perspektyvy* [Social work in modern society: tendencies, challenges, perspectives]: *Proceedings of all-Ukrainian scientific-practical conference* (pp. 63-68). Kyiv 2017, February, Ukraine. [In Ukrainian].

[34] V. Bykov, M. Leshchenko, L. Tymchuk, *Tsyfrova humanistychna pedahohika [Digital humanistic pedagogy],* Kyiv 2017, Ukraine: "LAT&K". [In Ukrainian].

[35] Yu. H. Nosenko, A. S. Sukhikh, *Zdoroviazberezhuvalne vykorystannia prohramno-aparatnykh zasobiv u navchalnomu protsesi osnovnoi shkoly* [Health-saving use of software and hardware tools in the educational process of general school]. Kyiv 2017, Ukraine: "Komprynt". [In Ukrainian].

who are prone to it.

Ways to solve. A significant contribution to the study of the problem was made by the research team of the Institute of Information Technologies and Learning Tools of the National Academy of Educational Sciences of Ukraine[36,37]. In addition to the general requirements for EER (compliance with psychological, pedagogical and ergonomic requirements) now, in the context of the model of inclusive education in Ukraine, it is advisable to introduce requirements for adaptability of EER, the ability to configure them for different categories of users, including visually impaired. Such developments must undergo an examination and testing procedure to achieve high quality indicators and minimize potential risks. Modern EER should be able to adjust the size of the font and images according to user needs, have a psychologically balanced design, optimal color and optical contrast, well-chosen examples and illustrations, etc. Teachers should prefer ESD recommended by the responsible government body.

Problem 4. Development of computer addiction. The most common forms of computer addiction include: gambling, web surfing ("wandering" on various sites), virtual communication. The danger is to reduce the sense of the line between the virtual world and the real one, when the alternative reality becomes more attractive, displacing the real reality. Computer addiction can provoke changes in behavior (isolation, emotional imbalance, apathy, abandonment of other activities, etc.), decreased academic performance, impoverishment of language and vocabulary, chronic physical disorders (migraine, tearing in the eyes, pain in the back, chronic fatigue), etc.

The secondary deviations of the development of children with visual impairment include difficulties with the formation of personality qualities: lack of active life position, isolation, low self-esteem, lack of self-confidence and others. As a result, children with disabilities can easily become addicted to computers if their needs are not met in the real world, they are deprived of communication with peers, and they do not feel recognized and attached to themselves[32].

Ways to solve. Since communication is an important component of personality development, in the process of which social orientation, volitional

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[36] E. A. Kosova, *Metodyky ynkliuzyvnoho obuchenyia v prepodavanyy matematycheskykh y kompiuternыkh dystsyplyn* [Inclusive teaching methods in teaching mathematical and computer disciplines]. In *Dny nauky KFU im. V.Y. Vernadskoho*: *Collection of theses II scientific. conf. prof.-lecturer composition,* 2016, p. 563. [In Ukrainian].

[37] *Lohopedycheskiye trenazhery* "Delfa-142.1" [Speech therapy trainers "Delfa-142.1"]. Retrieved from: http://delfam.ru/maker.php?page=main [In Russian] 2018, June, 11.

efforts and value qualities, etc. are formed, one of the most effective ways to prevent the development of computer addiction in children with disabilities is their active involvement in various activities (extracurricular, participation in amateur groups, volunteering, etc.). An important role belongs to the teacher, who can regulate the work with ICT in school, as well as carry out explanatory work with students and their parents, emphasizing the expediency of replacing computer-based leisure with alternative activities with peers and family members.

ICT support for educating children with hearing impairments

According to the World Health Organization, in February 2017, there were 360 million people in the world suffering from disabling hearing loss, including 32 million children. It is projected that by 2030 the number of patients with irreversible forms of hearing loss will increase by 30%[38]. These data make the problem of habilitation, rehabilitation and integration into society of children with hearing impairment an urgent social problem.

A person with hearing impairments thinks more slowly, has less developed speech and cognitive activity, which is manifested in the imperfect development of logical concepts, has significant difficulties with abstract perception of reality, which significantly reduces the level of mental activity. However, the process of development of children's thinking in this nosology is adjusted by a system of purposeful technologies and methods.

In the field of educational process, researchers emphasize the exceptional importance of clarity for children with hearing impairments and empowerment. ICTs make the provision of educational information more saturated, visual and accessible due to the inclusion in the learning process of color, graphics, animation, interactivity, etc.[39,40].

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[38] *Vsemyrnaia orhanyzatsyia zdravookhranenyia. Hlukhota i poteria slukha. Informatsyonnyi biulleten* [World Health Organization. Deafness and hearing loss. News bulletin]. Retrieved from: http://www.who.int/mediacentre/factsheets/fs300/ru/ [In Russian] (2018, June, 11).

[39] T. M. *Dehtiarenko, Poshyrennia idei uprovadzhennia informatsiino-komunikatsiinykh tekhnolohii u systemu spetsialnoi osvity* [Dissemination of ideas for the introduction of information and communication technologies in the system of special education]. In *Informatsiini tekhnolohii i zasoby navchannia*, 2015. 2 (46), 11-21. Retrieved from: https://journal.iitta.gov.ua/index.php/itlt/article/download/1207/917. [In Ukrainian]. (2018, June, 11).

[40] S. I. Netosov*, Vykorystannia prohramno-aparatnoho zabezpechennia v protsesi korektsii vad slukhu ta movlennia u ditei* [The use of software and hardware in the process of correction of hearing and speech defects in children]. In *Informatsiini tekhnolohii i zasoby navchannia*, 2016, 4 (54), 72-82. Retrieved from: http://journal.iitta.gov.ua. [In Ukrainian].

Corrective and developmental importance of the use of ICT in working with children with hearing impairments is determined by the fact that digital technologies are widely used in the process of diagnosing hearing disorders – help identify problem areas of child development, help determine vocabulary, to characterize the psychomotor development of the person, which opens the way to drawing up an individual plan of corrective action on the child and provides control over the effectiveness of the proposed measures. Table 1 shows examples of software and hardware tools for diagnosing, correcting, and prevention of children's auditory and speech disorders.

Table 1. ICT tools for diagnosis and correction of deaf and dumb disorders

T i t l e	T y p e	P u r p o s e
"Longitude" ("Лонгітюд")	Expert software package	Diagnosing problem areas of the child's development and developing individual recommendations for overcoming the identified violations
"Lohomer" ("Логомер")	Program-didactic complex of interactive games and polygraphic materials	Diagnosing, individual and group classes on the correction of hearing disorders
"Live sound" ("Живий звук")	Software and hardware methodical computer complex	Organization and carrying out of correctional and compensatory training of children with functional disorders of hearing and speech origin
"Visible language" ("Видима мова")	Software and hardware complex	Formation and correction of oral speech
"Delpha" ("Дельфа")	Computer simulator	Organization and carrying out of training and correctional exercises of logopedic character, formation of oral and written speech in children with psychophysical disorders

Effective use of ICT to solve educational and correctional tasks in the process of inclusive education of children with hearing impairments should be conducted subject to such conditions:

– Taking into account the mechanism of impairment, patterns of its manifestation and the specifics of speech and thinking in students;
– Preparing a disabled child to work with ICT;
– Systematic use of ICT in the educational and correctional process;

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– Teachers training for the introduction of ICT in an inclusive environment;
– Extensive use of high-quality ICT-based visualization;
– Awareness that ICT do not replace the teacher, but act as a factor in expanding the system of didactic and corrective work in an inclusive education.

Thus, the use of ICT in the process of diagnosing hearing disorders makes it possible to identify problem areas of child development, determine the nature of hearing impairment, assess the degree of damage and auditory function, determine vocabulary, characterize the psychomotor development of a person. impact on the child and provides control over the effectiveness of the proposed measures.

ICT support for educating children with Down's syndrome

Modern ICT tools allow to some extent to compensate for disorders and allow disabled children to learn at the level of other peers. The use of modern ICTs to support the educational activities of children with disability, including computer-based technologies and multimedia programs, not only increases interest in learning, but also improves the quality of education, contributes to the systematization of existing knowledge.

A separate category of children with disability are children with Down syndrome. The syndrome is caused by a genetic abnormality, namely the presence of a unique 3rd copy of the 21st pair of chromosomes. If in an ordinary person the total number of chromosomes is 46, then in a person with Down syndrome they are 47. According to the World Health Organization, in the world such patients are born approximately one in 750. This ratio is the same in different countries, climatic zones and social layers. Almost all of them can be full members of society, with the necessary psychological, pedagogical and medical support.

Children with Down syndrome are visuals, as 80 percent of information they perceive by the eyes. Therefore, the use of multimedia programs in the education of such children can have a positive effect. In this regard, the initiative group of students of Zhytomyr secondary school №17 (Zhytomyr city, Ukraine) led by computer science teacher M. Tarasyuk have launched project "Inclusion" (initial working title "Rozumyika"). The project is aimed at development of electronic educational game resource (EEGR), which will enable children 5-8 years old with disability, in particular children with Down syndrome, to carry out mental development, explore the world around them and prepare for school using a personal computer.

Among the main criteria for the development of this EEGR, the authors identified the following:

– Ease of management;
– Unpretentious to the system requirements of the computer;
– The ability to present in the network;
– Demonstration of elements of the surrounding world and recommendations on how to behave in it;
– Focus on the development of mental and manual abilities;
– Game format.

The EEGR is presented in three language versions: English, Ukrainian and Russian. The peculiarity of the project is that children use a mouse, keyboard and touchpad to practice manual skills, gaining PC skills, knowledge of the world around them and behavior in different circumstances.

"Inclusion" has four main modules: 1. Fruits; 2. Vegetables; 3. Let's make the world a better place; 4. Getting ready for school. Each of them is aimed at developing certain skills needed in everyday life. Before each game of the module, the child has the opportunity to learn individual elements by watching videos.

Each module contains four main levels and additional bonus levels. Levels are designed so that the child gets to the next only when he passes the previous one. The number of passes of each level is unlimited. After each successful completion of the module, there is a standing ovation and an image of the winner's cup. Sound effects are very important and play a key role in a child's emotional state during play. The EEGR contains sound signals of positive and negative nature, which serve as a hint of right or wrong action.

Among the tasks presented in EEGR are the following: dragging objects with the mouse or touchpad, controlling the keyboard, solving logical problems, working with colors, shapes, typing on the keyboard on the sample for a certain time, entering numbers from the keyboard, etc. All tasks can be performed individually (on a PC or tablet) or on an interactive whiteboard, thus involving more children in learning through play. After completing the four modules, the game does not end and the child goes into a "free" game, where they develop the skills necessary for everyday social life: navigating the map, traveling by public transport, visiting the library and amusement park, garbage collecting and sorting, money earning, food shopping, etc.

Currently, the project "Inclusion" is being tested on the basis of the Zhytomyr Regional Center "Children of the Sun" (Ukraine) and the educational, socio-cultural center of St. Anthony for children with special needs in Lviv

city (Ukraine). The EEGR is used mainly as a tool of supporting the children preparation for school. However, in some cases it is also used in primary school.

It is recommended that every child who works with "Inclusion" do so with an instructor, a parent or teacher. Although it is easier for children to work with the touchpad, it is recommended to use a mouse and keyboard, which promotes better motor development.

The "Inclusion" project has been repeatedly presented at various exhibitions and competitions both in Ukraine and abroad. In the near future it is planned: completion of the created modules, making adjustments in accordance with the results of testing, spreading the geography of use of the "Inclusion" EEGR.

ICT – support for inclusive education at higher education institutions (case of math training of blind and partially sighted).

Formation and improvement of educators' competencies in the field of education of persons with disabilities is one of the priority areas of modern higher education. Based on the analysis of research in this area, it can be argued that supporting the training of people with profound visual impairments requires thorough training of educators.

The results of interviews with university educators who teach mathematics and computer science disciplines confirmed the need for the formation of competencies in the field of teaching people with visual impairments. So, to the question "Would you like to undergo advanced training in teaching mathematics and computer science to students with profound visual impairments?" 38.7% of respondents answered positively, of which 29% preferred distance learning. Another 22.6% consider professional development as a need that does not depend on their own desire, but on professional requirements. Interestingly, of the segment of those who "do not want", almost 42% believe that full-fledged education of a student with profound visual impairments in mathematical areas of training is impossible even if a special educational environment is created. At the same time, examples of the life and work of prominent blind mathematicians of the XX century (L. Pontryagin, V. Zubov, A. Vitushkin) prove the opposite[41].

[41] K. O. Kosova, *Pidhotovka vykladachiv matematychnykh dystsyplin do navchannia studentiv z hlybokymy porushenniamy zoru* [Training of teachers of mathematical disciplines to teach students with profound visual impairments]. In Nosenko Yu. H. (Ed.). *Suchasni zasoby IKT pidtrymky inkliuzyvnoho navchannia* [Modern ICT tools to support inclusive

The analysis of scientific-methodical and technical literature allowed to systematize the knowledge, skills and abilities necessary for university educators to teach mathematics and computer science disciplines to blind and partially sighted students. The researcher C. Kosova[40] developed appropriate *recommendations*:

1. **Studying of formats of mathematical and scientific notation.**
   a. Studying Nemeth Code. Nemeth Code is a Braille method for encoding mathematical and scientific notation linearly using six standard 6-dot Braille dots. Knowledge of Nemeth Code is an absolutely necessary competence of a blind student. It is desirable that an entrant with profound visual impairments study in Braille and Nemeth systems in a boarding school or inclusive school. For those who have lost their sight in adulthood, continuing education requires the development of new specifications and alternative methods of perception of educational material. This is hard work that requires the support of a group of professionals, including educators.
   b. Use of reference books and manuals on mathematical notation. A teacher of mathematics who is beginning his career in the field of teaching students with profound visual impairments needs methodological assistance in mastering Braille, Nemeth and appropriate computer formats. References on this topic can be found on the Internet.
   c. Use of on-line services to convert formulas. To work with mathematical formulas, a student with profound visual impairment should listen to the content of a formula or set of formulas using one of the screen access programs. Special software libraries are used to convert scientific text with subsequent listening. For example, the recognition of mathematical formulas in the content of a Web document is implemented by MathJax of JavaScript library, which is designed to translate mathematical notation in web browsers, and using MathML, ASCIIMathML and LaTex markup[42]. MathJax supports over 40 languages and works with all modern browsers.
2. **Preparation of available didactic materials.**
   a) Using tools for embossing, drawing and printing. The presence of devices for relief thermography significantly facilitates the development and expands the range of didactic materials. A document created in

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education] (pp. 215-230). Poltava 2018, Ukraine: PUET. [In Ukrainian].

[42] MathJax: A JavaScript display engine for mathematics that works in all browsers. Retrieved from: https://www.mathjax.org [In English] (2018, June, 06).

any text or graphic editor in "black on white" mode is printed on special paper for thermal printing. After that, the finished sheet is passed through a thermal heater. The output will be a graphic image in which the colored areas rise above the surface of the sheet (swell), forming a relief. Pros of the method: the ability to scale text and images in a text editor (for varying degrees of myopia) with subsequent printing; ensuring the sensory perception of didactic materials (black and white image plus relief). Cons: high cost of equipment and paper for thermal printing.

b) Braille printers have similar properties. These are devices for printing in Braille and tactile graphics (with and without ink). If you have a Braille printer, you do not need to have a separate thermal heater, all processes take place inside one device. Unfortunately, the high cost of printer and paper significantly reduces the availability of the method.

c) Using software to convert formats to Braille. Performing manual work on the Nemeth Code set is a process that requires special knowledge and many years of practical experience. Similar work can be done effortlessly with the help of special software formats. Among the free software for translating flatbed text in Braille, we should mention odt2braille – an extension of OpenOffice.org Writer[43]. The program has the following properties:
   - translation of OpenOffice.org Writer documents into Braille;
   - support for more than 60 languages;
   - support for 8-point Braille;
   - support for multilingual documents;
   - support for major Braille printers (over 40 items);
   - translation of mathematical formulas in Braille (Nemeth, etc.);
   - adapted settings for editing and formatting documents;
   - adapted preview and print settings.

3. **Application of multisensory approach and universal design.** The multisensory approach in teaching involves the use of several analyzers by students. Didactic materials of the multisensory type are a combination of visual, audio and kinesthetic layers in a single container. In other words, the student gets the opportunity to see, listen and tactilely feel the learning material. For a student with partial blindness, the potential for residual vision must be considered, even if the person distinguishes only color.

[43] Retrieved from: http://odt2braille.sourceforge.net [In English] (2018, June, 11).

4. **Use of assistive hardware and software**. An inclusive environment is, first of all, the organization of special conditions for the education of students with disabilities. The workplace of a student with profound visual impairments in practical classes in mathematics and computer science should be equipped with the necessary tools for independent work. Table 2 [Kosova] systematizes data on hardware and software tools for people with blindness and low vision.

Table 2. Hardware and software tools for people with blindness and low vision

Title	Description
Hardware Tools	
Braille printers	Devices for printing text and graphic information, which are designed to obtain images in the form of Braille characters and tactile graphics on a special thick paper.
Devices for relief thermography (heater and thermal paper)	Devices for applying relief on thermal paper by passing a printed sheet through a heater, where the colored areas swell, creating a relief.
Braille displays	Output devices for tactile display of text information in the form of 6-dot or 8-dot Braille characters. May contain a built-in keyboard for Braille characters.
Typhlocomputers (organizers for the blind)	Laptops with Braille display, Braille keyboard and speech synthesizer. Sometimes a QWERTY keyboard is built in instead of a Braille keyboard.
Video magnifiers	Text and graphic information output devices. The image scanned by the camera is transmitted to the monitor screen. They are equipped with a camera with zoom function.
DAISY-players	Devices for playing Daisy books in various formats. They are equipped with sound systems of prompts and navigation. The Daisy standard combines different ways of presenting material: text, illustrations and audio.
Braille E-book	Output devices (Braille displays) that are made using heated wax or electroactive polymers. Provide display of Braille characters.
Talking Tactile Tablets	Input devices that provide a link between graphic information on paper and image software. Generate a verbal response to the tactile study of image elements.
Marking for the keyboard in Braille	Volumetric contrast stickers with Braille.
Keyboards for the visually impaired	Keyboards with large contrasting symbols, mostly on a yellow background.
Scanners	Devices for recognition of printed texts and graphic images.
Software Tools	
Text-to-speech soft-	Software for sounding text on the screen (i.e., ClickHear,

ware	ClipSpeak).
Screen magnifiers	Software to enlarge a fragment of the image on the screen (i.e., MAGic, Supernova Magnifier, Virtual Magnifying Glass).
Speech recognition software	Software for language translation into text (speech-to-text software) and voice control software (i.e., Яндекс.Діктовка, RealSpeaker, Typle).
Braille translation software	Software for text translation and mathematical formulas in Braille and Braille Nemeth (i.e., Duxbury Braille Translator, Index-direct-Braille, Euler).
Optical character recognition software	Software for converting images of printed and handwritten texts into computer character format (i.e., OpenBook, OmniPage, ABBYY FineReader).
Programs for creating and reading e-books with a speech function	Software for the development of e-books in DAISY format (i.e., Easy Reader / Easy Converter, Dolphin Publisher).
Screen readers	Software that combines some or all of the above functions. Announces all events happening on the screen (i.e., JAWS, NVDA, Window-Eyes).

Equipping the visually impaired users' workplaces is complicated by the high cost of special equipment and software. It is recommended to use free software and general purpose equipment where it is possible to do without assistive technologies. The minimum set of hardware and software that provide a workplace for a visually impaired student includes:

– Stationary workstation or laptop;
– Audio system (microphone and headphones);
– Scanner;
– Program for scanning and recognition of flatbed texts;
– Screen access program (NVDA, Emacspeak or other free applications);
– Internet access.

Based on the analysis of best practices, it is possible to formulate requirements for knowledge, skills and abilities necessary for teachers to organize and support inclusive education for people with profound visual impairments. Therefore, a teacher of mathematical disciplines should:

Know: principles of mathematical notation in Braille and Nemeth formats; methods of converting formats to TeX, LaTeX, Nemeth ASCII Braille, Nemeth; methods of developing available didactic materials in mathematical disciplines; principles of universal design and multisensory learning; basic hardware and software tools to support the learning of students with profound visual impairments.

Be able to: use reference resources for formatting mathematical notation in TeX, LaTeX, Nemeth ASCII Braille, Nemeth; use on-line services to convert formulas; create accessible teaching materials manually and with the help of information technology; develop and conduct lectures and practical classes using a multi-sensory approach; use adaptive and assistive technologies and software to organize training for visually impaired students.

Mastering the system of knowledge, skills and abilities to teach mathematics to the target category of students will increase the overall competence of teachers and form the necessary professional base for mathematics and technical faculties to teach students with profound visual impairments.

Conclusions

The development and implementation of the principles of democracy, humanism and openness in education contributes to social progress and comprehensive intellectual and spiritual development of the individual. Responding to the needs of the individual and society as a whole brings us closer to the establishment of the educational paradigm, which is the need to ensure equal access to quality education for each individual, regardless of his / her features and limitations.

In the conditions of computer-oriented learning environment and widespread use of ICT in leisure, the problem of students' health is relevant nowadays. This problem is especially acute for educators working in inclusive education, with children with disabilities, as the health measures of these students will be different from those applied to children with typical development.

All educators, regardless of the level of education at which they work (preschool, general or higher education), need to master the system of knowledge, skills and abilities on the specifics of teaching students with different types of disorders. Subject to a pedagogically balanced approach ICT can be a significant factor in positive change, as their use allows to attract more participants in education at lower cost, meet the requirements of social justice for all groups, opens wide prospects for improving the quality of education, its accessibility for people with disabilities, promoting equal access to information and educational services, full and fruitful social integration.

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